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Research article

The influence of curricular physical activities on the values of body balance indices in university students

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ABSTRACT: The investigation analyzes the effect of specific motor structures on the indicators of the static and dynamic balance of the students of Dunărea de Jos University in Galați (99 boys aged = 20.29 years, body weight = 84.17 kg, height = 180.08 cm, respectively 96 girls aged = 20.09 years, mass bodyweight = 60.88 kg, height = 164.73 cm. The members of the tested group have no concerns related to performance sports or physical activities as a lifestyle. The application of the experimental program was made during the 28 weeks of the academic year 2018-2019, with 3 distinct moments: T1 / initial at the beginning of the 1st semester, T2 / intermediate before the winter break, T3 / final at the end of the academic year. The battery of tests included 7 tests: One leg standing test with eyes closed (sec), Stork test (sec), Flamingo test (number of attempts), Bass test (points), Functional reach test (cm), Walk and turn field sobriety test (errors) and Fukuda test (degrees). The results of the Anova parametric test with repeated measurements revealed statistically significant values of F associated with critical thresholds ($p < 0.05$), and the values of Partial eta squared (η^2_p) indicate strong influences of the proposed program on test performance in most cases, both at the level of the whole group and also for each gender. It should be noted that the performance improvements are greater in the first part of the study (differences between initial and intermediate tests, with $p < 0.05$), compared to those in semester 2 (differences between intermediate and final tests), which can be explained by the adaptation to the planned and applied stimuli, so modifying or changing their dosage is necessary in order to have a better chance of improving the results. Significant differences are confirmed for most tests of both genders ($p < 0.05$), with exceptions being the Walk and turn field sobriety test for boys (at the level of the difference between intermediate and final testing) and the Fukuda test for both genders (for differences between initial and intermediate testing). However, the results should be viewed with caution, the low level of physical training and sedentary behavior of most students providing the premises for such progress, even with a single weekly physical activity.

Keywords: *students, balance, postural stability, physical exercise, progress, motor skills*

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INTRODUCTION

The vestibular, visual and proprioceptive systems play a major role in the manifestation of static and dynamic balance, affecting these senses / analyzers generating poor performance of postural stability (1). As we age, a good interaction between the visual and vestibular systems must be harnessed to maintain balance. There is a suppression of the soleus H reflex by the vestibular system, but for the elderly the visual input is necessary for suppression, according to (2).

A study made on a group of Chinese children (3-6 years old) in Beijing showed that static, dynamic balance and proprioception have different values at different ages, and static balance and proprioception are also different depending on gender. Static and dynamic equilibrium are positively and significantly correlated with GMD / gross motor

development, but no significant associations are found between BMI and balance, according to (3). Cervical proprioception provides additional information in addition to those provided by vestibular and auditory analyzers. The research conducted by (4) finds associations between kinesthetic information at the level of the neck and the balance on the non-dominant / non-preferred leg of Taekwondo fighters, as an adaptation that is not present in the untrained people.

The center of pressure (CoP) provides important data in assessing the postural stability, being the point at which the resulting GRF / ground reaction force is applied to the body. The antero-posterior component (AP) of GRF is more involved in maintaining balance in young people than in the elderly, according to (5).

The quantification of balance problems for people who have suffered from subacute stroke through the Fukuda test is done by (6,7). The instrumented version of this test can be used for anyone with postural deficiencies, not just those who have suffered a stroke. The response of stroke patients with balance problems to challenging virtual environments is analyzed by (8). Static and dynamic posturography testing, with eyes closed and open, showed that the dynamic variant (in more difficult conditions) generated greater posture disorders in those with stroke, than in the case of healthy people.

Balance problems are reported in subjects with type 2 diabetes, postural control being affected by stimulation of the vestibular system and disruption of the proprioceptive system. Anterior-posterior / AP balance is significantly altered by open-eyes unstable surface and stable closed-eyes testing, according to (9). Musculoskeletal problems (especially with the manifestation of scoliosis) are reported in 50% of patients with type 1 neorofibromatosis (FB1), according to (10), and melatonin has a therapeutic role in visual analyzer disorders in the elderly people (11).

Investigating balance values can provide information about the presence of CLBP / chronic low back pain. Those diagnosed with these problems have lower scores on the static / one leg standing balance assessment tests and higher CoP / center of pressure oscillations for dynamic balance (12). Balance is also influenced by postural deviations. The study conducted by (13) identifies these problems chronologically (students in the range of grades 1-5), head, spine, shoulders, chest, abdomen and lower limbs.

The effects of trazodone (medicine for anxiety and depression) on balance through the Field sobriety test are being studied by (14). Even if the mean test performance values do not decrease significantly after 2 hours after trazodone administration, there are individual cases of poorer results in the evaluated group.

The effectiveness of physical exercise in alleviating the problems caused by type 2 diabetes is highlighted by (15). Active women have lower BMI and high cardiovascular resistance, and the deterioration of the tiptoe dynamic balance impairments is associated with the presence of inflammatory conditions, poor glycemic control and hypercoagulation phenomena. The role of motor structures associated with physical therapy and physical education in improving joint problems, rehabilitating motor deficiencies, increasing the range of motion and installing well-being are highlighted by (16–20).

Impaired static and dynamic balance for young athletes (18-25 years old) with a history of chronic ankle sprain injuries, involved in athletic sports (track and field sports) are reported by (21), the same problems being identified for foot proprioception. The warning on the neglect of the process of developing the balance, through programs specific to the different branches of sports (football) is made by (22). The balance is decisive in the execution of the complex technique and the avoidance of potential injuries, and its optimization educates the sensorimotor skills necessary for top performance.

Correct posture in sports has the role of maintaining static and dynamic balance, and an objective and fast postural assessment, through video rasterstereography, for athletes and sedentary people is proposed by (23).

The need for balance differs depending on the specifics of each sport, but the values of static and dynamic balance between those who do individual sports and those involved

in team sports (team and individual athletes) are still statistically insignificant, according to (24). The balance in the pubertal stage, correlated with the dominance of the cerebral hemispheres has a role in guiding children in various tests in athletics (25,26), and the assimilation and application of technical procedures in volleyball requires a good balance (27). Balance problems are a factor that can lead to injuries and poor performance in sports (football), according to (28). The author does not find significant differences between genders for static and dynamic balance tests, but they are significant between football and sedentary groups at the level of university students, so involvement in physical activities optimizes the values of balance.

The types of tasks influence the balance of the body. For healthy seniors, it has been found that dual motor task with cognitive demands have caused static balance disturbances due to the focus on solving challenging dual motor tasks or dual motor task with cognitive demands. (29). The balance is also affected by obesity. Physical activity in school curricula alone is not enough to effectively combat this problem, according to (30). The declining involvement of young people in Montenegro (8th grade) in physical activity, with major problems in BMI values, is reported by (31), which finds that 37.1% of the girls and 34.2% of the boys are overweight and obese. Sports activities contribute to the social integration of the participants, and body balance is also important in the sports activities of people with disabilities, for example in the game of wheelchair tennis (32,33)

People with forward head posture have higher movements and swinging speed both in the closed and open eyes position, on a hard surface and on an unstable surface/sponge. The position generates significant differences only for the evaluation of the static balance, not for the dynamic one, according to (34).

The importance of the visual analyzer in maintaining static and dynamic balance for young ballet dancers in Poland is highlighted by (35). The performance on the static balance test (30 sec) was reduced for the closed-eyed version, and the older ones (18 years old) have superior performance and are more stable than the 14-year-olds. No differences were found for dynamic equilibrium in rotational motion when the support base is low.

The usefulness of the one leg standing, as a test for assessing balance and diagnosing symptoms associated with musculoskeletal disabilities, for the elderly is highlighted by (36). The short time to maintain balance signals and predicts negative events and problems: illness, falls, decreased involvement in daily activities, fragility, etc.

MATERIAL AND METHOD

The aim of the research is the progressive improvement of the indicators of static and dynamic balance, at the level of university students, by using specific motor structures, within the physical education lessons.

Working hypotheses:

H1: We assumed that the implementation of the experimental program will generate significant improvements of the equilibrium values, at the level of the whole group.

H2: We consider that they are prerequisites for obtaining significant differences between the initial, intermediate and final tests, separately by gender (male and female).

Participants

The investigated subjects are 195 students of the University of the Lower Danube in Galați, of which 99 boys (age = 20.29 years, body weight = 84.17 kg, height = 180.08 cm) and 96 girls (age = 20.09 years, body weight = 60.88 kg, height = 164.73 cm) (with various specializations: Dentistry, Computer Science, Automation, Applied Electrical and Electronic Engineering), all included in years 1 and 2 of study / license. None of the study participants are engaged in high-performance physical activities, so the dynamics of the results on the applied test battery cannot be influenced by this aspect. All participants had favorable medical recommendations regarding the availability of physical effort exertion and were instructed about the purpose of the research.

Procedures

The research took place during the 2018-2019 academic year, before the onset of the Covid 19 pandemic. Subjects were tested with a set of 7 static and dynamic balance assessment tests at 3 distinct times: at the beginning of semester I (initial testing), before winter break (intermediate testing), and at the end of semester 2 (final testing). The tests used are: One leg standing with eyes closed (sec), Stork (sec), Flamingo (number of attempts), Bass (points), Functional reach (cm), Walk and turn field sobriety (errors) and Fukuda (degrees), their description and quantification being analyzed by the sources (37–39). The whole group participated in the physical activities related to the physical education lessons (28 weeks x 1 activity of 2 hours per week). The duration of the application of the structures intended to influence the balance parameters varied between 15-25 minutes in each lesson, and the efforts were individualized, in accordance with the individual motor availability. The variants proposed in the experimental syllabus and applied during the lessons are summarized in Table 1, separately for static and dynamic balance. The students who did not regularly attend classes were excluded from the study in order not to negatively influence the results. The current study presents the performances of the whole group, but also the dynamics of the performances at the 3 tests, separately for girls and boys. No comparative statistical analyzes of gender or BMI performance have been performed, and these data will be presented in future papers.

The rules for organizing scientific research and academic writing have been observed, according to (40).

The statistical – mathematical analysis:

The statistical calculation was performed using SPSS software (version 24). Anova parametric techniques with repeated measurements, Maucly's Test of Sphericity with Greenhouse-Geisser correction factors (for $\varepsilon < 0.75$) and Huynh-Feldt (for $\varepsilon > 0.75$), calculation of F values, significance thresholds (p / sig.) and a Partial eta squared (η^2_p). At the level of the whole group and separated by genres, the indicators of the central trend for the 3 test moments were calculated, highlighting the differences between them and the related significance thresholds, using the Bonferroni correction factor (41–44). The dynamics of the average values of the whole group, for all these tests and the comparison between the average results by genres were represented graphically with the help of Microsoft Excel and Microsoft Word.

RESULTS

The processed data were summarized in Tables 2-5, and the average values in the balance tests (for the whole group and comparative by gender for each of the 3 test moments) were represented in Graphs 1-8.

The results of the Anova test with repeated measurements at the level of the whole group show for all 7 tests significant values of F ($p < 0.05$), according to table 2. The results of Partial eta squared (η^2_p) indicate a strong influence of the proposed program on the test values, with very high values for Functional reach test (where 71% of the variance is attributed to the independent variable / experimental program), Stork test (where 59.5% of the variance is explained by the influence of the program), respectively Flamingo test and Bass test (at both 50.9% of variance is due to the applied program). The least influence of the applied exercises is found for the Fukuda test (only 4.5% of the variance is due to the planned physical activities).

Table 3 analyzes the results of the Anova test with repeated measurements for each genre. Only statistically significant values of F ($p < 0.05$) are found in total. The strongest influences of the proposed program are for Functional reach test in boys (82.6% of the variance is attributed to the independent variable) and girls (with 63.4% of variance), Bass test in girls (81% of variance is determined by the applied program) and boys (with 77.5% of the variance), Stork test in girls (68.7% of the variance is attributed to the program). The weakest influence is found for the Walk and turn field sobriety test in boys (15.6% of the

variance is attributed to the effect of physical activity) and girls (with 14.6% of the variance), respectively Fukuda test in girls (only 5.8% of the variance of this sample is explained by the effect of the program).

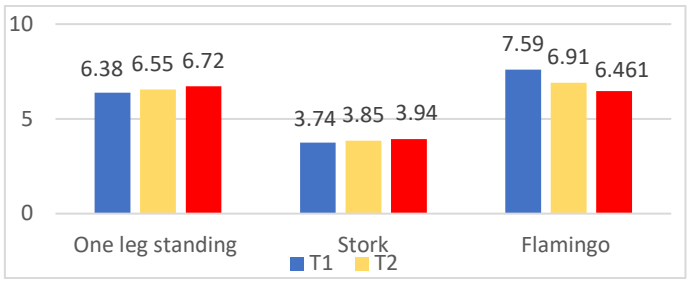

Fig. 1 Dynamics of average values of results in static balance tests (whole group)

Graphs 1 and 2 show the dynamics of the average values of the whole batch for the initial / T1, intermediate /T2 and final/T3 tests, for the evaluation of the static and dynamic balance, respectively. It is noted that for the whole set of tests there is progress from one stage to another, the differences between them and the related significance thresholds are summarized in Table 4. Between the initial test / T1 and the final / T3 significant progress is found for all 7 tests, which shows that the accumulations in the lessons allowed the improvement of the performances in the balance tests throughout the year ($p < 0.05$). For all static balance tests and for the first 2 dynamic balance tests (Bass test and Functional reach test) significant differences are also reported between the initial / T1 test and the intermediate / T2 test, respectively between the intermediate / T2 and the final / T3 test. However, better progress is reported, resulting in larger differences between T1 and T2, compared to the differences between T2 and T3. This aspect supports higher accumulations for these tests during the first semester, followed by slightly lower progress in the second semester, possibly as a reaction of adaptation to the planned exercises.

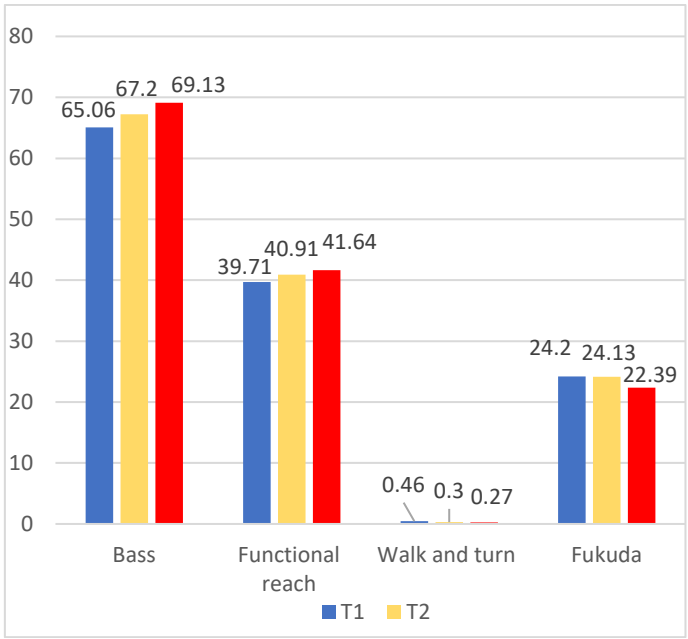

Fig.2 Dynamics of average values of results in dynamic balance tests (whole batch)

The results of the last 2 dynamic balance tests no longer fall into this pattern of evolution. For the Walk and turn field sobriety test there is significant progress only for the first semester (T1-T2), instead for the 2nd semester there is an insignificant progress ($p = 0.250$, value> 0.05) so at the level of the whole group there is the capping of accumulations for this test. For the Fukuda test the situation is reversed as accumulations per semester (for

the first semester there is a weak and insignificant progress, with p = 1.00, value > 0.05, but the situation is remedied in semester 2, when the difference between T2 and T3 is statistically significant, with p = 0.010, value <0.05.

Graphs 3-4 show the evolution of the average performances of the two groups for the initial tests at the static and dynamic balance tests, graphs 5-6 the same dependent variables for the intermediate tests / T2, and graphs 7-8 the dynamics of the performances of the 2 groups for the final tests / T3.

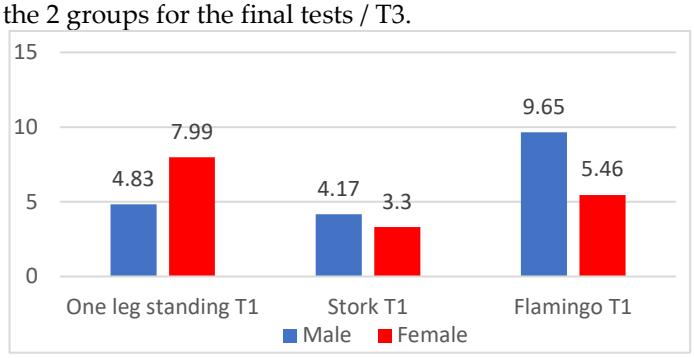

Fig. 3 Gender comparison of mean values in static balance tests (initial assessment / T1)

The initial tests to assess the static balance show the superiority of the girls for 2 tests: One leg standing, with almost double values of maintaining position and Flamingo, where they have a lower number of attempts (and implicitly falls, to total the 60 sec standing). However, the boys had slightly higher average results on the Stork test.

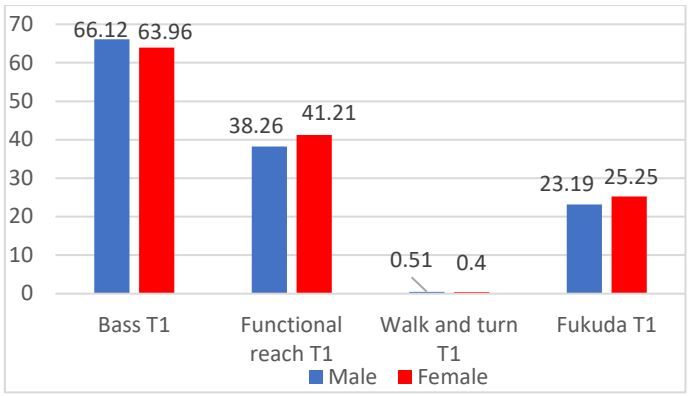

Fig. 4 Gender comparison of average values in dynamic balance tests (initial assessment / T1)

Initial tests to assess the dynamic balance show that boys perform slightly better on the Bass test and the Fukuda test (fewer degrees of rotation around the body axis), and that girls score better on the Functional reach test (possibly also due to their flexibility) and the Walk and turn field sobriety test (where they make fewer mistakes in covering the distance on the line drawn on the ground).

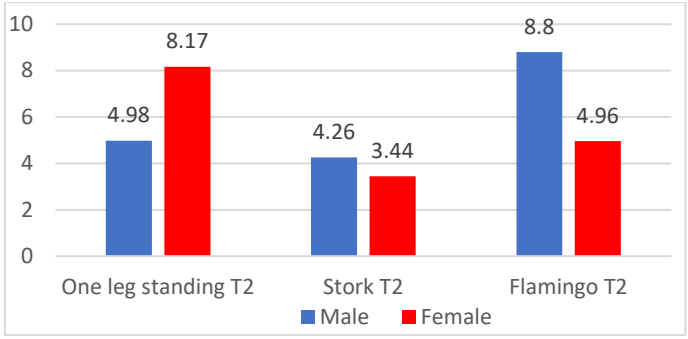

Fig. 5 Gender comparison of average values in static balance tests (mid-term evaluation / T2)

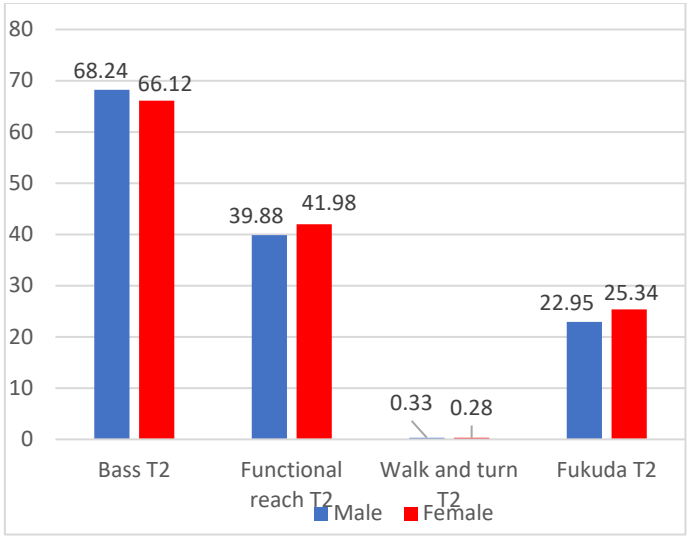

Fig. 6 Gender comparison of average values in dynamic balance tests (mid-term evaluation / T2)

Graphs 5 and 6 show the value of the average performances for the balance tests, gender based in the mid-term evaluation/T2 tests. It is observed that the values are improved compared to the first assessment for each gender, with statistically significant values ($p < 0.05$), the only test where the progress is not significant is Fukuda, in girls there is even a regression ($p = 1$, value> 0.05) and for boys the progress is weak ($p = 0.232$, value> 0.05), according to the data in tables 5-6.

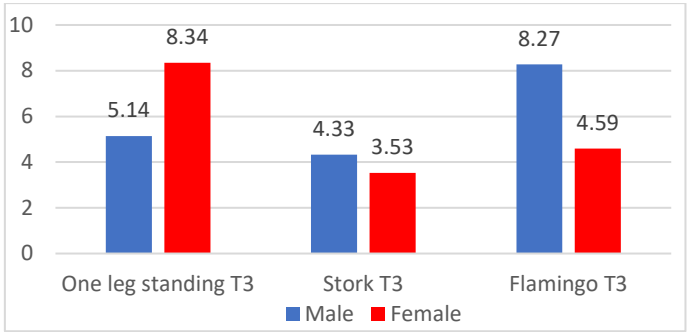

Fig. 7 Gender comparison of average values in static balance tests (final evaluation / T3)

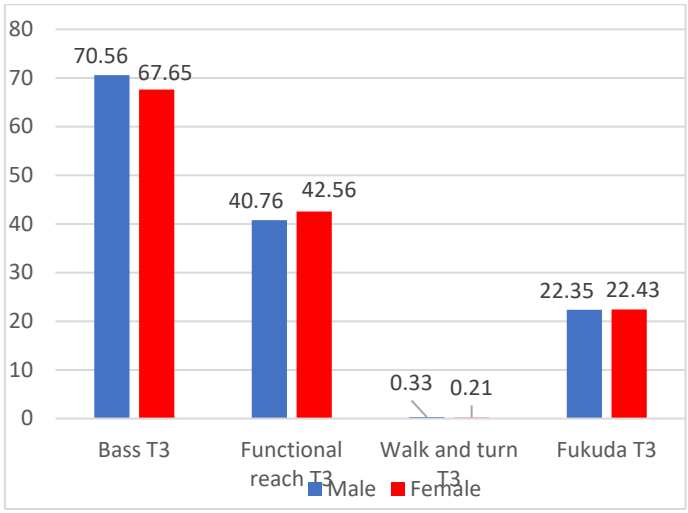

Fig. 8 Gender comparison of average values in dynamic balance tests (final assessment / T3)

Graphs 7 and 8 show the values of the average performance for the balance tests at the final/T3 tests. Although the progress between intermediate and final tests is more limited than between initial and intermediate tests, the thresholds for these differences are in most cases still significant ($p < 0.05$). The only exception is the Walk and turn test, where there is a stagnation of performance, with the absence of the minimum progress rate ($p = 1$, value> 0.05). The differences between the initial / T1 and final / T3 test averages are entirely significant for both genders ($p < 0.05$), which confirms the applicability and the practical utility of the proposed program.

Table 1 – Types of exercises included in the experimental program

Motor structures proposed for the development of static balance
• Standing, stand on tiptoes and hold the position, with the palms together at the level of the chest. • From sitting on one leg, swinging the other leg back and forth (sagittally). Same with frontal swing. Same with rotating the knee outward and moving the arms in various directions. Same with rotating the outstretched foot forward from the ankle joint. • From standing on one leg, with the other one raised and supported behind the knee of the supporting leg (popliteal space), maintaining the position with the arms outstretched sideways or vertically. • From standing on one leg with the arms sideways, successively lifting one knee and back, without touching the ground with the foot. Same with reversing the support leg. Same with raising the knee with the palms, up to the abdomen and holding position for 5-10 sec. • From standing on one leg, rotating with the tip of the other leg pointed to the ground, the knee is slightly flexed. • From standing facing the wall or fixed ladder / appliance, lifting one knee, unbalancing forward and balancing by placing your palms on the wall / ladder. Same with twisting the torso right / left and placing one hand on the wall. • Making the scale on one leg (low, medium or high). Same with twisting the torso right / left. • Maintaining balance by sitting on a medicine / basketball / football ball, with your palms on the wall, then raising your palms off the wall. • Forward and lateral bends, with easy lifting of the outstretched foot (back or side) from the ground and maintaining the position for 5-20 sec. • Tiptoes lifts on a support (bench-step) with maintaining the position for 5-10 seconds and return. The same goes for climbing on the bench and maintaining balance only on the tip of one leg.
Motor structures proposed for the development of dynamic balance
• Running in different directions with bypassing obstacles / poles, balancing a tennis ball on a racket. Same with keeping a cane upright balanced on the palm. • Lateral jumps over a line or cord placed on the ground, with detachment on one leg and landing on the other. The same with landing on the detachment leg and maintaining balance for 2-3 sec. • From standing on one leg facing 5-6 bottles arranged in an arc, raising the other leg and successively touching the top of the bottles, then in the opposite direction with the other leg. The same goes for placing a glass on each bottle after touching it with your foot. • Moving on a line with an object / book held on the head in balance. The same goes for walking on a winding line or bypassing obstacles. • Lateral jumps on one leg from step to step, while maintaining balance. Same with turning the body to 90^0 for each jump. • Jumping over obstacles with body rotation in the air and landing on one foot, in circles or on clearly marked areas. • Move in pairs (one after another), keeping in balance a stick placed on the shoulders of the partners on one side right / left. • Moving between poles, keeping 2 balls in balance on the lateral outstretched hands. • Exercises performed on a special balance ball (bosu balance trainer): squats, pushups, lunges, maintaining the position of plank, etc. • Jumping from the ground on the gym bench and landing in support on one leg, maintaining the balance for 5-20 seconds, then return and the action resumes for the other leg.

ANOVA results with repeated measurements whole group (N=195)

Test	Maucly's Test of Sphericity		Correction factor	df	Error df	F	Sig.	Partial eta squared (η^2_p)
	Sig.	ε						
One leg standing	.000	.682	Greenhouse-Geisser	1.363	264.491	163.095	.000	.457
Stork	.000	.700	Greenhouse-Geisser	1.400	271.527	284.856	.000	.595
Flamingo	.000	.738	Greenhouse-Geisser	1.475	286.156	200.799	.000	.509
Bass	.000	.738	Greenhouse-Geisser	1.475	286.156	200.799	.000	.509
Functional reach	.000	.763	Huynh-Feldt	1.527	296.219	474.557	.000	.710
Walk and turn	.000	.819	Huynh-Feldt	1.639	317.962	33.365	.000	.147
Fukuda	.000	.555	Greenhouse-Geisser	1.111	215.449	9.128	.002	.045

Table 3 – ANOVA results with repeated measurements by gender (male / N=99); (female / N=96)

Test	**Lot**	**Maucly's Test of Sphericity**		**Correction factor**	**df**	**Error df**	**F**	**Sig.**	**Partial eta squared (η^2_p)**
		Sig.	**ε**						
One leg standing	M	.000	.677	Greenhouse-Geisser	1.354	132.645	76.888	.000	.440
	F	.000	.676	Greenhouse-Geisser	1.351	128.367	85.899	.000	.475
Stork	M	.000	.612	Greenhouse-Geisser	1.223	119.887	100.432	.000	.506
	F	.000	.789	Huynh-Feldt	1.578	149.935	208.817	.000	.687
Flamingo	M	.000	.739	Greenhouse-Geisser	1.477	144.759	133.219	.000	.576
	F	.000	.783	Huynh-Feldt	1.565	148.702	78.111	.000	.451
Bass	M	.005	.922	Huynh-Feldt	1.843	180.641	338.172	.000	.775
	F	.000	.835	Huynh-Feldt	1.670	158.627	403.702	.000	.810
Functional reach	M	.000	.836	Huynh-Feldt	1.671	163.775	466.817	.000	.826
	F	.000	.851	Huynh-Feldt	1.702	161.728	164.825	.000	.634
Walk and turn	M	.000	.816	Huynh-Feldt	1.633	160.002	18.092	.000	.156
	F	.000	.807	Huynh-Feldt	1.613	153.239	16.220	.000	.146
Fukuda	M	.391	1	Sphericity Assumed	2	196	32.980	.000	.252
	F	.000	.537	Greenhouse-Geisser	1.075	102.079	5.889	.015	.058

Table 4 – The results of the differences in the mean values of the whole group (N=195)

Test	**Mean**	**Std. deviation**	**Std. error**	**T1-T2**	**Sig.[b]**	**T1-T3**	**Sig.[b]**	**T2-T3**	**Sig.[b]**
One leg standing T1	6.3859	6.07458	.435	-.170*	.000	-.338*	.000	-.168*	.000
One leg standing T2	6.5561	6.09961	.437						
One leg standing T3	6.7241	6.12893	.439						
Stork T1	3.7437	3.37345	.242	-.115*	.000	-.199*	.000	-.083*	.000
Stork T2	3.8590	3.37198	.241						
Stork T3	3.9425	3.37013	.241						
Flamingo T1	7.5949	4.46463	.320	.677*	.000	1.133*	.000	.456*	.000
Flamingo T2	6.9179	4.35694	.312						
Flamingo T3	6.4615	4.28282	.307						
Bass T1	65.0615	13.49938	.967	-2.138*	.000	-4.072*	.000	-1.933*	.000
Bass T2	67.2000	13.61571	.975						
Bass T3	69.1333	13.84720	.992						
Functional reach T1	39.7168	6.74373	.483	-1.201*	.000	-1.932*	.000	-.731*	.000
Functional reach T2	40.9179	6.53270	.468						
Functional reach T3	41.6487	6.31811	.452						
Walk and turn T1	.4615	.72674	.052	.154*	.000	.185*	.000	.031	.250
Walk and turn T2	.3077	.55398	.040						
Walk and turn T3	.2769	.57007	.041						
Fukuda T1	24.2051	26.92944	1.928	.072	1.000	1.810*	.000	1.738*	.010
Fukuda T2	24.1333	27.82053	1.992						
Fukuda T3	22.3949	26.15385	1.873						

*. The mean difference is significant at the .05 level.
b. Adjustment for multiple comparisons: Bonferroni.

Table 5 – Results of differences in mean values male (N=99)

Test	Mean	Std. deviation	Std. error	T1-T2	Sig.[b]	T1-T3	Sig.[b]	T2-T3	Sig.[b]
One leg standing T1	4.8305	3.37245	.339	-.157*	.000	-.318*	.000	-.161*	.000
One leg standing T2	4.9878	3.41993	.344						
One leg standing T3	5.1489	3.45799	.348						
Stork T1	4.1704	3.99939	.402	-.095*	.000	-.164*	.000	-.069*	.000
Stork T2	4.2651	4.00559	.403						
Stork T3	4.3340	4.00868	.403						
Flamingo T1	9.6566	4.37097	.439	.848*	.000	1.384*	.000	.535*	.000
Flamingo T2	8.8081	4.49189	.451						
Flamingo T3	8.2727	4.59773	.462						
Bass T1	66.1212	12.13972	1.220	-2.121*	.000	-4.445*	.000	-2.323*	.000
Bass T2	68.2424	12.31980	1.238						
Bass T3	70.5657	12.90085	1.297						
Functional reach T1	38.2677	7.58399	.762	-1.616*	.000	-2.495*	.000	-.879*	.000
Functional reach T2	39.8838	7.40099	.744						
Functional reach T3	40.7626	6.95772	.699						
Walk and turn T1	.5152	.70514	.071	.182*	.000	.182*	.000	.000	1.000
Walk and turn T2	.3333	.53452	.054						
Walk and turn T3	.3333	.58902	.059						
Fukuda T1	23.1919	25.69471	2.582	.232	.064	.838*	.000	.606*	.000
Fukuda T2	22.9596	25.86461	2.599						
Fukuda T3	22.3535	25.11293	2.524						

*. The mean difference is significant at the .05 level.
b. Adjustment for multiple comparisons: Bonferroni.

Table 6 – Results of differences in mean values female (N=96)

Test	Mean	Std. deviation	Std. error	T1-T2	Sig.[b]	T1-T3	Sig.[b]	T2-T3	Sig.[b]
One leg standing T1	7.9900	7.64858	.781	-.183*	.000	-.358*	.000	-.175*	.000
One leg standing T2	8.1734	7.66193	.782						
One leg standing T3	8.3484	7.68908	.785						
Stork T1	3.3038	2.52069	.257	-.137*	.000	-.235*	.000	-.098*	.000
Stork T2	3.4403	2.51374	.257						
Stork T3	3.5388	2.50844	.256						
Flamingo T1	5.4687	3.46396	.354	.500*	.000	.875*	.000	.375*	.000
Flamingo T2	4.9688	3.22312	.329						
Flamingo T3	4.5938	2.95075	.301						
Bass T1	63.9687	14.75588	1.506	-2.156*	.000	-3.688*	.000	-1.531*	.000
Bass T2	66.1250	14.82264	1.513						
Bass T3	67.6562	14.68105	1.498						
Functional reach T1	41.2113	5.39371	.550	-.773*	.000	-1.351*	.000	-.578*	.000
Functional reach T2	41.9844	5.32741	.544						
Functional reach T3	42.5625	5.46965	.558						
Walk and turn T1	.4063	.74802	.076	.125*	.001	.188*	.000	.063*	.041
Walk and turn T2	.2812	.57497	.059						
Walk and turn T3	.2188	.54682	.056						
Fukuda T1	25.2500	28.24330	2.883	-.094	1.000	2.813*	.000	2.906*	.044
Fukuda T2	25.3437	29.79150	3.041						
Fukuda T3	22.4375	27.31794	2.788						

*. The mean difference is significant at the .05 level.
b. Adjustment for multiple comparisons: Bonferroni.

DISCUSSION

The literature presents numerous studies that highlight the role of physical activity in optimizing postural control for normal subjects and those with various disabilities.
A study in young adults (x = 21 years) indicates that subjects who have moderate to vigorous physical activity have better balance values (the balance area is smaller). Women have better scores than men, and the open-eyed version outperforms the closed-eyed one. Reducing sedentary behavior can improve the static balance (45). The assessment of balance according to gender and age ranges is performed by (46). The 20-49 age range has similar performances, but they decrease after 50 years. Men perform slightly better than women.
High-intensity exercise generates a decrease in one leg standing test immediately after exercise, and 15 minutes after exercise there is an improvement in balance, according to (47). For the elderly, engaging in a variety of physical activities (swimming, dancing, tennis, badminton, netball, cricket, along with ice skating) are options with positive effects on health, improving balance and preventing falls (48). An exercise program for the elderly (6 weeks x 2 workouts / week), focused on flexibility, balance and strength of the lower limbs is proposed and applied by (49). Positive effects are found: limitation of the postural balance in the antero-posterior / AP direction with significant progress, associated with the decrease of the fear of falling, due to the improvement of the general posture.
Balance development programs should be applied differently, depending on age. For 6-12 year olds, using programs for 8 weeks demonstrates that the DIM / direct instructional model (in which students work in isolation / individually) is more effective in the 7-8 year range, while the TGM / tactical games model is viable for students over the age of 8, according to (50). The comparison of fitness values obtained in public schools vs. the private ones for children aged (7-11 years old) is made by (51). No significant differences were obtained in the Flamingo test (11.88 for public school and 11.66 for private school).
An unexpected result related to the balance of young football players is obtained by (52). No significant differences were found between pre-workout and post-workout balance values, so accumulated fatigue does not adversely affect performance on balance tests.
Applying a balance development program (6 weeks x 2 sessions / week x 30 minutes) for children in Brazil aged (6-9 years) improves plantar support (the surface of the support for the CoP), especially for the dominant leg (53). The use of static Yoga asanas for college students (18-25 years), by applying a program of 6 weeks x 3 workouts / week x 30min / session is proposed by (54), being noted improvements in muscle strength and static balance assessed by the Stork balance test.
Skiing used for 5 days - for people who have not used it before - successfully contributes to improving the dynamic balance, but also to maintaining the static one on the AP / antero-posterior direction (55). The effectiveness of Ai Chi / Ai Chi aquatic therapy and its combination with dry land therapy to improve static and dynamic balance for people with stroke (more exposed to the risk of falling) are identified by (56).
Strong associations between the shooting abilities of Indian snipers and the performance of the Stork static balance test are reported by (57).
The effect of WBV (whole body vibration) on the static and dynamic balance of healthy students, assessed by the flamingo test and the Y balance test is studied by (58). Significant improvements in balance are observed in the final tests, with WBV being useful and recommended for optimizing balance in the elderly and athletes.
The implementation of a dynamic core exercise program (DCE / dynamic core exercise) in the warm-up part of the physical education lessons, for 6 weeks, for children aged 10-11 has beneficial and significant effects on physical parameters, flexibility and balance, according to (59). The application of a program that requires visual analyzer / image training, for healthy students (x = 20 years), applied for 2 weeks x 10 min./day did not generate significant improvements in the values of static and dynamic balance, according to (60).

Improving static and dynamic balance for people with flat foot, using a combination of SMT (sensorimotor training) and SFE (short foot exercises) is proposed by (61), which by applying this variant 6 weeks x 3 sessions / week finds the efficiency in optimizing the balance.

Higher values of balance for male college students in the US compared to women, both in the static assessment on a stable / firm surface and unstable / dynamic, with eyes open and closed, women having almost 48% more body balance (62). However, the small number of subjects (16) is a limiting factor in generalizing these results.

The limits of balance development exercises for children with severe deafness are highlighted by (63). An exercise program for static balance improved performance only for standing time on one leg, but the degree of body balance was not significantly affected.

A study made on college students showed that those with ADD / ADHD performed poorly on balance tests (by measuring the median-lateral balance of the torso), when the level of awareness is low, but the results are better if the level awareness is high, according to (64).

A way to improve balance for those who sit / siting postural balance about 10 hours a day is proposed by (65), which uses a Linear Actuator and MR Dampe. The device offers combined exercises, strengthening the back muscles too weak and relaxing the contracted one, regulating the muscular activity of the trunk between the dominant and the non-dominant part.

The analysis of values in Eurofit tests, including static balance (Flamingo test), in 7-12 year old students with visual impairment shows their scores are lower compared to subjects without this disability. However, those with SVI (severe visual impairment) have better balance scores than those with MVI (moderate visual impairment), one explanation being that peripheral vision is more important in maintaining balance than the quality of central vision, according to (66). Also in the Flamingo test, a similar study of young people in Kosovo and Montenegro (13-15) years showed similar values of the results between the sexes, according to (67).

The sports practiced influence the manifestation of balance. Comparison between the values of static and dynamic balance of football players vs. handball in Turkey (15-18 years old) does not identify significant differences, due to the similarity of agility movements / changes of direction in the 2 sports. However, for football, significant differences are reported between the dynamic right / left balance, due to the asymmetrical development of the muscular strength of the dominant leg, which in handball is not found, according to (68). A 6-week study of athletes in Iran (based on plyometric training, strength exercises, but especially mixed exercises) demonstrated the effectiveness of such a program in improving dynamic balance and reducing the chances of injury, according to (69). The investigation made by (70) on Turkish athletes (x = 13 years old) involved in various fields and events (karate, gymnastics, judo, table tennis, basketball, volleyball, handball, tennis) showed that the balance improves with age, and the increase in time spent for workouts optimize dynamic balance. Higher values of those who do individual sports are found for balance tests, but they are weaker in reaction times, where the better values belong to those who practice team sports.

Significant differences in the manifestation of static balance are reported between women dancers over 7 years seniority and non-dancers (18-23 years), both for the dominant leg and for the non-dominant leg. The non-dancer group loses their balance more easily, so dance therapy is effective in preventing falls and good postural control, according to (71). Dancer women have fewer anterior cruciate ligament injury rates compared to active but non-dancing ones. The dancers obtain superior performances in some balance tests, but for the Bass test the results of the 2 studied groups are similar (72).

However, balance tests are not useful for highlighting basketball playing ability. The comparison of the results between the categories of collegiate basketball players, novice basketball players and collegiate basketball players non starter does not indicate significant

differences between the results of these groups for the Bass and Stork tests, according to (73). Other authors highlight the differences between manual and bimanual balance values by using Bosu balls, inflated to different pressure values, the reduced pressures negatively influencing the balance (74).
Healthy young people (x = 22.9 years) evaluated by FMS (Functional movement screen) and who have lower scores / profiles of movement, have a greater instability of balance on the antero-posterior direction, according to (75).
Impairing the dynamic balance for those with visual impairment generates an increased risk of falling. Stability training applied for 8 weeks to visually impaired children in Iran (8-14 years old) resulted in a significant improvement in the results of the Bass test, with high efficiency on walking safety, according to (76). The physical exercise with emphasis on static and dynamic balance is recommended for students with mental retardation in Iran (who have a lower level of fitness than the normal ones), in order to improve body posture. Progress is being made on static and dynamic balance on one leg, after applying a program for 8 weeks (77).

CONCLUSIONS

The results of the study at the level of the whole group and separated by gender demonstrate the applicability and efficiency of the proposed motor structures, to optimize the indices of static and dynamic balance, at the level of this age sample. Even if the differences between the initial and final tests are entirely significant (thus confirming the working hypothesis H1), these values must be viewed with caution, the low level of physical training and sedentary behavior of most students providing the premises for such progress, even with a weekly physical activity. It should be noted that the performance improvements are greater in the first part of the study (differences between initial and intermediate tests, with $p < 0.05$), compared to those in semester 2 (differences between intermediate and final tests), which can be explained by the adaptation to the planned and applied stimuli, so modifying or changing their dosage is necessary in order to have a better chance of improving the results. Working hypothesis 2 (H2) is confirmed for most tests of both genders ($p < 0.05$), with exceptions being the Walk and turn field sobriety test for boys (at the level of differences between intermediate and final testing) and the Fukuda test for both genders (for differences between initial and intermediate testing).
Regarding the comparison of the average values by gender, they demonstrate a relatively balanced distribution of performance, so we cannot say that girls have better results than boys or vice versa, in the whole set of tests. It is noticed that the girls have better scores in the tests: One leg standing, Flamingo, Functional reach and make fewer mistakes in the Walk and turn field sobriety test. The boys have a higher efficiency for the tests: Stork, Bass and Fukuda (where the values of the degrees regarding the body rotation are lower).

Limits of the study and future research directions

The investigation is not exhaustive; there are a number of statistically processed data, which could not be presented in this paper, due to the high volume of results obtained. It does not analyze the statistical differences between genders (independent samples), nor the influence of BMI levels (underweight, normal weight, overweight and obese) on the performance of balance tests, interesting aspects that deepen the investigation, but which will be presented in other publications. The study made by (78) emphasizes the importance of BMI values in sports (the distribution of basketball players in different positions / areas to optimize performance. One limitation of the study is the absence of laboratory tests, even if the entire set of field tests is internationally approved. Recent studies (79, 80) made on baropodometric platforms allow through the use of sensors, investigations of high accuracy of parameters that influence body balance, related to the projection of the center of pressure (CoP), weight distribution on each leg and plantar area, body oscillations in the frontal and sagittal planes, etc.

Declaration of conflict of interests-

There is no conflict of interest for the author regarding this paper.

Informed consent

The tested group received the information related to the study and its objectives, the research being carried out with the consent of all investigated subjects, respecting the rules of personal data protection.

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Case report

Neuromuscular rehabilitation interventions and COVID-19 management in a case of incomplete paraplegia with neurogenic bladder, post T3-T5 ependymoma

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ABSTRACT: INTRODUCTION: Spinal ependymomas are a group of mostly slow-growing tumors that can cause non-traumatic spinal cord injury with insidious clinical symptomatology ranging from neck or back pain to associated sensory-motor impairment. Due to their neurological and systemic frailty, patients with spinal cord injury might be especially vulnerable to the effects of SARS-CoV-2 infection and the resulting respiratory impairment. **CASE PRESENTATION**: We present the case of a 66 year old women admitted in our Neuromuscular Rehabilitation Clinic Division for severe incomplete paraplegia and neurogenic bladder. She was previously diagnosed in the Neurosurgical Ward with a thoracic grade II (classic) ependymoma and underwent a gross tumor resection. During the neurorehabilitation program the patient was diagnosed with COVID-19. The multi-drug related treatments were associated with supportive oxygen therapy and neuromuscular and respiratory rehabilitation techniques. **RESULTS**: Despite of the patient's favorable rehabilitation, consisting of walking abilities with support in a walking frame on short distances, her prognosis may be worsened by resting neurogenic bladder symptoms. COVID-19 has led to important acute respiratory morbidity in our patient, regardless of the mild course of the disease, and might further cause a post-infectious respiratory impairment. **ONCLUSION**: Spinal cord injury remains a life-long condition and emphasizes the necessity of supporting the affected patients on the long run.

Keywords: *students, balance, postural stability, physical exercise, progress, motor skills*

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1. INTRODUCTION

Spinal cord injury (SCI) is a neurological/neurosurgical condition that often generates long-term, functional impairments, systemic comorbidities and psycho-social challenges which can persist over a lifetime. Ependymomas are a heterogeneous group of rare central nervous system (CNS) tumors, (1.8% of all primary CNS tumors) (1), classically believed to develop from ependymal cells, while recent molecular evidences point out to radial glial cells, a type of neural stem cells, as the primary site of growth/transformation (2). Positive prognostic factors for ependymomas are spinal location and older age (3). Spinal ependymomas reach the highest incidence after the forth decade of life (4) and are the most common intramedullary tumors in adults (5). In most cases such tumors have a benign character and a good evolution. Usually the patients may develop insidious symptoms caused by the slow (6) and constant compression of close neural structures. Patients may present in a Neurological or Neurosurgical Unit with lasting neck or back pain and newly expressed or worsened sensory-motor impairment and sphincter or sexual

dysfunction, depending on the lesion's location (7). Long-standing non- traumatic SCI causes secondary complications such as diminished pulmonary function, respiratory infections, cardiovascular disease and immunosupression (8). Respiratory complaints are often related to high spinal cord injury, especially with long-standing neurological deficits, and are an important morbidity (9) and mortality cause (10). COVID-19 is a novel viral infectious condition which is transmitted by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). SARS-CoV-2 primarily affects tissues that express high levels of angiotensin converting enzyme 2 receptors, such as lungs, heart, vascular endothelium, gastrointestinal tract (11). It was hypothesized that COVID-19 would begin as a simple viral infection in the upper respiratory tract or the gut and could develop towards a local and systemic immune and vascular disease (12,13). It has also been hypothesized that the SCI population would be severely affected by COVID-19 and additionally difficult to diagnose too, due to symptoms and signs which at least are partially overlapping with each other: reduced respiratory symptoms, impaired cough and diminished fever reactivity (14).

CASE PRESENTATION

Reason for admission and evaluation. A 66 year old women with medical history of obesity, arterial hypertension was admitted in our hospital, in February 2021, for progressive upper and lower back pain with anterior irradiation towards the rib cage, decreased muscle strength and numbness in the lower limbs. She initially had difficulties in climbing/descending stairs and ultimately was unable to walk. Following admission in the Neurosurgical Unit the patient was diagnosed with AIS/Frankel D paraplegia with T2 neurological level. The magnetic resonance imaging (MRI) study with gadolinium-contrast enhancement revealed an expansive intramedullary lesion extending from T3 to T5 with homogeneous enhancement and hypo-intensity on T1-weighted and T2-weighted images. The lesion associated syringomyelia. The neurosurgical treatment was T2-T6 laminectomy and gross surgical excision of the tumor mass. The histological report confirmed the diagnosis of grade II (classic) spinal ependymoma.

The patient attended two successive rehabilitation admissions which lasted one month each. The AIS / (Frankel) scale (15) was used for the assessment of the spinal cord injury consequent neurofunctional impairment, according to the International Standards for Neurological Classification of SCI (16). Spinal Cord Independence Measure (SCIM) (17) and Functional Ambulation Categories (FAC) International Scale (18) were used in order to evaluate the patient's ambulation and motor functionality. The modified Ashworth scale (19) was used to describe the muscle tone status. The Quality of Life (QoL) was measured using a scale after Flanagan (20). In our Unit the patient presented with AIS/Frankel C paraplegia with T2 neurological level. She had hypoesthesia and neuropathic pain below the level of lesion. The patient needed an indwelling catheter for bladder voiding due to neurogenic bladder. Spasticity was discrete in the lower limbs (Ashworth 1/4). She had no muscle spasms. She could sit independently, but was not able to transfer into sitting position unaided. She was unable to maintain the upright position and could not walk.

Treatment plan and evolution. Treatment goals included the prevention of secondary complications caused by immobilization, the progressive mobilization in up-right position and initiation of walking, the management of neurogenic bladder and the overall improvement of quality of the patient's life. The pharmacological treatment included low molecular weight heparin, analgesics, non-steroidal anti-inflammatory drugs, gastric protector, urinary antiseptics, antihypertensive and anxiolytic drugs. The physiotherapy program included trunk and lower-extremity muscle strengthening, standing and balance exercises and walking re-training with assistive devices.

During the first admission the patient had a positive evolution. She could transfer from sitting to standing position with help from the physical therapist, maintained the orthostatic position for several minutes and exercised walking. Neurogenic bladder was approached initially through indwelling catheter and progressed through an intermittent

catheterization program. Spasticity remained unchanged. Following the second admission in our Unit the patient suddenly developed fever, chills, nasal congestion and dry cough. The laboratory tests for differential diagnosis included urine and blood cultures and a RT-PCR test for SARS-COV-2.

Table 1. Evaluation scores at admission and discharge.

Evaluation scale	Admission	Discharge
AIS / (Frankel) scale	C	D
AIS motor score	68/100	85/100
Spinal Cord Independence Measure (SCIM)	18/100	31/100
Functional Ambulation Categories (FAC)	1/5	2/5
Ashworth scale	1/4	1/4
Quality of Life after Flanagan (QoL).	105/112	109/112

COVID-19 episode

The patient was tested positive for SARS-COV-2 and had a positive urine culture for Pseudomonas aeruginosa. She was isolated and received together with the aforementioned pharmacologic treatment, a multidrug therapy including antiviral(remdesivir), corticosteroids (dexamethasone), antibiotic (for urinary tract infection) and respiratory support: low flow oxygen therapy in order to reach peripheral oxygen saturation (SpO2)=92-96%. The patient's symptoms and vital parameters were frequently monitored. The patient continued to benefit from physical therapy. Exercises included passive, active-passive, and active in-bed exercises combined with assisted transfers in sitting and standing position at the bedside if the patient could tolerate them. Respiratory rehabilitation techniques included diaphragmatic respiration with emphasis on expiration and cough assistance. T During this period the patient also developed gastrointestinal symptoms including diarrhea. The clinical evolution was constantly stable and characterized by no cardiovascular or respiratory acute complications. Despite this favorable evolution the patient lost the previously obtained progress and reported ongoing fatigue and marked exertion when exercising. A chest CT was done 9 days after the initial diagnosis and showed a moderate lung illness (Figure 1).

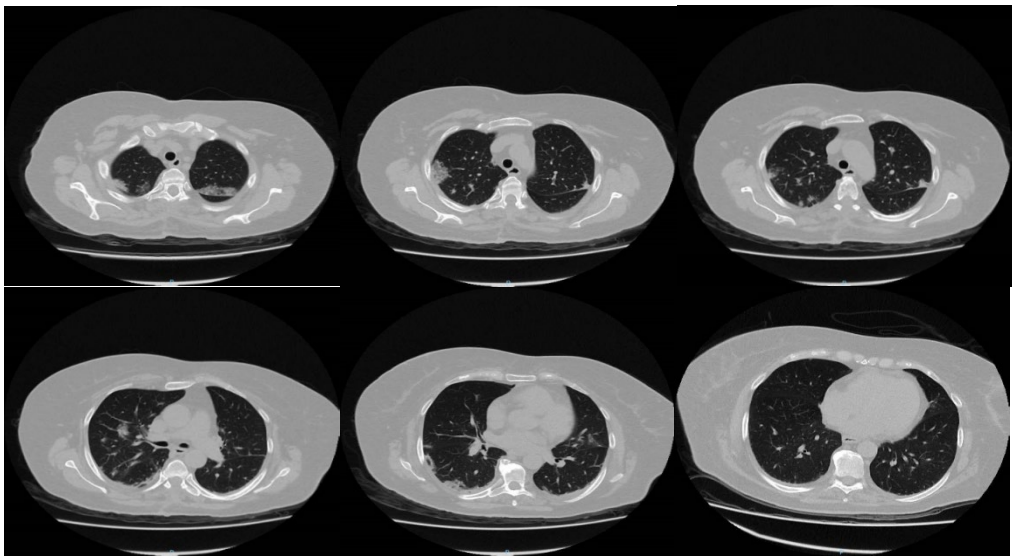

Figure 1. Chest CT performed 9 days after COVID-19 diagnosis reveals multilobar consolidations with positive air bronchograms, localized in the subpleural and central regions in both lungs, more frequently in the upper and lower pulmonary lobes.

Post-COVID-19 evolution. After having a negative RT-PCR test the patient re-attended the normal rehabilitation program, benefiting from exercises in the physiotherapy rehabilitation gym. The patient transfers and standing tolerance improved. She could maintain sitting and standing position for longer periods of time. She could endure walk on very

short distances (20 m) with support in wheeled frame and assistance from the physical therapist. The overall evaluation scores assessed at admission improved at discharge (Table 1). The intermittent catheterization program was interrupted in agreement with the patient's wish, due to her inability to perform it independently and an insufficient social support for this intervention. An indwelling catheter was mounted. The outcome of the control chest CT examination performed at discharge is represented in (Figure 2). Blood tests are shown in Table 2.

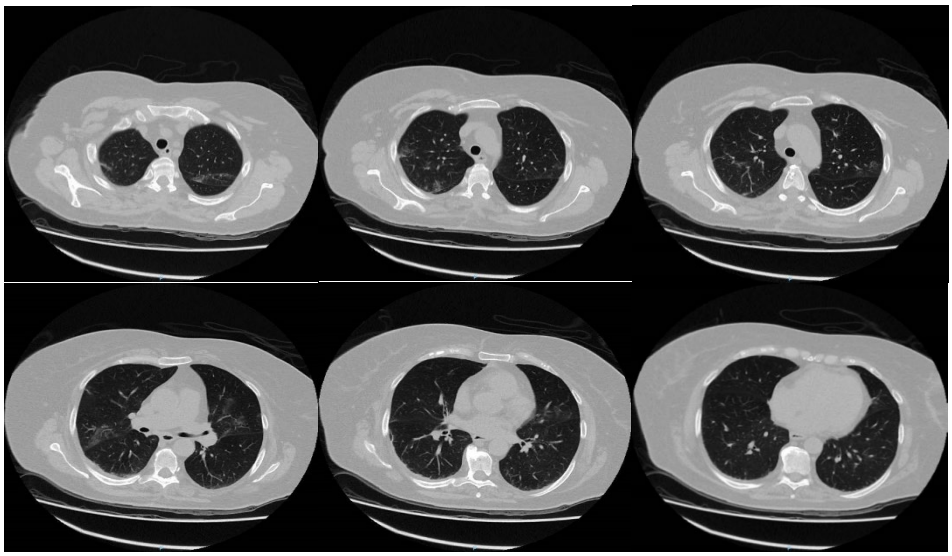

Figure 2. Chest CT performed at discharge (28 days after COVID-19 diagnosis) showing a gradual resolution of the multilobar pneumonia with remaining abnormalities (multiple ground glass opacities with predominant peripheral distribution, associating interlobular septal thickening and fine fibrotic bands).

Table 2. Biochemical parameters during a 28-day period from COVID-19 onset to discharge. Mild alterations included leucopenia, monocytosis, anemia, elevated erythrocyte sedimentation rates, single-time elevated ALT liver enzyme. WBC - white blood cells, PLT – platelet count, RBC – red blood cells, ESR - erythrocyte sedimentation rate.

	Positive SARS-COV-2 RT-PCR result	**Negative SARS-COV-2 RT-PCR result**	**Discharge**	**Measurement Unit**	**Reference range**
	(0 days)	**(+ 14 days)**	**(+28 days)**		
WBC	3.1	5.8	3.6	* 103/uL	[4.8 - 10.8]
RBC	3.62	3.43	3.61	* 106/uL	[4.2 - 5.4]
PLT	191	272	180	* 103/dL	[130 - 400]
Lymphocytes	26.1	41.1	40.7	**%**	[20.5 - 45.5]
Neutrophils	61.2	45.3	40.6	**%**	[43 - 65]
Monocytes	12.1	12.4	11.9	**%**	[5.5 – 11.7]
Eosinophils	0.4	0.9	6.3	**%**	[0.9 – 2.9]
Basophils	0.2	0.3	0.5	**%**	[0 - 1]
ESR	13	20	10	mm/h	[3 - 11]
Hemoglobin	11.5	10.8	11.4	g/dL	[12 - 16]
PT	14.1	16	15	s	[11.8 - 15.1]
APPT	28.8	27.4	27.1	s	[24.3 - 35]
INR	1.03	1.2	1.1	-	[0.85 -1.15]
Fibrinogen	492	352	416	mg/dL	[169-515]
Glycemia	93	72	80	mg/dL	[70-99]
Amylase	44	60	32	U/L	[25 - 125]
LDH	-	161	161	U/L	[125-220]
ALT/GPT	65	31	-	U/L	[0-55]
AST/GOT	33	15	22	U/L	[5-34]
Serum Albumin	3.6	3.3	3.0	g/dL	[3.5-5.2]
Cholesterol	202	179	208	mg/dL	[0-199]
Creatinine	0.61	0.69	0.65	g/dL	[0.57-1.11]
Urea	20	-	7	mg/dL	[19-43]

DISCUSSION

The patient's pre-operative neurologic and functional status are important for optimal postoperative outcomes in the case of spinal ependymomas (1). The tumor location has been shown to contribute to surgical morbidity and weaker results were reported for thoracic ependymomas as compared to other location (5,21). In this case the patient benefited from a gross total resection (GTR) of the tumor mass. GTR has been shown to be the most consistent factor determining the vital prognosis and the progression-free survival (22) and particularly for spinal ependymomas it has a high rate of success. Post-surgical outcomes, such as motor function, gait performance and sphincter control were also shown to differ with the tumor's location. Thoracic and cervical ependymomas have shown poorer recovery results then lower spinal tumors (5,20,23). Although the patient had an operated thoracic ependymoma she progressed during the rehabilitation program from AIS/Frankel C to AIS/Frankel D paraplegia and showed improvements in functionality and activities of daily living (Table 2), with unfortunately remaining neurogenic bladder.

A few observational studies that included patients with spinal cord injury and COVID-19 were reported to the present moment (24-28). In a systematic review analyzing the clinical characteristics of SCI patients with COVID-19 fever was the most important symptom (29). Interestingly, an important number of asymptomatic infections (20,69%) was reported too. A better understanding of COVID-19 infection in SCI patients could be updated by designing studies to include mild and asymptomatic illnesses. In our case report the COVID-19 onset symptoms were fever, dry cough and nasal congestion.

The 66 year old, hypertensive patient had a non-severe evolution during the acute phase of this infection. In two other studies similar results were reported (24,25). The enrolled patients had mean ages of 60 years25 or > 60 years24 and additional respiratory (tracheostomy (24), cardio-vascular or metabolic comorbidities (high blood pressure, dyslipidemia, obesity). No deaths or Intensive Care Unit admissions were registered. The studies took place in a hospital setting, therefore, following COVID-19 confirmation, the patients were promptly treated, including with supportive respiratory interventions. Yet, two other clinical studies have contradictory results. In a series of cases, Burns et al. (26) report a 2.4 times higher death rate in SCI US Veterans with COVID-19 as compared to non-SCI Veterans with COVID-19.The authors state that these results might be overestimated, due to overlooking the real number of community based COVID-19 cases among veterans with SCI (asymptomatic and mild cases) and also biased towards selecting the more severe cases with older ages and associated comorbidities. Galea et.al27 also present a high case fatality rate (3 out of 7 patients registered deaths) in a similar population, SCI US Veterans with COVID-19. The death incidents were reported in patients suffering from life-threatening conditions such as multiple organ failure and septic shock. The authors conclude that pre-existing comorbidities are the most reliable predictors for severe COVID-19 in the SCI population and admit that early diagnosis might lead to better outcomes. An interesting aspect discussed is that a long-lasting condition with a spinal cord injury predisposes to secondary complications that would negatively impact COVID-19 evolution. This was not the case of our patient, who had a recently discovered non-traumatic SCI caused by a spinal ependymoma.

The question to be answered remains why no death incidents and non-severe acute complications of patients with SCI, advanced age, as well as comorbidities and COVID-19 were registered in our study as well as in other clinical studies (24, 25)? A prompt diagnosis and complex treatment administered early in the disease's evolution could provide one answer. Such interventions were shown to markedly reduce mortality in elderly with COVID-19 in nursing homes (30). Secondly, a newly emerged hypothesis on COVID-19 pathophysiology might offer additional arguments in that direction. COVID-19 may act as a type III immune mediated hypersensitive disease consisting of three phases that intertwine and overlap: viral replication, cytokine storm, and endothelial injury (12). In the first phase the viruses rapidly replicates and propagates. The aim of the other two phases,

immunological and hemo-vascular, is to efficiently produce a coordinated humoral response against these pathogens. If this fails, emerging micro-vascular damages and thrombosis develop. This then reverberates on the respiratory system and on the entire body through the affected blood vessels. Calvo E et (31) al quantified the proteomic profile of patients with SCI and COVID-19 and compared those to patients with SCI and without COVID-19. They described that individuals with SCI and COVID-19 had significantly lower levels of fibrinogen and other pro-thrombotic proteins than the control group, which would explain a non-severe evolution in this population. According to the authors, patients with SCI already receive prophylactic doses of anticoagulant therapy in order to avoid vascular complications caused by immobilization (usually 0,4 mg/24h) before developing COVID-19 and they receive therefore increased doses (up to 0,6-0,8mg/12h) after the infection is confirmed. The study results include correlations (without statistical significance) between the level of coagulation proteins in the two groups and the doses of anticoagulation therapy (heparin) administered. The different heparin regimes between the two groups, the SCI patients with COVID-19 and without COVID-19, could be an answer for the reduced quantity of coagulation proteins in the infected SCI group and could represent a very important protective factor. The strategy of adjusting anticoagulant therapy to higher doses (if not contraindicated) in SCI patients with COVID-19 was regarded to be a necessity in order to combat life-threatening vascular complications (29). Our patient received prophylactic low molecular weight heparin anticoagulation therapy (0,6 mg/day) until the COVID-19 onset, and afterwards increased doses (0,8-1,4 mg/day) for 12 days. The anticoagulation therapy has been reduced to the previous prophylactic doses after this 12 days period and in the next days the patient has been tested negative for SARS-COV-2. Our results are interestingly completed and contrasted by the results of multi-institutional autopsy cohort from Italy and New York City. In this study, A C.Borczuk et al. report the presence of frequent thrombi and vascular injuries in the pulmonary vessels, and less frequent thrombotic microangiopathy in other extrapulmonary organs. Out of all studied cases, 71% (48/68) received anticoagulant therapy (the authors do not provide additional information to the therapeutic regime) and still had large pulmonary thrombi (22/48) and/or microthrombi of the arterioles and capillaries (42/48) (32). This further underlines the importance of coagulation alterations in COVID-19 (coagulopathy, endotheliopathy, vasculitis) and underlines the need to analyze the death toll according to multiple factors such as: comorbidities, COVID-19 evolution and complications (systemic inflammation secondary to cytokine release, endothelial inflammation, acute respiratory distress syndrome), treatment setting, medication.

The acute respiratory dysfunction was manifested in our patient by hypoxemia, which required oxygen support and respiratory rehabilitation interventions, such as bronchial secretions drainage, respiratory muscle strengthening and improvement of lung capacity. The results of the study of Rodríguez-Cola M, et al. (24) point out to the need of all SCI patients with COVID-19 to benefit from bronchial drainage and hyperinflation techniques, which were initially required only for patients with SCI and tracheostomy. S.D'Andrea, et al. (25) report that low flow oxygen therapy was required by 60% of the patients with COVID-19 and SCI as compared to approximately 30% of the control group (general population with COVID-19). Regardless of a mild course of the disease, COVID-19 may still lead to important respiratory morbidity in patients with SCI. Reduced respiratory volumes and flow rates and the loss of innervation to the abdominal and/or intercostal muscles predispose patients with SCI to a chronic respiratory dysfunction (33) . These functional changes are of restrictive type, similar to the COVID-19 pneumonia induced sequelae (34-36).

CONCLUSION

Spinal ependymomas are regarded as benign tumors, but need to be further considered in terms of tumor grade, localization as well as clinical features at the time of diagnosis which are important therapeutical outcome predictors. Surgical treatment has a high rate

of success but is not completely without risks and complications. Spinal cord injury remains a life-long condition and emphasizes the necessity of supporting these patients on the long run11. COVID-19 is a potentially serious respiratory infection, especially for SCI patients who require additional respiratory interventions in the acute phase of the disease. The patient had a favorable neurological evolution, consisting of walking abilities with support in a walking frame on short distances. In addition to the persisting dysfunctional neurogenic bladder, post-COVID-19 residual respiratory impairments could develop due to parenchyma fibrosis and remodeling. These negative effects may worsen the patient's prognosis. The non-severe evolution during the acute phase of COVID-19 in our patient could be related to the prompt diagnosis followed by a multi-drug treatment, including higher doses of anticoagulation therapy (without contraindication), and additional respiratory interventions, consisting of oxygen support and rehabilitation techniques performed by physical therapists. More complex and large studies, with SCI patients and control groups, in patients having COVID-19, could provide more results that would lead to stronger based generalization.

CONFLICT OF INTERESTS The authors declare no conflict of interest.

ETHICS This case presentation received the THEBA Ethics Committee approval (Nr 24389/28.06.2021).

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Research article

Estimating the effectiveness of the multi-/interdisciplinary therapeutic program in elderly patients with incomplete myeloradicualar injuries after cervical spinal cord injury

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ABSTRACT: Nowadays elderly persons may be frequent victims of traumatic cervical spinal cord injury (CSCI). A selected group of 28 (7 women (25%) and 21 (75%) men) elderly tetraplegic patients with traumatic CSCI, were admitted to the THEBA Neuromuscular Rehabilitation Clinic with incomplete (AIS-B, -C, -D) myeloradicular injuries. The female patients had an average age of 71.42 years, 5 of them coming from rural areas and 2 from urban areas. The male patients had an average age of 69.11 years, 10 of them living in rural areas, and 11 in urban areas. The spine lesion location was at the C2 vertebral level (in 3 women and 4 men), C3 (in a woman and 4 men), C4 (in a woman and 6 men), C5 (in 1 woman and 5 men); C6 (in a woman); C7 (for 2 men). The patients' neurological levels of injuries were: C2 (in 3 women and 4 men), C3 (in one woman and 4 men), C4 (in one woman and 6 men), C5 (in one woman and 5 men), C6 (in one woman) and C7 (in 2 men). The AIS / Frankel degree at admission, was: complete lesion (AIS-A), in 1 women patient, incomplete lesion AIS-B (in 2 male patients), AIS-C (for 2 women and 10 men), AIS-D (for 4 women and 9 men). The average muscle strength at admission was 62.71 (SD 23.32) for women patients and 59.44 (SD 26.89) for male patients; and at discharge these averages were 70.5 (SD 21.23) for women and 69.22 (SD 27.06) for men. In the study group there were 19 operated patients (3 women and 16 men); in which the anterior osteosynthesis was performed (for 3 women patients and 10 male patients) and respectively the posterior vertebral approach (in 6 male patients). The neurological evolution was favorable, so that at discharge were only patients with incomplete lesions AIS-C (1 women and 11 men), AIS-D (6 women and 10 men). The following comorbidities were associated: obesity (in 2 men), arterial hypertension (in 7 women and 11 men), diabetes (in 2 women and 4 men), traumatic brain injury (in 7 men), chronic alcoholism (in 2 men), pneumonia (in one woman and 6 men), neoplastic diseases (in 2 men), osteoporosis (in one woman and one man), anemia (in one woman and one man), glaucoma (in one woman), depression (in one woman), Lyme disease (in one woman), ischemic heart disease (in 3 women and 1 man), gastric ulcer in one man and ankylosing spondylitis (in 2 men). Complications of the immobilization syndrome were enterocolitis (in 2 men), bronchopneumonia (in 6 male patients), urinary tract infections (in 6 women patients and in 12 male patients) and bedsores (in one male patient). Effectiveness of the final therapeutic approach was assessed (in percentage) by evaluating the progress of the muscle strength (quantified and compared at discharge vs. admission) reported to the number of days of treatment. Statistics was performed for small groups (Anova and Pearson) to establish the effectiveness of the rehabilitation program, evaluating the level of correlation between the scores quantified with the aforementioned the scales. An inversely proportional relationship was found between spasticity and kinetic therapy efficacy (F 0.000, Pearson -0.09), between the PENN scale scores and kinetic therapy efficacy (F 0.000, Pearson -0.24) and a directly proportional relationship between the scores assessing quality of life, FIM and the efficacy of kinetic therapy (F 0.02, Person 0.42). These results underline the importance of a multi-interdisciplinary team approach in the management of the tetraplegic patients after CSCI during the subacute post-lesional/ post-operative stage.

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1. INTRODUCTION

Spinal cord injury (1,8,9) is a medical condition that has dramatic consequences in the personal and social life of the patient through motor and sensory deficits (somatic and vegetative) that it produces (2,10,12). Most spinal cord injuries have a traumatic cause (3,4,5). In the modern world, spinal cord injuries occur in all age groups (11,13,14). Among them, elderly patients represent a population category at risk of both spinal cord injury and life-threatening complications (6). Of all the methods of recovery from spinal cord injury (including in elderly patients), physical therapy exercises bring the most benefits in the short, medium and long term (7,8,9,15-19).

Material and methods

A retrospective study (January 2019-March 2021) we conducted with the approval of the Ethics Commission of THEBA, to assess the results of the complex medical rehabilitation program during the subacute period. The statistical processing of the information (and scale analysis of: Functional Independence Scale, FIM; QualityOf Life, QOL; Modified Ashworth Scale, MAS; PENN spasm frequency scale; MRC muscle strength scale) was done using Office Windows 2013. Effectiveness of the final therapeutic approach was assessed by evaluating (in percentage) the progress of the muscle strength (quantified and compared at discharge vs. admission) reported to the number of days of treatment. Statistics was performed for small groups (Anova and Pearson) to establish the effectiveness of the rehabilitation program, evaluating the level of correlation between the scores quantified with the aforementioned scales.

A selected group of 28 elderly tetraplegic paients [7 women (25%) and 21 (75%) men] with traumatic SCI, were admitted to the THEBA Neuromuscular Rehabilitation Clinic with incomplete myeloradicular injuries.

The female patients had an average age of 71.42 years, 5 of them coming from rural areas and 2 from urban areas. The male patients had an average age of 69.11 years, 10 of them living in rural areas, and 11 in urban areas.

The patient neurological levels of injuries were: C2 (3 women and 4 men), C3 (1 woman and 4 men), C4 (1 woman and 6 men), C5 (1 woman and 5 men), C6 (1 woman) and C7 (2 men).

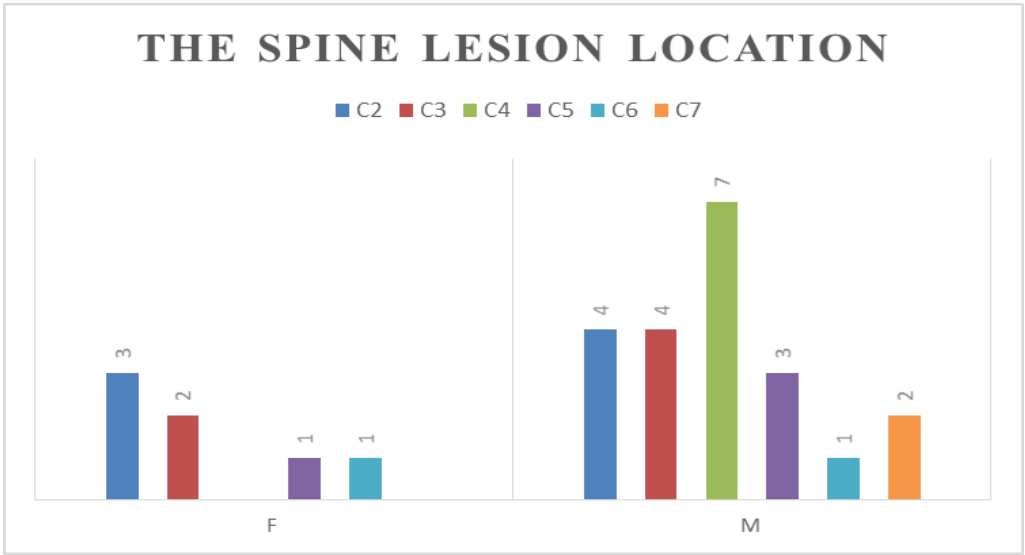
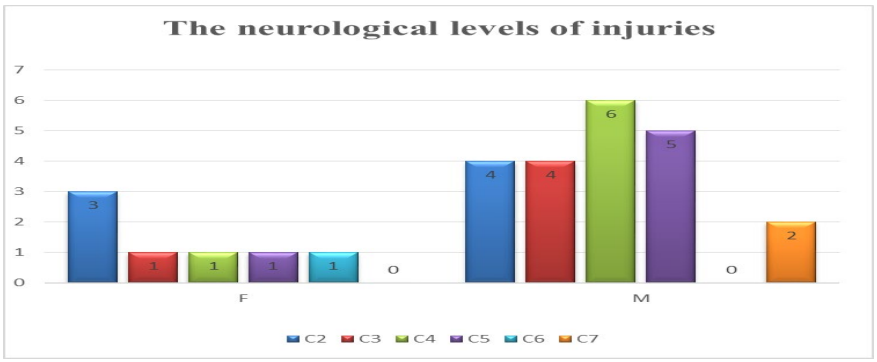


Fig no1. The spine lesion location

The spine lesion location was at the C2 vertebral level (3 women and 4 men), C3 (1



woman and 4 men), C4 (1 woman and 6 men), C5 (1 woman and 5 men); C6 (a woman); C7 (2 men).

Fig no2. The neurological levels of injuries

In the study group there were 19 operated patients (3 women and 16 men); in which the anterior osteosynthesis was performed (for 3 women patients and 10 male patients) and respectively posterior vertebral approach (in 6 male patients).

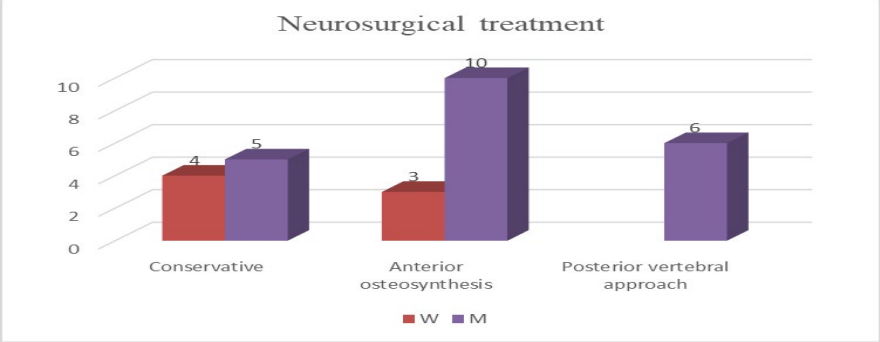


Fig no3. Patients treatment

The following comorbidities were associated: obesity (2 men), arterial hypertension (7 women and 11 men), diabetes (2 women and 4 men), traumatic brain injury (7 men), chronic alcoholism (2 men), pneumonia (1 woman and 6 men), neoplastic diseases (2 men), osteoporosis (1 woman and 1 man), anemia (1 woman and 1 man), glaucoma (1 woman), depression (1 woman), Lyme disease (1 woman), ischemic heart disease (3 women and 1 man), gastric ulcer in one man and ankylosing spondylitis (2 men).

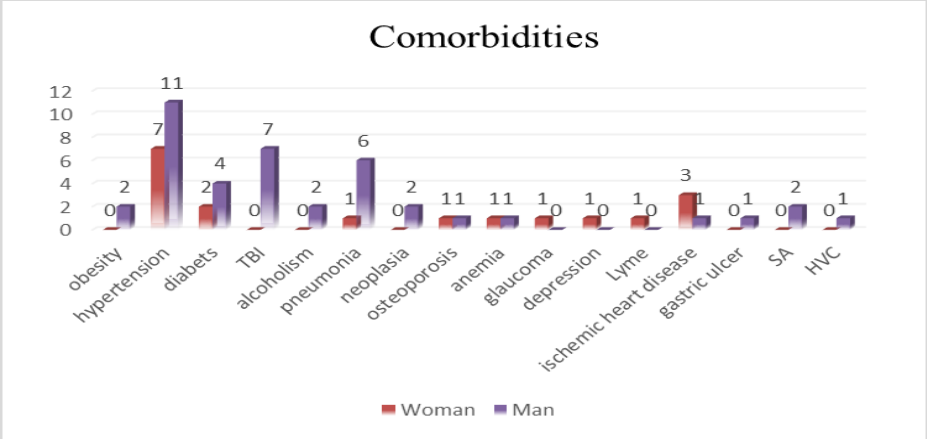


Fig no4. Patients comorbidities

The neurological evolution of patients was favorable, with a positive evolution of the muscle strength scores at discharge compared to admission.

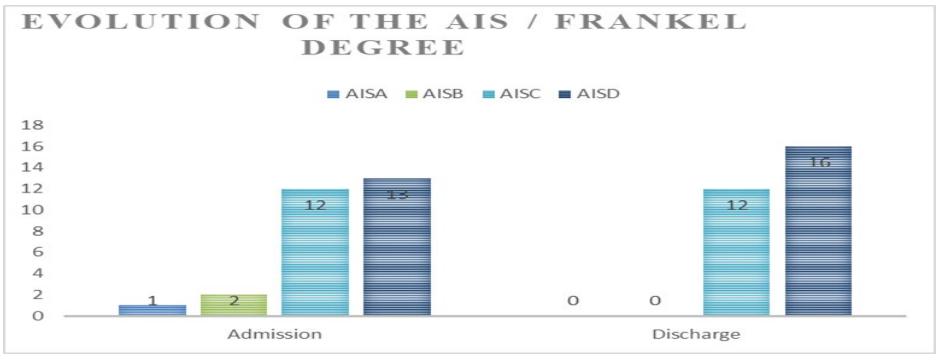
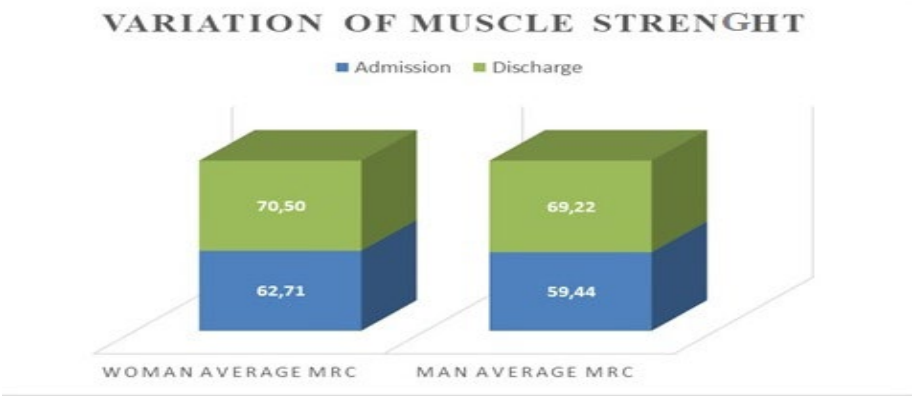


Fig no5. The evolution of the AIS/ Frankel degree

The average muscle strength at admission was 62.71 (SD 23.32) for women patients and 59.44 (SD 26.89) for male patients; and at discharge these averages were 70.5 (SD 21.23) for women and 69.22 (SD 27.06) for men.

Fig no6. Variation of muscle strenght in woman and man



Complications of the immobilization syndrome were enterocolitis (2 men), bronchopneumonia (6 male patients), urinary tract infections (6 women patients and 12 male patients) and bedsores (1 male patient).

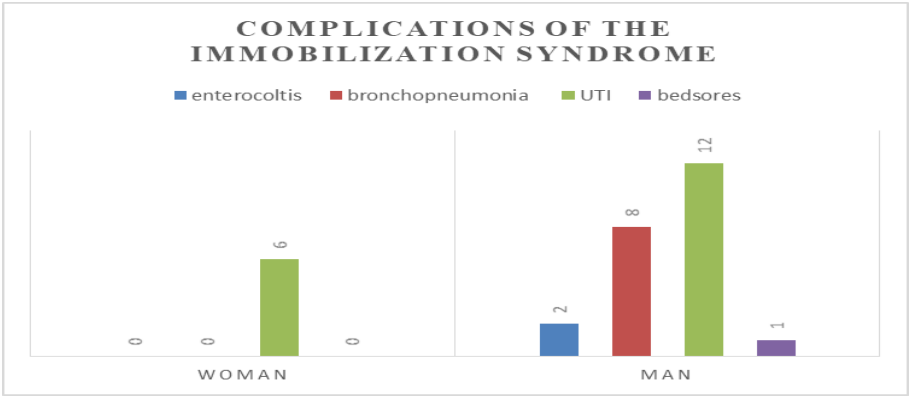


Fig no7. Complications of the immobilization syndrome

The AIS / Frankel degree at admission, was: complete lesion (AIS-A), in 1 women, incomplete lesion AIS-B (in 2 male), AIS-C (for 2 women and 10 men), AIS-D (for 4 women and 9 men).

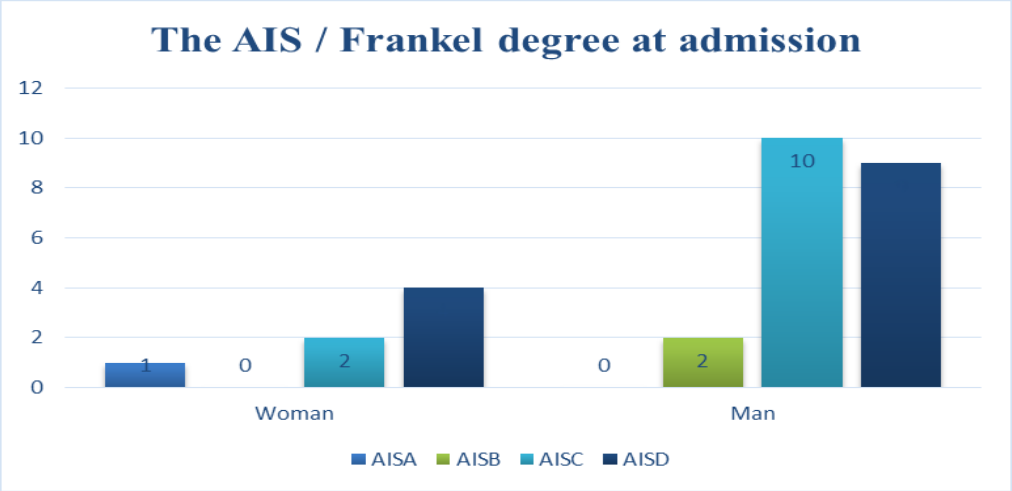


Fig no8. The AIS/ Frankel degree at admission

At discharge there were only patients with incomplete lesions AIS-C (1 women and 11 men) and AIS-D (6 women and 10 men).

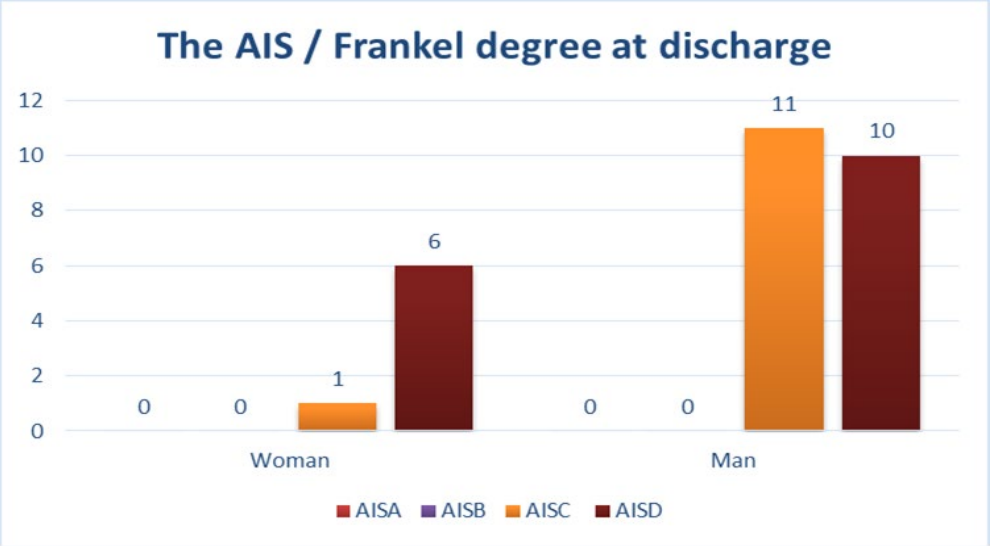


Fig no9. The AIS/ Frankel degree at discharge

An inversely proportional relationship was found between spasticity and kinetic therapy efficacy (F 0.000, Pearson -0.09), between the PENN scale scores and kinetic therapy efficacy (F 0.000, Pearson -0.24).

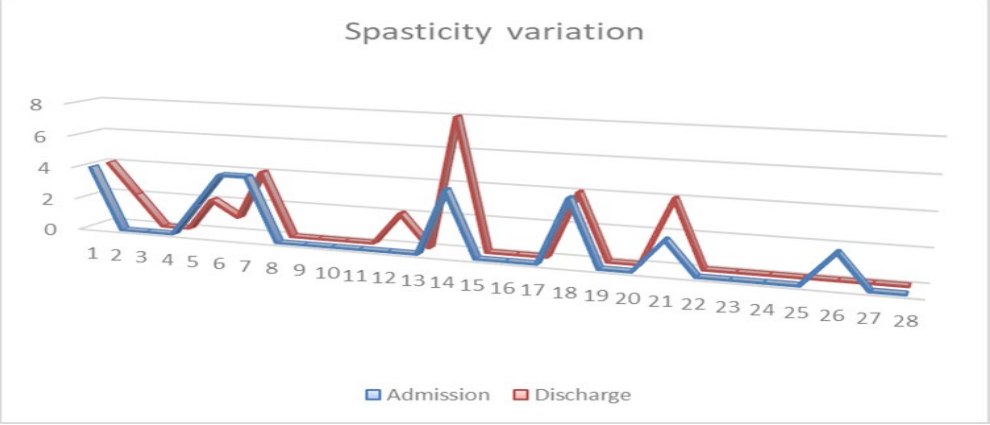


Fig no10. Spasticity variation

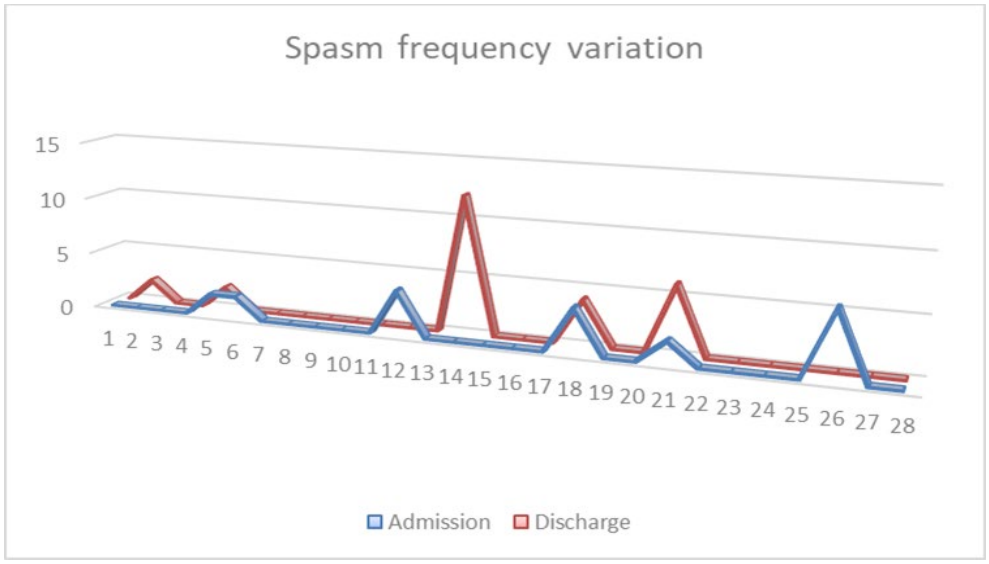


Fig no11. Spasm frequency variation

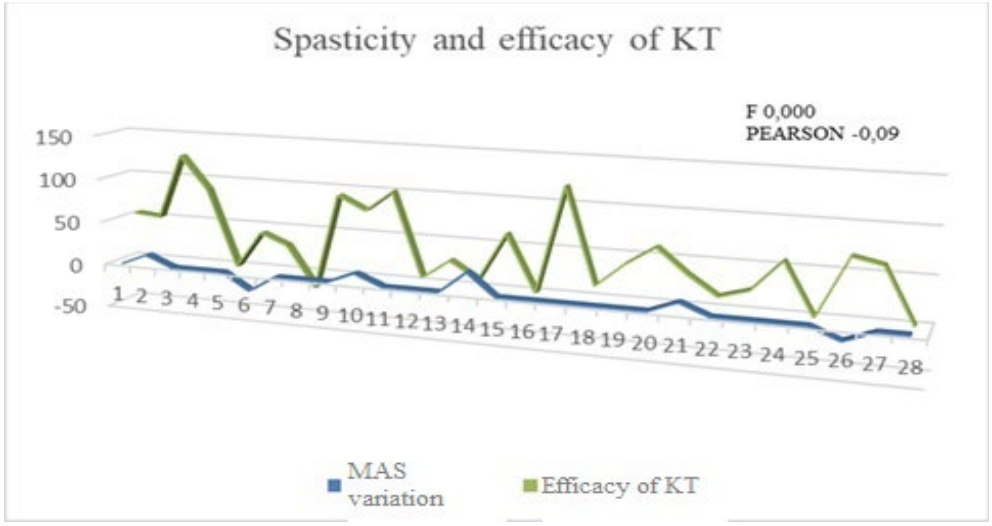


Fig no12. Spasticity and efficacy of KT

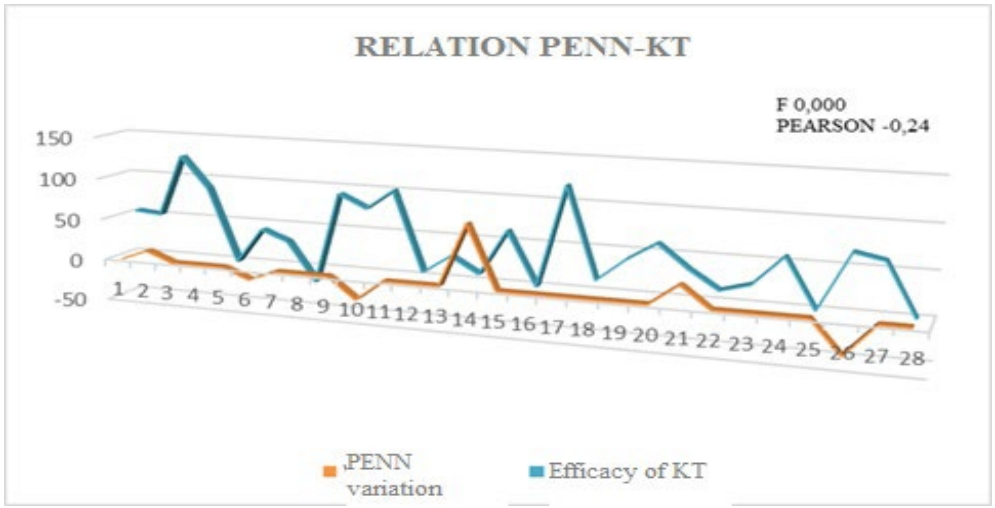


Fig no13. The relation PENN-KT

A directly proportional relationship was found between the scores assessing quality of life, FIM and the efficacy.

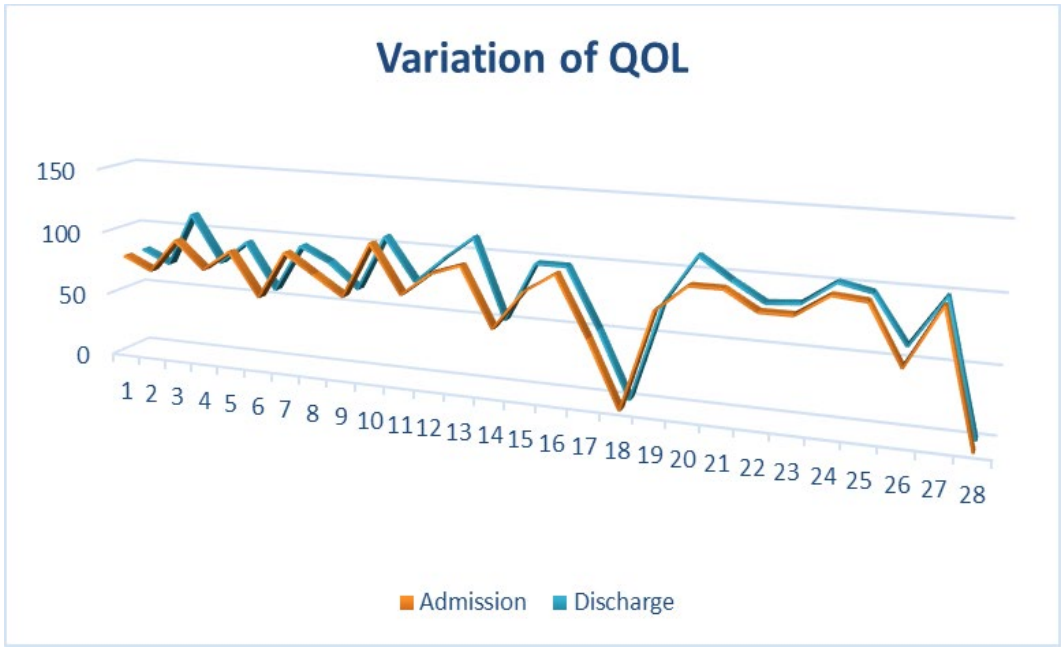


Fig no14. Variation of QOL

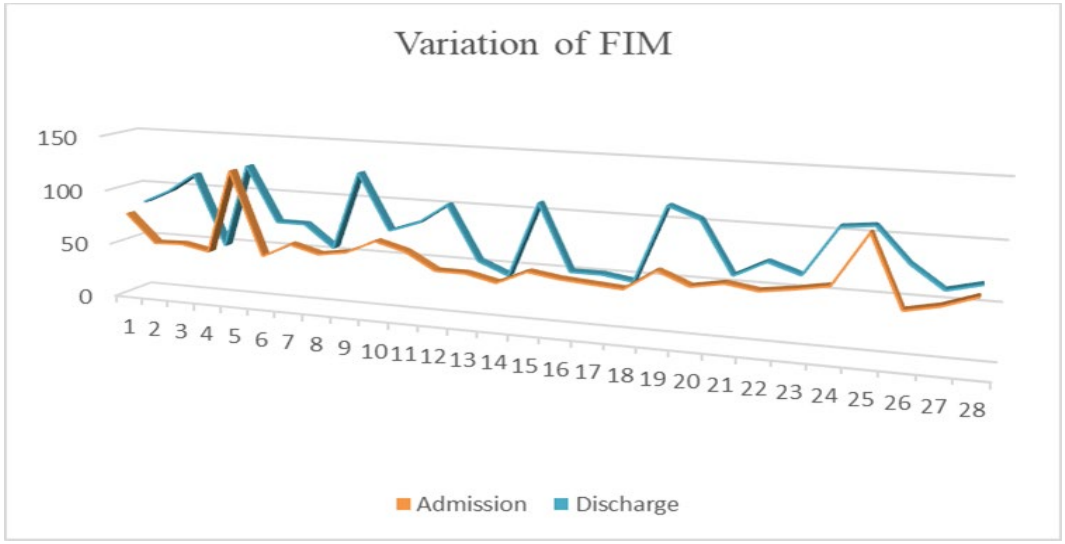


Fig no15. Variation of FIM

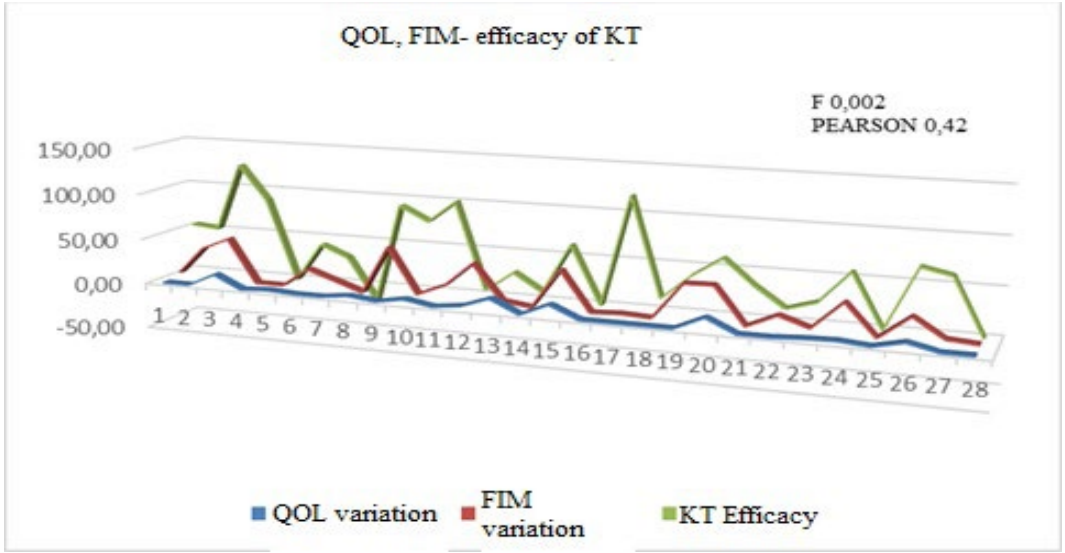


Fig no16. The QOL, FIM and efficacy of KT rellation

Discussion

An inversely proportional relationship was found between spasticity and kinetic therapy efficacy (F 0.000, Pearson -0.09), between the PENN scale scores and kinetic therapy efficacy (F 0.000, Pearson -0.24) and a directly proportional relationship between the scores assessing quality of life, FIM and the efficacy of kinetic therapy (F 0.02, Pearson 0.42).

Conclusions

These results underline the importance of a multi-interdisciplinary team approach in the management of elderly tetraplegic patients after CSCI during the subacute post-lesional/ post-operative stage.

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Randomized Controlled Trial

Comparison of the efficacy of Kinesiology Taping versus Therapeutic Ultrasound in the management of Plantar Fasciitis

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ABSTRACT: Plantar fasciitis (PF) is one of the most common musculoskeletal complain of the foot affecting a huge population. However there is a scarcity of evidence regarding treatment efficacy, therefore this trial aimed to compare the efficacy of Kinesiotaping (KT) vs. Ultrasound Therapy (UT) in the management of pain and physical functioning of foot/ankle in patients with PF.
Methodology: Two arms, parallel-group design RCT was conducted on PF patients. Participants aged between 25-60 years, having symptoms of PF for at least 6 months, presenting with unilateral and/or bilateral heel pain were included. However, patients with fractures, dislocations, or open wounds around ankle/soles and patients allergic to taping were excluded. 30 patients were randomly divided into group A (KTG=15): received KT and group B (UTG=15): received Ultrasound Therapy (UT). Both the groups also received cold pack with stretching exercises. Treatment was provided on an alternate days for 30 minutes to each group for two weeks. Visual Analogue Scale (VAS) was used to determine pain and Foot/Ankle disability index (FADI) was used to assess foot and ankle functioning. Readings were taken pre and post intervention.
Results and discussion: The mean pain score before treatment was 8.00 but after treatment was reduced to 1.13, in KTG. However, in UTG mean pain score before treatment was 9.13 and after treatment reduced to 4.20. The mean FADI score before treatment was 52.80 but after treatment decreased to 11.46 in KTG. However, in UTG the mean score of FADI before treatment was 58.53 and after treatment, it was decreased to 39.46.
Conclusion: The results concluded that KT and UT both are effective techniques for reducing pain and improving ankle/foot physical functioning in patients with PF. However, KT was found to be more effective than UT.

Keywords: *Foot/ankle disability index, Plantar Fasciitis, Pain, Kinesiotaping, Therapeutic ultrasound*

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1. INTRODUCTION

Plantar Fasciitis (PF) also known as heel pain syndrome, heel spur syndrome, or painful heel syndrome is defined as inflammation of the plantar fascia, it usually worsen on arising in the morning and after periods of prolonged standing and sitting (1). PF is one of the most common musculoskeletal complain of the foot as it accounts for about 85% of all the cases of heel pain, however, researchers observed that 10% of the general population experience it at least once in their lifetime (2). The prevalence of PF in the security forces of Peshawar, Pakistan was reported to be 13.2% (3). Previous researches show that PF mostly affect athletes; however, current literature shows that people with a sedentary lifestyle are also commonly affected. PF can occur at any age and both genders are equally prone (4, 5).
PF is considered the most common cause of foot pain and is estimated to account for 11–15% of all foot problems in adults (6). The exact pathology is still unknown (7). This

disorder is reported to be multifactorial in origin and can be triggered by obesity, excessive periods of weight-bearing activity and decreased ankle range of motion (8).

Evidence reported numerous non-surgical treatments as effective in relieving symptoms associated with PF including anti-inflammatory agents (NSAIDs, steroid injections), modalities (iontophoresis, ultrasound, extracorporeal shock wave therapy, electrical stimulation, cryotherapy, and whirlpool), manual therapy (joint and neural mobilizations, massage), stretching and external support (orthotics, night splints, and taping) (9, 10). Most treatments endeavor to resolve the symptoms caused by PF; while orthotics and taping aim to repair the poor biomechanics of the foot (11).

Kinesio-taping (KT) is a common clinical intervention utilized in physical therapy facilitating pain reduction, joint support, proprioception, and muscle tone normalization with a simple procedure requiring no more than ten minutes to implement, resulting in an immediate positive effect on pain and occasionally on function (12). The rigidity of the tape allows a mechanical correction in joint position (13), changing patellar inclination (14), and foot position (15).

Evidence shows that most health care professionals also recommend Ultrasound Therapy (UT) for the treatment of PF and proved it to be effective in reducing pain and enhancing the quality of life (16).

A plethora of studies were conducted to compare the various treatment modalities for PF and highlighted the positive effects (17). Although many researchers have reported KT and UT as effective in the management of PF complications. However no research to date has compared the efficacy of KT with UT, therefore this Randomized Controlled Trial (RCT) aimed:

- To compare the efficacy of KT vs. UT in the management of pain using the Visual Analogue Scale (VAS) in patients with PF after two weeks of intervention.
- To compare the efficacy of KT vs. UT in improving foot/ankle function through Foot and Ankle Disability Index (FADI) in patients with PF after two weeks of intervention.

2 Methodology:

A two-arm, parallel-group design RCT was conducted on the patients suffering from PF at the outpatient physiotherapy Department of Jinnah Post Graduate Medical Centre and KK Rehabilitation Centre and Consultant Clinics Karachi, Pakistan. The trial was completed from February to August 2021. The inclusion criteria of this trial was voluntary participants aged from 25 to 60 years, having symptoms of PF for at least 6 months, presenting with the pain that worsens when the step is placed on the floor or walking after rest or increasing with activity, presenting with unilateral and/or bilateral heel pain, pain localized to the inferior heel or plantar surface of the foot. However patients with fractures, dislocations, or open wound around ankle/soles of feet, elderly individuals with weakened connective tissue such as (ligaments sprain and muscles strain, marked osteoporosis, history of lower limb congenital or traumatic deformity, congenital anomalies, patients allergic to taping were excluded from the study. VAS was used to determine PF pain intensity and FADI was used to assess foot and ankle functioning. VAS is marked between 0-10. Patients mark on it considering the intensity of pain, '0' representing 'no pain' and '10' maximum pain. The FADI is a 34-item questionnaire. Both the assessment parameters establish good reliability. ICC value of VAS= 0.92 (18) and ICC value of FADI= 0.89 (19).

A total of 30 PF patients were included in the study. This sample was calculated by using online software OPEN EPI version 3. Participants whose have given written informed consent and fulfill the eligibility criteria were randomly divided into group A=15 (KTG group) and group B=15 (UTG). Group A received KT and cold pack with stretching exercises (see figure 1), and group B received UT (Ultrasound at 0.5 w/cm^2, 3 MHz, pulsed 1:4, for eight minutes) and cold pack with stretching exercises (see figure 2). Treatment was provided on an alternate days for 30 minutes to each group for two weeks. All

patients were examined for pain and foot/ankle function before and after 2 weeks of treatment.

Figure 1: Application of KT (Group A)

Figure 2: Application of UT (Group B)

Data were stored and analyzed using IBM-SPSS version 20.0. Counts with percentages and mean were reported for baseline characteristics of studied samples. P-values less than equal to 0.05 were considered significant at 95% CI.

3 Results:

This trial was conducted on 30 PF patients. Randomly divided into group A (KTG=15) and group B (UTG=15). The age of the participants ranges from 25 to 60 years. 33.3% of the participants were male and 66.7% were female (see table 1).

Table 1: Gender Distribution (N=30)

Gender	Frequency	%
Male	10	33.3%
Female	20	66.7%
Total	30	100%

The results show that the mean pain score of VAS before treatment was 8.00±1.06 but after treatment was decreased to 1.13±1.06, in group A. The mean pain score of VAS before treatment was 9.13±0.63 and after treatment, it was decreased to 4.20±0.56 in group B. (see table 2).

Table 2: VAS score pre and post-treatment

VAS scale		Mean	SD	P-value
Group A	**Before**	8.00	1.06	0.00
	After	1.13	1.06	
Group B	**Before**	9.13	0.63	0.00
	After	4.20	0.56	

The results show that the mean FADI before treatment was 52.80 ± 4.36 but after treatment was decreased to 11.46 ± 3.20 in group A. The mean score of FADI before treatment was 58.53 ± 1.35 and after treatment, it was decreased to 39.46 ± 4.61 in group B. (table 3).

Table 3: FADI Scale pre and post-treatment

FADI Scale		Mean	SD	P-value
Group A	**Before**	52.80	4.36	0.00
	After	11.46	3.20	
Group B	**Before**	58.53	1.35	0.00
	After	39.46	4.61	

4 Discussion:

This trial compared the effectiveness of KT vs. UT for PF, which showed that both the treatment strategies are significantly effective in reducing PF pain and improving foot/ankle function. However, more improvement was found in the KT technique.

The findings of this trial are comparable to the study by Radford which showed that low dye taping decrease pain and improve functional outcome (20). Similarly the results of this study are in line with the findings of a study conducted in 2018 by Robert A (21). Furthermore a study endorsed KT to be easier, cost effective and faster to apply for therapist, than other techniques (22).

In September 2019, a RCT was conducted by Aishwarya A et al. to find out the comparative effectiveness of low dye taping in conjunction with conventional treatment, it was found that KT improves heel pain and disability in subjects with PF (23).

Another study by Apr, Banu Ordahan et al. aimed to compare the efficacy of extracorporeal shockwave therapy (ESWT) and KT in the treatment of PF and concluded that both ESWT and KT treatments improved pain levels, function and quality of life in individuals with PF. Neither method was superior in treating PF (24).

Research published in the Journal of Orthopaedic & Sports Physical Therapy by Yigal Katzp, aimed to evaluate the additive effect of UT in the treatment of PF in terms of pain, function, and quality of life, study concluded that addition of therapeutic ultrasound did not improve the efficacy of conservative treatment for PF. Therefore, the authors recommend excluding therapeutic ultrasound from the treatment of PF and agree with the results of previous studies that stretching may be an effective treatment for healing PF (25).

Among all the positives discussed above, it is worth mentioning that this study provided specific results with the easier determination of cause and effect relationships. On the other hand, small sample size, human error, and short follow-up duration were the few limitations that need to be addressed in the future.

5 Conclusion:

The results concluded that KT and UT both are effective techniques for reducing pain and improving ankle/foot physical functioning in patients with PF (26,27). However, KT was found to be more effective than UT. Hence calcaneal taping is found to be an effective tool for the relief of plantar heel pain and may act as a precursor to long-term management through the use of tape. It is easy and quick for the therapist to apply, and creates immediate symptom relief.

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Conflict of Interest:

No conflicting interests were declared.

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Research article

Study on the effects of the use of therapeutic ultrasound in the treatment of osteoarticular diseases

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ABSTRACT: Introduction. The use of therapeutic ultrasounds is a method that proved its efficiency in articular and periarticular pathology, in the subacute and chronic stages. The biological effects of the ultrasound use are determined by their interaction with the cellular structures whereas the results depend on the used parameters. The purpose of the survey is to evaluate / identify the effects of using ultrasounds in the treatment of musculoskeletal conditions (lumbar discopathy), knee osteoarthritis). Material and method. The survey was conducted on an outpatient basis in a period of 7 months and it is of the longitudinal type. It included 151 patients diagnosed with low back pain and knee osteoarthritis. The evaluated parameters were: pain, functional skills, articular rigidity and the quality of life. Results. The effects of the use of ultrasounds is found in the decrease of pain, the stiffness of the joints and the contracture of the muscles, as shown by the results of several surveys. Our survey proves that the use of ultrasounds decreases pain and increases the functional skills, it influences the physical function more obviously in patients with knee osteoarthritis, which is an aspect found in others surveys. Discussion. The use of a complex ultrasound treatment (in the pulsed way to avoid thermal effects) and kinesiotherapy enabled in our research the decrease of the pain and of the rigidity in the joints, the increase of the functional skills and the quality of life, whereas these obtained results are in accordance with those of others surveys. Conclusions. The use of the therapeutic ultrasounds can have the following effects: the decrease of the pain and of the joint rigidity, the improvement of the physical capacity for daily activities and the improvement of the quality of life. The use of low intensity ultrasounds can determine biological effects with actions for a short period or for an average one.

Keywords: *therapeutic ultrasound, treatment, osteoarticular diseases, quality of life*

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1. INTRODUCTION

Ultrasounds are mechanical waves oscillating with a frequency of $8x10^5$ Hz, determining chemical, biological and thermal effects. As for the biological effects, they depend on the applied intensity (1) and they are represented by vasodilation, hyperemia and the growth of the permeability of the cellular membrane. Therapeutic ultrasounds find their applicability due to the physiological effects, namely the modification of the permeability of the cellular membrane, the stimulation of the blood circulation, the fibrolytic, anti-inflammatory and analgesic effects, and local vasodilation (2).

The use of therapeutic ultrasounds is a method that proved its efficiency in articular and periarticular pathology, in the subacute and chronic stages (1,3,4). They also have a role the in the periosteal reconstruction, by the growth of the vascular permeability and by the local vasodilation (5).

There is a growing trend about the use of the therapeutic ultrasound in the management of the pain (6). The use of the therapeutic ultrasounds may determine: the intensification of the cellular metabolism by the improvement of the redox reactions and by the acceleration of the biochemical reactions (2,6), the increase in the local temperature, by enabling the blood flow by producing thermal and mechanical energy (7), the modification of the number of red blood cells (actually a false decrease), slowing down the blood coagulation process, the influence on the values of the total serum calcium (8), but all these according to the application method (pulsed or continuous) and the used frequency (3).
The ultrasound therapy may cause a thermal effects but also non-thermal ones (mechanical stress, cavitation) (3) whereas the ultrasound dosimetry is very important for the minimization of the side effects.
The important physical parameters in the recovery therapy by ultrasounds are: frequency (800 kHz), intensity (W/cm^2), the application mode (continuous or pulsed), the contact environment, the used dose, the duration of the applicability and the interval between the sessions for the treatment use (7, 9, 10).
The biological effects of the ultrasound use are determined by their interaction with the cellular structures whereas the results depend on the used parameters.
The therapeutic effects of ultrasounds are determined by the application parameters (the used frequency, the length of the waves, the intensity of the work, duration).
They cause thermal action (during the continuous use of the ultrasounds) and non- thermal action (during the pulsed use of the ultrasounds) (11).
The ultrasound used continuously determine thermal effects whose consequences are the growth of the capillary permeability and the growth of the tissue metabolism.
By the increase in the local temperature, analgesia occurs, the pain threshold increases and the tissue fiber is extensible. The used pulsed ultrasounds result in the modulation of the permeability of the cellular membrane, the increase in the protein synthesis and the activation of the local immune response by stimulating the regeneration of the tissue that is damaged (12).
Studies have shown that ultrasounds can produce energy which can be stored in tissues and may be determine biological effects (13).
The ultrasound therapy, in continuous form or pulsed, enables, according to the coupling environment, the transport of topical pharmacologist agents to teguments and we are talking about the method named sonophoresis (8, 14, 15).
A review of 2016 (16) showed that the beneficial effects of ultrasounds depended on the duration of the symptoms presented by patients, the period of using ultrasound therapy, the number of sessions and the total energy used in each session.
Knee osteoarthritis affects approximately 250 million people worldwide (17), it determines economic, social and medical consequences (18), it is a frequent cause of pain, disability and the decrease in the functional skills of the adults (19,20). Ultrasounds can be beneficial for patients with knee osteoarthritis. Ultrasounds may decrease the muscular pain and reduce spasms, by facilitating the repair of tissues through the increase in the local blood flow and the stimulation of the inflammatory mediators (21).
The use of therapeutic ultrasound enables, due to the mechanical vibrations, the penetration of these waves in the tissues, it has a fibrinolytic role and it relaxes the muscles (8,19,22). In order to be able to penetrate the tegument, the anti-inflammatory for the topical administration must have a certain active concentration in terms of pharmacodynamics, which depends on the molecular weight, water solubility, small molecules that are more hydrophilic, but also lipophilic properties to enable the easy transfer through layers (23, 24). Osteoarthritis has an inflammatory component (18,25), and the pain is the result of the inflammatory ways that produce an increased answer of the nociceptors from the peripheral joints (26).

Ultrasounds intervene through the attenuation of the inflammatory process, by potentiating the repair phase and having a role in healing (14). This procedure may be a conservative therapeutic option in the treatment of the knee osteoarthritis (27, 28).
The low back pain is a suffering of the lower axial lumbosacral segment caused by the musculo-ligamentous imbalance and static behavior not adapted to the daily needs.
The optimal frequency for ultrasound therapy is 1 MHz because at high frequency, the energy is largely absorbed on the surface and it does not reach the depth, whereas at low frequency ultrasounds penetrate deeply, but with great energy dissipation.
The best results for the body are obtained for values of the intensity of the ultrasound between 0.1-0.8 W /cm ^{2} (1). The deficitary posture in childhood and adolescence is accompanied by frequent pain at the level of the dorsal and lumbar spine, with a higher incidence of dorsalgia during the growth period (29).
The lack of physical activity, the sedentary lifestyle, carrying a heavy schoolbag, the endocrine and metabolic disorders in adolescence, the improper nutrition are factors that can aggravate the vertebral static disorders, with consequences in adulthood, respectively back pain (30). The low back pain is felt by the occurrence of muscular contractions and by issues in the propagation of the nerve pulse. Calcium and magnesium ions play a vital role as they are necessary for the determination of the total calcium and magnesium in the serum (32,33). In low back pain, ultrasounds were used for analgesic, myorelaxing and hyperemic effect (34).The purpose of the survey is to evaluate / identify the effects of using ultrasounds in the treatment of musculoskeletal conditions (lumbar discopathy), knee osteoarthritis).

Material and method

The survey was conducted on an outpatient basis in a period of 7 months and it is of the longitudinal type. It included 151 patients diagnosed with low back pain and knee osteoarthritis. The inclusion criteria in the study were: the age over 35, algic and functional symptoms determined clinically and radiologically, in the lower area and in the knees, without comorbidities, patients who agreed to participate in the survey.
The exclusion criteria were: the age below 35, suggestive symptoms of neurological disorders, physiotherapy treatment in the past 5 months, dermatologic diseases, epilepsy, decompensated chronic conditions, neuropsychiatric disorders, non-cooperating patients.
The patients who accepted to participate in the survey and to which were applied ultrasounds were divided into two groups:

- a group of patients diagnosed with low back pain
- a group of patients diagnosed with knee osteoarthritis

All the patients also made physiotherapy.
The evaluation of all the patients was made at the beginning of the treatment, 2 weeks after the beginning of the treatment and at the control, 5 weeks after the end of the application therapy. The demographic variables were registered (age, sex, height) and the body weight. The evaluated parameters were: pain, functional skills, articular rigidity and the quality of life.
The pain was evaluated by using the VAS scale (values between 0 = no pain and 10 = unbearable pain) and the subscale of pain in the WOMAC Index (it contains 5 questions, the score between 0 = no pain and 20 = maximum pain).
In order to evaluate the functional skills, the subscales were used: rigidity (2 questions, value 0 = no rigidity and 8 = maximum rigidity) and the physical function (17 questions, scor 0 = normal, scor 68- severe functional limitation) for knee osteoarthritis and the Roland-Morris Disability Assessment Questionnaire for the low back pain (the minimum score is 0 = no disability and the maximum score is 24 = disability). In order to evaluate the quality of life, was used Quality of life QOL scale (with 16 questions, score 16 = "unhappy" and score 112 = "delighted").

The demographic variables were registered (age, sex, height) and the body weight).
The equipment used for the ultrasounds was Chattanooga Intellect Mobile Ultrasound that produces ultrasound with the frequency of 1 MHz.
This was the chosen frequency because it is known the fact that there is a connection between energy absorption and application frequency.
Thus, at high frequency, the energy is absorbed especially on the surface and it does not reach the target area whereas at the too low frequency, the ultrasounds reach deeply with energy dissipation along the way.
The intensity of the ultrasounds used in the survey was 0.6W / cm^2, in a pulsed way, a dynamic method for 5 minutes, daily use for 2 weeks, by using a gel with therapeutic properties (non-steroidal anti-inflammatory for the topical administration).
It was not allowed the topical administration of another anti- inflammatory, the tegument was always cleaned with alcohol before the beginning of the procedure.
The kinesiotherapy program for the low back pain lasted for 30 minutes a session and monitored the muscle relaxation in the subacute phase, and toning the paravertebral muscles and the psoas-iliacus muscle.
In the chronic phase the emphasis was on toning the paravertebral muscles and the abdominal ones, by using Williams method. The objectives were: to reduce pain, to improve the functional skills, to increase the force for the abdominal muscles and for the paravertebral ones, to improve the quality of life. The kinesiotherapy program for knee osteoarthritis lasted for 30 minutes a session and included passive, active mobilizations and active with resistance, as well as coordination and balance exercises, useful in the recovery of the posture and gait. The objectives were: to decrease the pain, to improve the functional skills, to increase the force for the abdominal muscles and for the paravertebral ones, to increase stability, to recover the static and dynamic balance for the posture and gait, to improve the quality of life.

Demographic data

The group of patients diagnosed with low back pain included 78 patients, among which 40 (51.29%) were female and 38 (48.71%) were males, whereas the group of patients diagnosed with knee osteoarthritis included 73 patients among which 36 (49.31%) were female and 37 (50.69%) were males. The data were registered in Table no. 1.
It is found that most of the patients were in the age group of 35-49 years and 50-64 in the group with low back pain whereas in the group with knee osteoarthritis in the age group of 50-64 years and over 65 years. The variables and measurement time were identical in both groups.

Statistical analysis

The collected data were entered in the Microsoft Excel program and were calculated: the minimum, maximum and average values, the standard deviation.
In order to compare the average values of the quantity variables was used the "t -student" test to see if the hypothesis was confirmed.

Results

The pain decreased by 28.57% 2 weeks after the beginning of the treatment and 5 weeks after the completion of the therapeutic interventions, for both groups. From the beginning of the treatment until the control 7 weeks later, the pain improved by 57.14 % in both study groups. The functional skills that enable the daily activities were evaluated with the help of Roland Morris questionnaire, they improved 2 weeks after the beginning of the treatment and 5 weeks after the completion of the treatment with 14.28% in the group with low back pain.
In the group with knee osteoarthritis, the increase in the functional skills, evaluated with the help of WOMAC subscale, was of 33.33% 2 weeks after the beginning of the treatment and of 16.66% 5 weeks after the completion of the treatment.

From the beginning of the treatment until the control 7 weeks later, the functional skills improved by 28.57% in the patients with low back pain and by 50% in the patients with knee osteoarthritis.

Two weeks after the beginning of the treatment and five weeks after the completion of the therapeutic interventions, the group with knee osteoarthritis registered a decrease in the stiffness of the joints by 28.57%, and then, from the beginning of the treatment until the control 7 weeks later, the decrease was of 57.14%

The quality of life, another important parameter, increased 2 weeks after the beginning of the treatment by 11.49% in the group with low back pain and by 13.79% in the group with knee osteoarthritis.

Two weeks after the beginning of the treatment and 7 weeks after the completion of the treatment, the quality of life improved by 13.79% in the group with low back pain and by 21.83% in the group with knee osteoarthritis.

From the beginning of the treatment until the control 7 weeks later, the quality of life increased by 25.28 % in the group with low back pain and by 35.63% in the group with knee osteoarthritis (Table no. 2).

Discussions

The effects of the use of ultrasounds is found in the decrease of pain, the stiffness of the joints and the contracture of the muscles, as shown by the results of several surveys. (8) The method of using therapeutic ultrasounds is non- invasive, it is produced by sound waves, it has no side effects and it can be used in the recovery treatment. The effects of the use of ultrasounds in the pulsed way enabled the decrease of the inflammation, the relaxation of the muscles, the regeneration of the tissues, then the obtained results were similar to those in the specialty literature (9, 26). Sonophoresis favors the absorption in the skin of an inflammatory applied topically to the deep tissues, by influencing inflammation and by decreasing pain (14). The current survey proved that the use of the therapeutic ultrasounds is a safe treatment to decrease the pain and the rigidity of the joints, as well as to improve the physical activities of patients with KOA, results confirmed by the survey of Wu (15). The therapeutic use of the ultrasounds enabled the decrease of the pain and rigidity, the improvement of the functional skills in patients with knee osteoarthritis, which is confirmed by a systematic review and a meta-analysis published in 2019 (15), but also in other surveys (12, 19, 35-37). Our survey proves that the use of ultrasounds decreases pain and increases the functional skills, it influences the physical function more obviously in patients with knee osteoarthritis, which is an aspect found in others surveys (19). Even if there is evidence to support the nonpharmacological options for the treatment of knee osteoarthritis, the survey of Selten (38) suggests that these therapies are still unused. The therapeutic ultrasounds were used as a non-pharmacological option in the recovery treatment in our survey. They are useful for the management of pain, for the influence on the physical function (12,15,39,40), for the improvement of the functional skills, for the healing of soft tissues, results found in other surveys (12,41).

The surveys of Cochrane (42) show that ultrasounds have an important role in the patellar syndrome and knee osteoarthritis, acting on the biomolecules. In our survey we used low intensity ultrasounds (0.6W /cm ^{2}) and we obtained the expected biological effects, as shown by the specialty literature. The survey of Ahmadi (43) points out that the biological effects of the ultrasounds are obtained when using low intensities. The use of a complex ultrasound treatment (in the pulsed way to avoid thermal effects) and kinesiotherapy enabled in our research the decrease of the pain and of the rigidity in the joints, the increase of the functional skills and the quality of life, whereas these obtained results are in accordance with those of others surveys (44). DURMUS (45) in his survey communicated the results of a survey in which he shows the role of using ultrasounds and pharmacological therapy, together with the physical exercises in order to decrease pain and

disability, to improve mobility and the quality of life for the people diagnosed with low back pain (46-52).

The limitations of the current survey are given by the relatively small number of patients included in the study. It is necessary to make clinical surveys on long periods in order to verify the persistence of the effects of the ultrasound therapy for the clinical and functional improvement of patients diagnosed with osteoarticular diseases.

Conclusions

The use of the therapeutic ultrasounds can have the following effects: the decrease of the pain and of the joint rigidity, the improvement of the physical capacity for daily activities and the improvement of the quality of life. The use of low intensity ultrasounds can determine biological effects with actions for a short period or for an average one. The statistically significant results were obtained after the use of the ultrasound therapy in knee osteoarthritis.

It is important to combine ultrasounds and kinesiotherapy in the management of the osteoarticular diseases.

Author contributions.

All the authors had the same contribution

Conflict of interest.

The authors declared no conflicting interest

Accordance to ethics standards.

The study complies with the rules of ethics and deontology according to the legislation in force.

Table no. 1. Distribution of patients in the two groups.

Variable	**LBP group**		**KOA group**	
	Baseline *(mean, SD)(95% CI)*		**Baseline *(mean, SD) (95% CI)***	
Age (years)	52 ± 11.36 (35 to 75)		62 ± 12.27 (35 to 78)	
	Female	Male	Female	Male
35-49 years	15	18	10	10
50-64 years	16	14	13	12
> 65 years	7	8	13	15

Table no. 2. Evolution parameters evaluated for the 2 groups

VARIABLE	**Baseline *(mean, sd) (95% ci)***	**10 wk *(mean, sd) (95% ci)***	***p* - value ***	**Baseline *(mean, sd) (95% ci)***	**20 wk *(mean, sd) (95% ci)***	***p* - value ***
LBP group						
VAS	7 ± 1.61 (4 to 10)	5 ± 1.24 (2 to 7)	0.0229	7 ± 1.61 (4 to 10)	3 ± 0.63 (1 to 4)	0.0496
Roland-Morris	14 ± 2.13 (11 to 17)	12 ± 1.67 (9 to 15)	0.0042	14 ± 2.13 (11 to 17)	10 ± 2.11 (10 to 13)	0.0018
QOL	65 ± 6.43 (50 to 70)	75 ± 7.56 (56 to 80)	0.0032	65 ± 6.43 (50 to 70)	87 ± 11.98 (62 to 90)	0.0039
KOAgroup						
VAS scale	7 ± 1.59 (3 to 9)	3 ± 0.77 (2 to 6)	0.0231	7 ± 1.59 (3 to 9)	3 ± 0.77 (1 to 4)	0.0442
WOMAC pain	14 ± 1.04 (13 to 16)	10 ± 0.16 (10 to 11)	0.0154	14 ± 1.04 (13 to 16)	6 ± 0.56 (4 to 6)	0.0314
WOMAC stiffness	7 ± 0.49 (6 to 7)	5 ± 0.47 (4 to 5)	0.0157	7 ± 0.49 (6 to 7)	3 ± 0.49 (2 to 3)	0.0361
WOMAC daily activities	30 ± 10.31 (30 to 60)	20 ± 7.74 (15 to 40)	0.0452	30 ± 10.31 (30 to 60)	15 ± 2.69 (10 to 19)	0.0372
QOL	56 ± 7.54 (40 to 65)	68 ± 7.17 (50 to 75)	0.0059	56 ± 7.54 (40 to 65)	87 ± 11.68 (62 to 90)	0.0099

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Retrospective study

Effectiveness of the multi-/interdisciplinary neurorehabilitation program in young patients with incomplete myeloradicualar injuries after spinal cord injury

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ABSTRACT: Nowadays young persons may be frequent victims of traumatic cervical spinal cord injury (CSCI). Material and methods A retrospective study (January 2019-March 2021) we conducted with the approval of the Ethics Commission of THEBA, to assess the results of the complex medical rehabilitation program during the subacute period. A selected group of 23 young tetraplegic patients with traumatic CSCI, were admitted to the THEBA Neuromuscular Rehabilitation Clinic with incomplete (AIS-B, -C, -D) myeloradicular injuries. All patients were males, aged between 19 and 57 years (with a mean of 44.35 years, SD 12.9). Patients came from urban areas 11 (48%) and the remaining 12 (52%) from rural areas. Results The spine lesion location was located at C2 vertebral level (4 men), C3 (4 men), C4 (3 men), C5 (6 men); C6 (in 2 patients); C7 (in 2 men); T6 and T7 in 1 patient each. The patients' neurological levels of injury were: C1 (in 2 patients), C2 (in 2 patients), C3 (in 4 patients), C5 (in 7 patients), C6 (in 4 patients) and C7 (in 2 patients). The AIS/ Frankel degree at admission was: incomplete lesion AIS-B 3 patients, AIS-C 11 patients, AIS-D 9 men. The average muscle strength at admission was 60.72 (SD 25.74). In the study group 20 patients were operated: anterior osteosynthesis was performed in 16 patients and posterior vertebral approach in 4 patients. The neurological evolution was favorable: at discharge there were only patients with incomplete AIS-C (8 men), respectively AIS-D (15 men) grade type of lesions, and their average muscle strength at discharge was 71.97 (SD 22.30). The following comorbidities were associated: arterial hypertension (in 2 patients), traumatic brain injury (in 14 patients), alcoholism (in 9 patients), pneumonia (in 6 patients), neoplastic disorders (in 1 patient), gastric ulcer (in 2 patients), depression (in 2 patients). Complications of the immobilization syndrome were: enterocolitis (in 3 men), bronchopneumonia (in 3 patients), urinary tract infections (in 13 patients) and bedsores (in 2 patients). Discussion Effectiveness of the final therapeutic approach was assessed (in percentage) by evaluating the progress of the muscle strength (quantified and compared at discharge vs. admission) reported to the number of days of treatment. The external-internal variations of the numeric scores of the quality of life, FIM, Ashworth and Penn were evaluated. Statistics was performed for small groups (Anova and Pearson) to establish the effectiveness of the rehabilitation program, evaluating the level of correlation between the scores quantified with the aforementioned the scales. An inversely proportional relationship was found between spasticity and efficacy of physical therapy (F 0.000, Pearson -0.35), between the scores of Penn scale and the effectiveness of physical therapy (F test 0.000, Pearson -0.18), respectively directly proportional relationship between the kinetic therapy and FIM (F test 0.000, Pearson 0.74), similar to the relationship between physical therapy and the scores assessing the quality of life (F test 0.01, Pearson 0.02). Conclusions These results underline the importance of a multi-interdisciplinary team approach in the management of the tetraplegic patients after CSCI during the subacute post-lesional/ post-operative stage.

Keywords: *neurorehabilitation program, incomplete myeloradicualar injuries, spinal cord injury*

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INTRODUCTION

In the contemporary world, scientific advances have changed the lifestyle, which influences medical problems (especially among young people) (1,3,5,9). Spinal cord injuries are a serious health problem in this population category, and the attempt to return to a normal life is made with the help of a multidisciplinary medical recovery team (4,7,13,15). Among the therapeutic-recovery modalities, medical gymnastics is an essential place, by stimulating neuroplasticity, neurogenesis and neurorecovery (2,6,8,10,11,12,14,16-20).

Material and methods

A retrospective study (January 2019-March 2021) we conducted with the approval of the Ethics Commission of THEBA, to assess the results of the complex medical rehabilitation program during the subacute period. A selected group of 23 young tetraplegic patients with traumatic CSCI, were admitted to the THEBA Neuromuscular Rehabilitation Clinic with incomplete (AIS-B, -C, -D) myeloradicular injuries. The statistical processing of the information was done using Office Windows 2013. Effectiveness of the final therapeutic approach was assessed by evaluating (in percentage) the progress of the muscle strength (quantified and compared at discharge vs. admission) reported to the number of days of treatment. The external-internal variations of the numeric scores of the Quality of Life (QOL), Functional Independence Measure (FIM), Modifiesd Ashworth Scale (MAS) and Penn were evaluated.

Statistics was performed for small groups (Anova and Pearson) to establish the effectiveness of the rehabilitation program, evaluating the level of correlation between the scores quantified with the aforementioned the scales.

All patients were males, aged between 19 and 57 years (with a mean of 44.35 years, SD 12.9).

Patients came from urban areas 11 (48%) and the remaining 12 (52%) from rural areas.

The spine lesion location was located at C2 vertebral level (4 men), C3 (4 men), C4 (3 men), C5 (6 men), C6 (2 patients), C7 (2 men), T6 and T7 in 1 patient each.

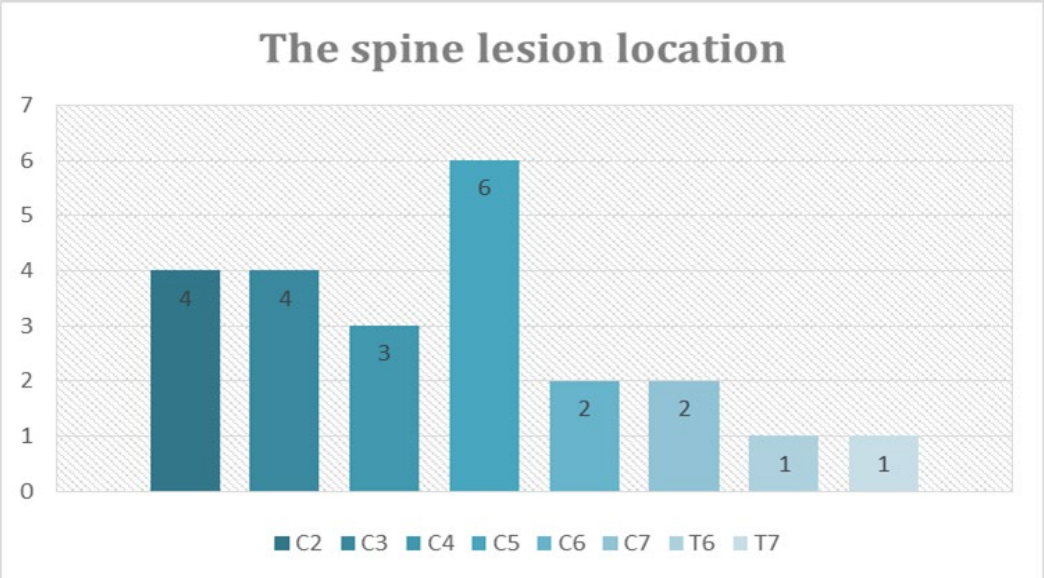

Fig no1. The spine lesion location

The patients' neurological levels of injury were: C1 (2 patients), C2 (2 patients), C3 (4 patients), C5 (7 patients), C6 (4 patients) and C7 (2 patients).

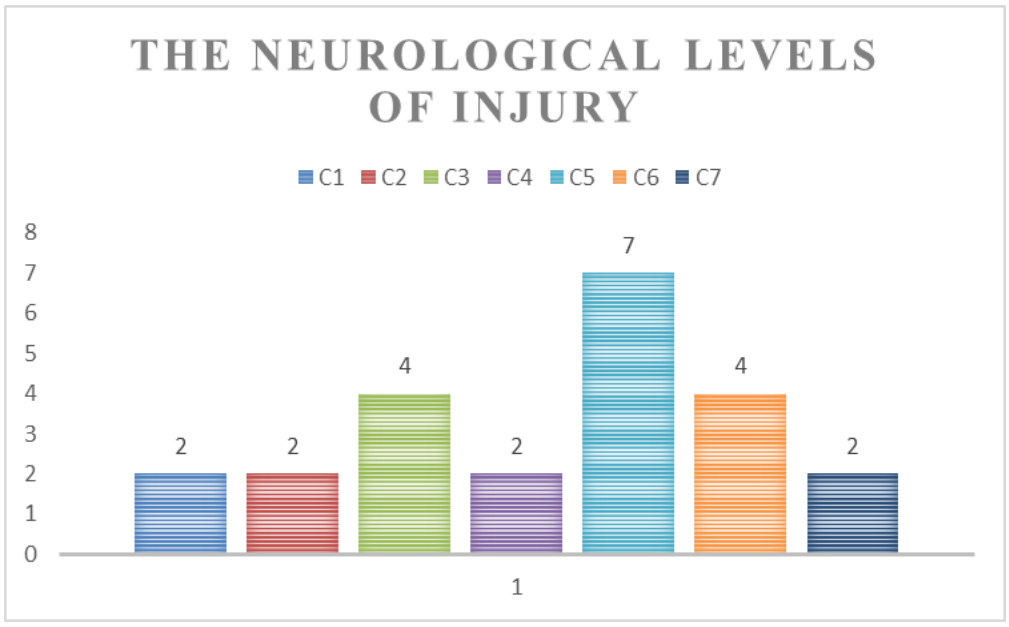

Fig no2. The neurological levels of injury

In the study group 20 patients were operated: anterior osteosynthesis was performed in 16 patients and posterior vertebral approach in 4 patients.

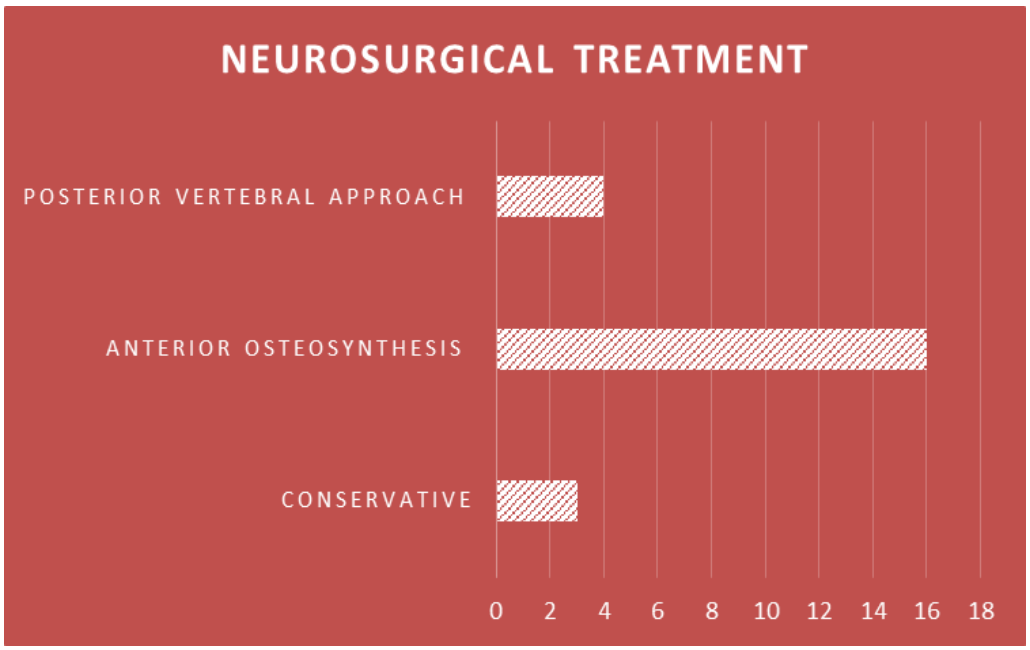

Fig no3. The neurosurgical treatment

The following comorbidities were associated: arterial hypertension (2 patients), traumatic brain injury (14 patients), alcoholism (9 patients), pneumonia (6 patients), neoplastic disorders (1 patient), gastric ulcer (2 patients), depression (2 patients).â

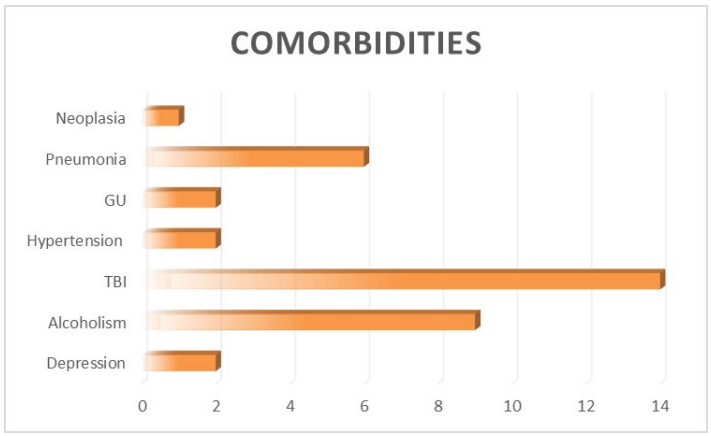

Fig no4. The comorbidities asscociated

Complications of the immobilization syndrome were: enterocolitis (3 men), bronchopneumonia (3 patients), urinary tract infections (13 patients) and bedsores (2 patients).

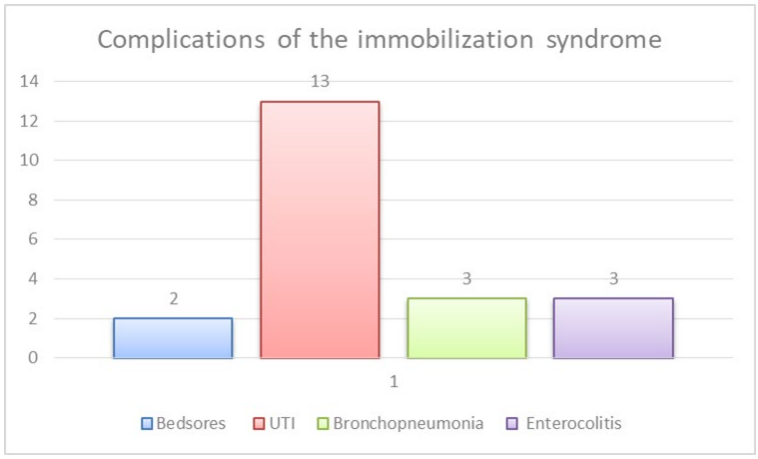

Fig no5. Complications of the immobilization syndrome

The AIS/ Frankel degree at admission was: incomplete lesion AIS-B 3 patients, AIS-C 11 patients, AIS-D 9 men. The neurological evolution was favorable: at discharge there were only patients with incomplete AIS-C (8 men), respectively AIS-D (15 men) grade lesions.

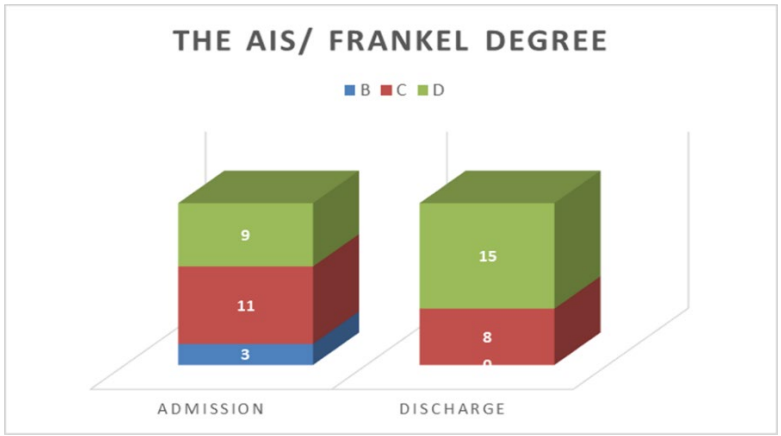

Fig no6. The neurological evolution of the patients

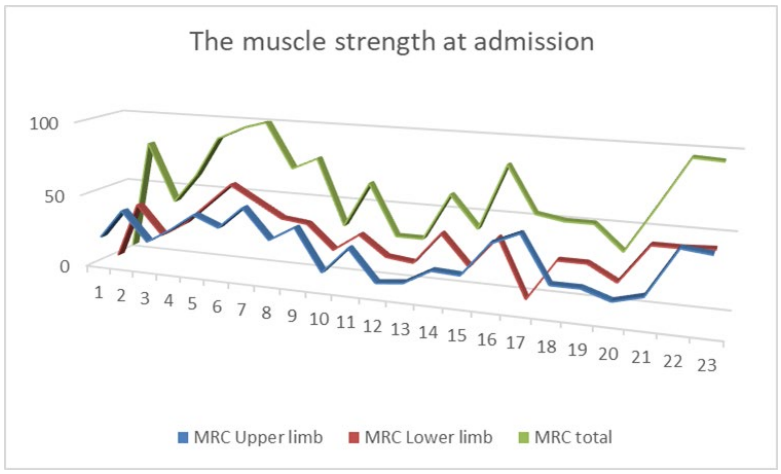

Fig no7. The muscle strenght at admission

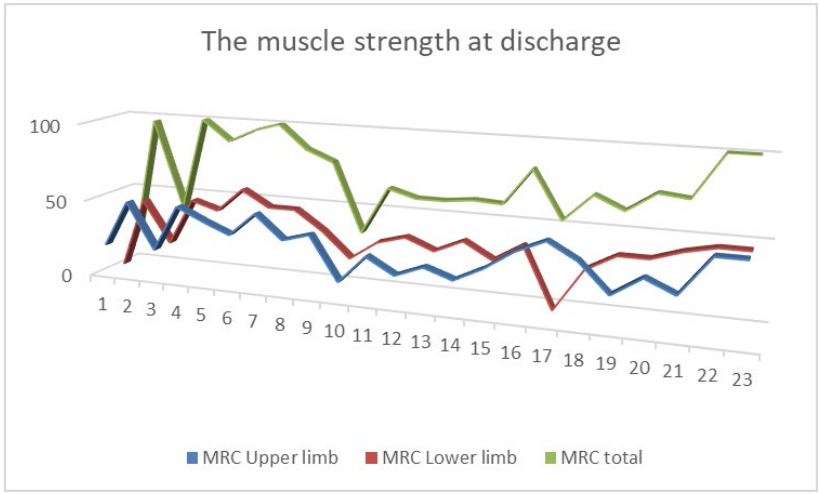

Fig no8. The muscle strenght at discharge

The average muscle strength at admission was 60.72 (SD 25.74). The average muscle strength at discharge was 71.97 (SD 22.30).

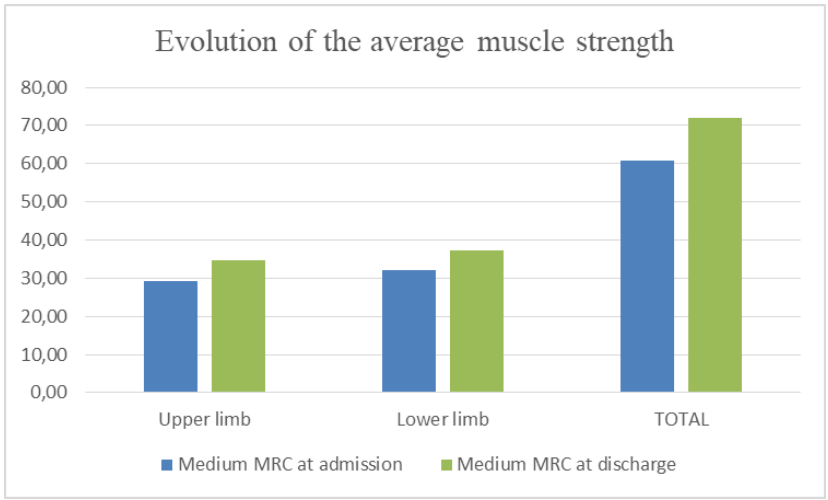

Fig no9. Evolution of the average muscle strength

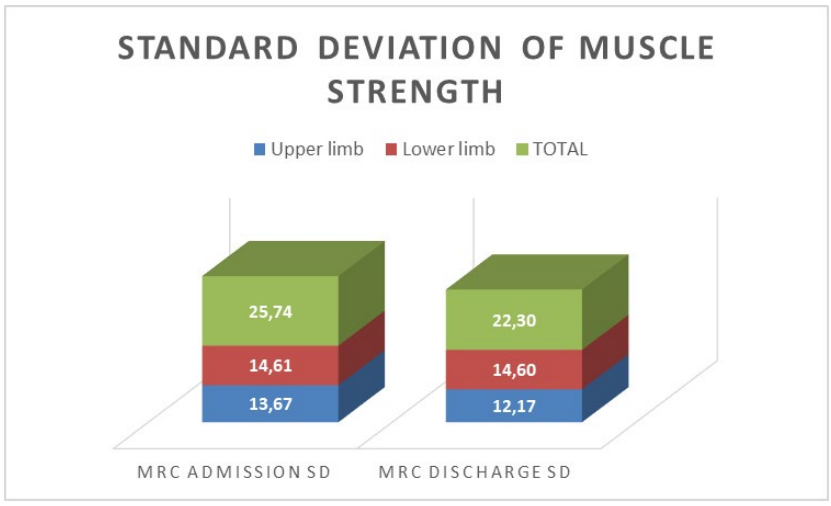

Fig no10. Standard deviation of muscle strength

An inversely proportional relationship was found between spasticity and efficacy of physical therapy (F 0.000, Pearson -0.35) and between the scores of Penn scale and the effectiveness of physical therapy (F test 0.000, Pearson -0.18).

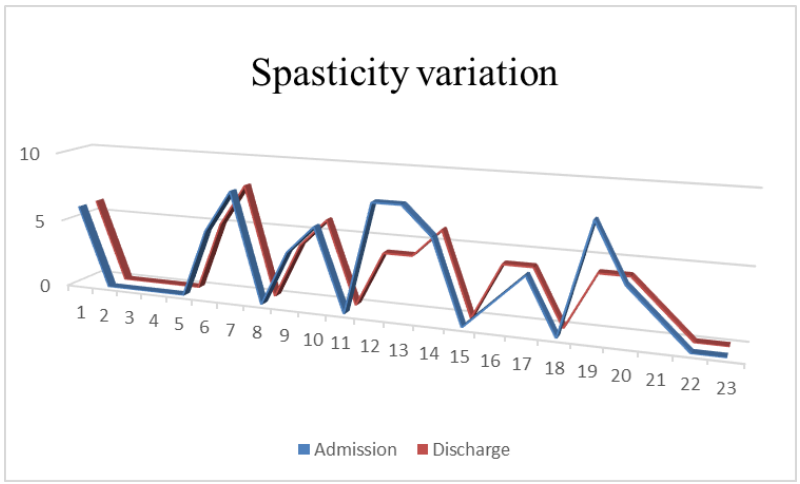

Fig no11. Spasticity variation

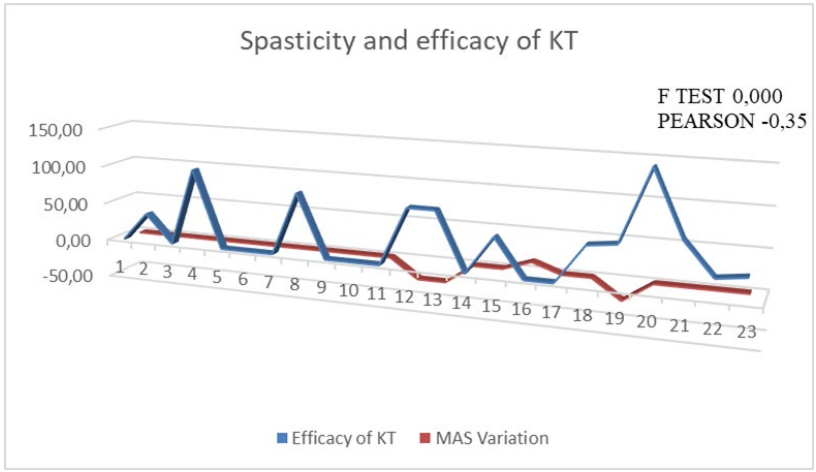

Fig no12. Spasticity and affecacy of KT

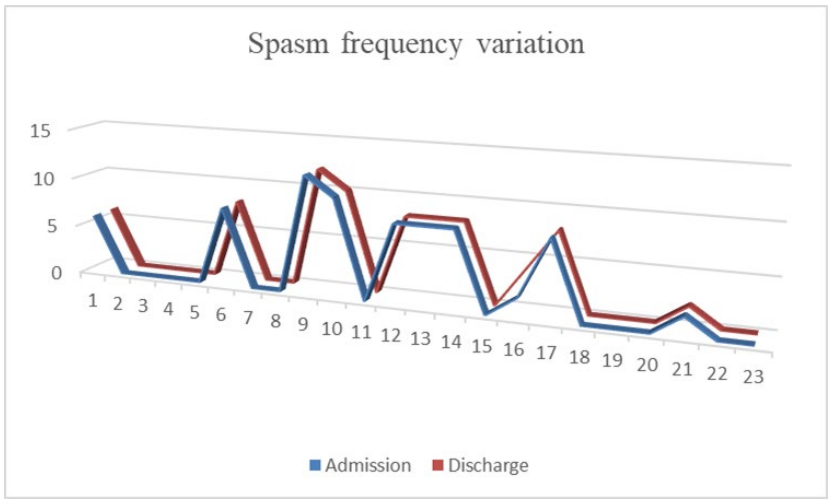

Fig no 13. Spasm frequency variation

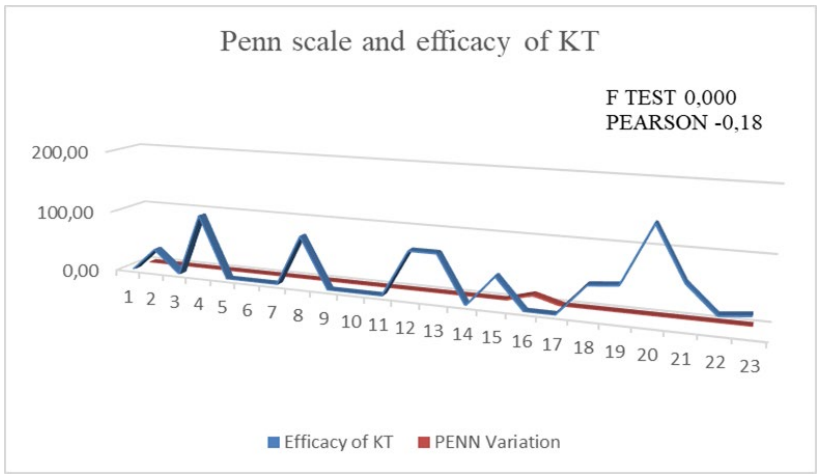

Fig no14. Penn scale and efficacy of KT

An directly proportional relationship was found between the kinetic therapy and FIM (F test 0.000, Pearson 0.74), similar to the relationship between physical therapy and the scores assessing the quality of life (F test 0.01, Pearson 0.02).

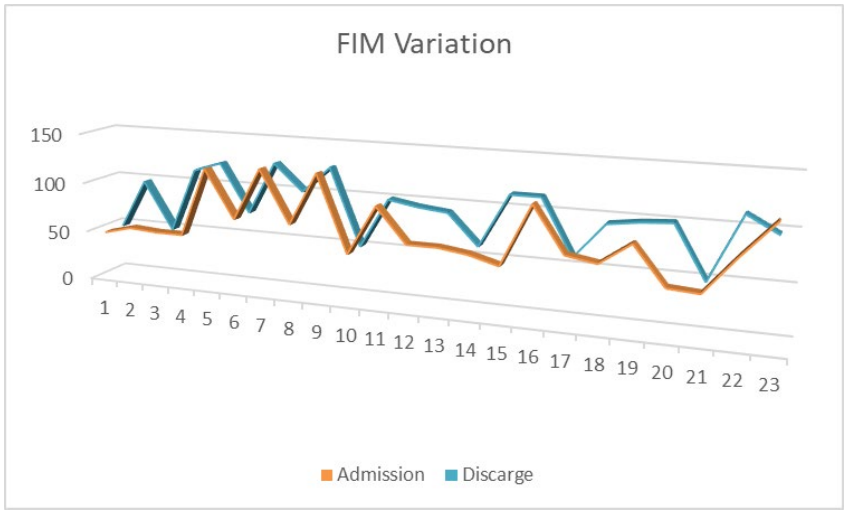

Fig no15. FIM variation

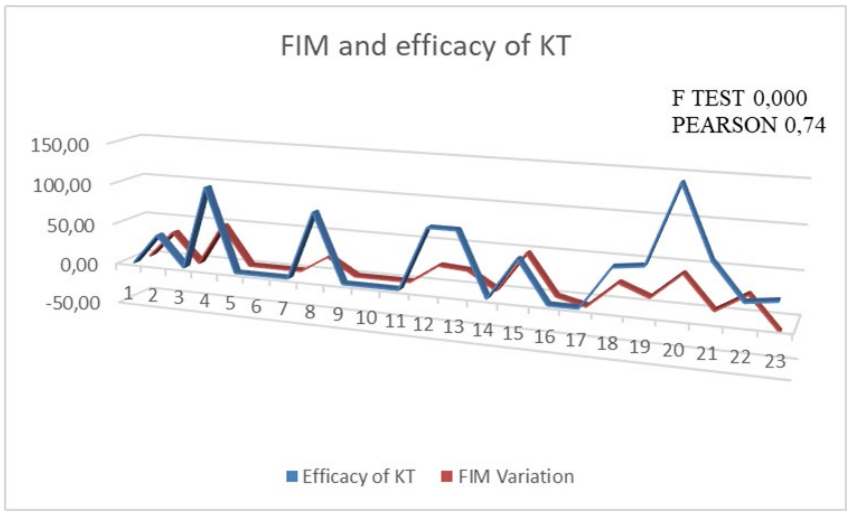

Fig no16. FIM and efficacy of KT

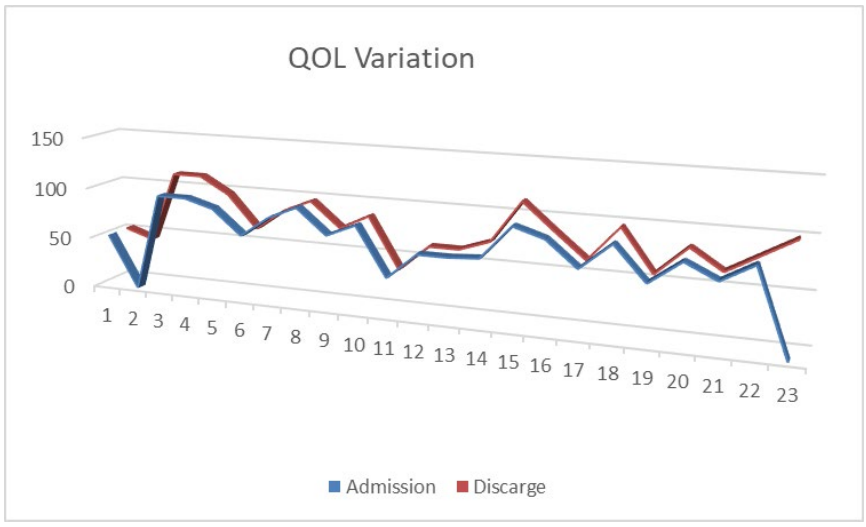

Fig no17. QOL variation

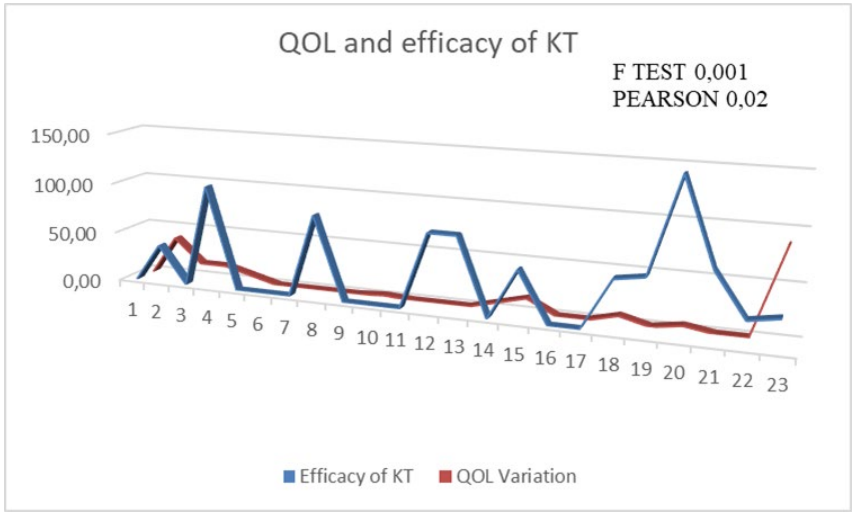

Fig no18. QOL and efficacy of KT

Discussion

An inversely proportional relationship was found between spasticity and efficacy of physical therapy (F 0.000, Pearson -0.35), between the scores of Penn scale and the effectiveness of physical therapy (F test 0.000, Pearson -0.18), respectively directly proportional relationship between the kinetic therapy and FIM (F test 0.000, Pearson 0.74), similar to the relationship between physical therapy and the scores assessing the quality of life (F test 0.01, Pearson 0.02).

Conclusions

These results underline the importance of a multi-interdisciplinary team approach in the management of young tetraplegic patients after CSCI during the subacute post-lesional/ post-operative stage.

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Case presentation

Clinical particularities regarding rehabilitation treatment of a young patient with right pontine ischemic stroke, resulting in dysarthria and left side brachial and crural hemiparesis, and quite recent COVID-19 history

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ABSTRACT: Introduction. Cerebrovascular attacks are one of the leading causes of mortality and morbidity in the world. The most severe are considered to be pontine strokes, because of the high risk of vital functions impairment. The clinical presentation of a pontine stroke can vary from the classical crossed syndrome (ipsilateral cranial nerve palsy and contralateral motor and/or sensory impairment) to pure motor hemiplegia or pure sensory stroke, which are less common.[1]
Materials and methods. This presentation describes the case of a 39-year-old patient with a recent history of untreated SARS-COV 2 infection that was followed in the next month by a sudden onset of facial paralysis, dysarthria and a progressive left hemiplegia. The patient's functional status was assessed in our Neuromuscular Clinical Division and he underwent a rehabilitation program consisting of physical, occupational and speech therapies. Multidisciplinary efforts were made in order to find the underlying cause of the pontine ischemic stroke.
Results. The patient had a personal history of cardiovascular disease risk factors (essential hypertension and hyperlipidaemia), without other pathological brain imagining outcomes and normal bleeding tests. The suspicion of an interatrial communication was raised. The patient managed to rapidly maintain the standing posture and to practice walking with unilateral support. At discharge, the facial paralysis and dysarthria were almost completely remitted. The left brachial extremity also showed signs of improvement, as the patient was able to perform flexion and extension movements of the fingers, wrist and forearm.
Conclusion. To conclude, the patient's evolution was favourable, although the certain cause of the underlying stroke has not been clarified. The neurological complications of COVID-19 include ischemic strokes, and cases were reported in young adults too[2,3]. If this were the case, prevention of further cerebrovascular attacks and their complications is necessary[1]. Caution in terms of medium/long-term prophylactic anticoagulant therapy and careful control of associated cardiovascular disease risk factors has been proposed and discussed in the multidisciplinary team: rehabilitation physician, neurologist, cardiologist.

Keywords: *cerebrovascular attacks, COVID-19, cardiovascular disease risk factors, ischemic strokes, rehabilitation*

1. INTRODUCTION

Pons is the largest component of the brainstem located distal to the midbrain and proximal to the medulla oblongata (1). Any obstruction of blood supply to the pons, whether acute or chronic, causes pontine infarction, a type of ischemic stroke (1).

The most common causes of pontine infarction include small artery disease, large artery atherosclerosis, and cardiogenic emboli, with the latter two being less frequent causes (4). The majority of the blood supply of pons is from the paramedian perforating arteries and the short circumferential arteries which arise from the basilar artery of the posterior circulation (1).
Risk factors for pontine stroke: hypertension, diabetes, smoking, hypercholesterolemia, history of ischemic heart disease, hypercoagulable states, and vasculitis (1).
Infarction can also result from atheromatous plaques in the larger arteries (vertebral or basilar artery), which in turn can obstruct blood flow to the smaller perforating arteries of pons (microatheromas) (5).

Materials and Methods:
Having the patient's consent, this article presents the case of a 39-year-old male patient with a recent history of untreated SARS-COV 2 infection (late March 2021) that was followed in the next month by a sudden onset (12.04.2021) of facial paralysis, dysarthria and progressive left hemiplegia with crural (moderate) and brachial (severe) motor deficit.
On 16.04.2021 he was admitted in the National Institute of Neurology and Neurovascular Disease, where he was diagnosed with right pontine ischemic stroke.
He was admitted in our Neuromuscular Rehabilitation Clinic on 23.04.2021 where he underwent a rehabilitation program consisting of physical, occupational and speech therapies.
Regarding the patient's medical history, of great importance were hypercholesterolemia and hypertension which are cardiovascular risk factors, and also iron deficiency anemia.
On admission, the patient was fully conscious and oriented, in a good general state and he was able to maintain the sitting and standing positions, with a discreet balance disorder. He presented asymmetrical facial expression with central type left facial paresis.
Cardiovascular system examination on admission
- normal heart sounds, with no pathological murmurs
- Pulse = 105 bpm
- BP = 140/70 mmHg

Respiratory system examination on admission
- bilateral vesicular murmur present
- no signs of respiratory failure
- SpO2 = 96% spontaneously

Digestive system examination on admission
- supple abdomen
- painless on superficial/deep palpation,
- liver and spleen within normal limits

Urogenital tract examination on admission
- impalpable kidneys
- physiological urination

Cranial nerves examination on admission
- symmetrical pupils
- asymmetrical facial expression with central type left facial paresis
- dysarthria, dysphonia

Muscle tone examination on admission
- predominantly left brachial hemiplegia
- muscular force LEFT upper & lower limbs: proximal and intermediary MRC=3/5 and distal MRC=1/5

Sensitivity examination on admission:
- discrete left hemi-body hypoesthesia

OTR (osteo-tendinous reflexes) examination on admission:

- reduced on all levels, but more visible on the LEFT side
- Babinski reflex: positive on the LEFT side

Functional evaluation

The patient was dynamically evaluated using the following scales: Barthel Index, MOCA (Montreal cognitive assessment), Ashworth, GOS-E (Glasgow outcome scale extended), Rankin, QOL (quality of life scale), FAC. (functional ambulation categories), ADL (activities of daily living scale), MRC (muscle power scale). As it can be observed in the table below, considerable favorable evolution has been made, especially if analyzing the Barthel Index (65/100 on admission and 80/100 points on discharge) and ADL scale (3/6 on admission and 5/6 on discharge).

Table 1. Scales on admission vs. discharge

SCALES	ON ADMISSION	ON DISCHARGE
Barthel Index	**65/100**	**80/100**
MOCA	24/30	27/30
Ashworth	1+	1
GOS-E	4	5
Rankin	4	3
QOL	74/112	82/112
FAC	2	4
ADL	**3/6**	**5/6**

Moreover, important muscle power development has been made, considering the patient's MRC scores on admission in comparison to discharge. On admission, our patient scored a 1 (Flicker or trace of contraction) for distal force in his left limbs and on discharge he scored a 3 (Active movement against gravity), whereas for proximal and intermediary force on the same side, he scored a 3 on admission (Active movement against gravity) and a 4 on discharge (Active movement against gravity and resistance).

Table 2. MRC Muscle Power Scale

Score	Description
0	No contraction
1	Flicker or trace of contraction
2	Active movement, with gravity eliminated
3	Active movement against gravity
4	Active movement against gravity and resistance
5	Normal Power

Interdisciplinary consultations

Cardiology:

- EKG= R wave hypovoltage in V1
- Blood tests show high CK & CK-MB. and inflammatory syndrome
- Recommendations: transoesophageal echocardiogram to exclude interatrial communication

Neurology (April 26th):

- No signs of meningeal irritation
- Central left facial paresis, moderate dysarthria
- Reduced on all levels, but more visible on the LEFT side
- Hemiplegic gait with unilateral support
- Recommendations: antiaggregant therapy (aspirin), lipid lowering treatment (statins), antihypertensives and cerebral MRI

Neurology (May17th):

- Reduced left hemiparesis compared to earlier consultation

- Upper LEFT limb: finger flexion 4/5, extension 3/5, hand flexion on arm 3-4/5, arm flexion on forearm 4/5
- Lower LEFT limb: proximal and intermediary 4/5
- Hemiplegic gait without unilateral support

Paraclinical examination

Cerebral MRI: Right hemipons lesion in T2 hypersignal, T1 hypersignal, without restrictions on the difusion sequences. Post right hemipons ischemic CVA status. No other lesions observed.

Doppler echocardiography: Left ventricle- normal kinetic energy. Normal ejection fraction.

Cardiac ultrasound: raises suspicion of an interatrial aneurysm -> thrombophilia tests and additional cardiologic investigations are recommended.

Thrombophilia tests (CRP, Lupus anticoagulant, S protein, C protein, Activated protein C resistance APCR, anti-β-2-Glycoprotein-1 antibodies, IgM, IgA) were all negative.

Transoesophageal echocardiogram: Left ventricle- normal contractility & emptying velocity. Left & right ventricle systolic frequency- normal. Mitral valve- supple cusps, normal regurgitation. Aortic valve- 3 supple cusps. Congenital malformations: hypermobility of interatrial septum without visible communication on Doppler examination; contrast agent did not pass the valves.

Case particularity

Multidisciplinary efforts were made in order to find the underlying cause of the pontine ischemic stroke (Cardiology, Neurology, Oro and Maxillofacial surgery). Thrombophilia tests were all negative, and other investigations showed no important modifications and the cerebral MRI showed no signs of vascular anomalies.

Taking all the investigations and consultations into consideration, it is very possible that the cerebrovascular attack was favoured by the patient's cardiovascular risk factors and post SARS COV-2 infection status.

Clinical diagnosis

Left side brachial and crural hemiparesis, dysarthria and dysphagia, due to a right pontine ischemic stroke that happened shortly after an untreated SARS COV-2 infection.

Rehabilitation program- general objectives

Considering the patient was diagnosed with left side brachial and crural hemiparesis, dysarthria and dysphagia, the rehabilitation program's objectives consisted of full body mobilisation, walking practice, fine grasp practice with left hand, vocal re-education and dysphagia resolution.

These objectives have been met through ergotherapy, logopaedics and kinesiotherapy, consisting of the following exercises:

- Elbow articulation
- Shoulder articulation
- Hand muscles, fist and fingers articulations
- Lower limb articulation
- Knee articulation
- Foot muscles, ankle and foot articulations

Results

The patient managed to rapidly maintain the standing posture and to practice walking (with unilateral support if necessary) on long distances. On discharge, the facial paralysis and dysarthria were almost completely remitted. Moreover, the left brachial extremity also showed signs of improvement, as the patient was able to perform flexion and extension movements of the fingers, wrist and forearm.

Recommendations on discharge

The following recommendations have been made on discharge:

- Adequate hydration (2 litres/day), normocaloric diet (high protein, high fibre, low fat)
- Correction of iron deficiency anaemia

- Avoidance of screen exposure (TV, Laptop etc.) for more than 2 hours/day, with a distance of at least 3.5 meters when watching TV
- Continuation of kinesiotherapy exercises. A cane is to be used when walking longer distances
- Active and passive exercises of hand and fingers of the upper left limb.
- Maxillary and neck muscles strengthening exercises as indicated by the Logopaedic specialist

Conclusions

To conclude, the patient's evolution was favourable, although the certain cause of the underlying stroke has not been clarified. The neurological complications of COVID-19 include ischemic strokes, and cases were reported in young adults too (2,3). If this were the case, prevention of further cerebrovascular attacks and their complications is necessary (1). Caution in terms of medium/long-term prophylactic anticoagulant therapy and careful control of associated cardiovascular disease risk factors has been proposed and discussed in the multidisciplinary team: rehabilitation physician, neurologist, cardiologist (6-12).

Conflict of interest

No conflict of interest declared. This study has approval of the **Ethics Commission** of the Clinical Emergency Hospital "Bagdasar-Arseni" (N.O. 24389/28.06.2021)

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Case presentation

Clinical and rehabilitative considerations in a complex case of spastic tetraplegia, mixed aphasia, secondary encephalopathy – post severe traumatic brain injury with hemorrhagic and ischemic lesions – with favorable late evolution and post-symptomatic status after SARS-COV-2 infection

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ABSTRACT: The traumatic brain injury remains a current research topic considering the severity and the increased incidence of this pathology. Both physical and neuro-psychological sequelae require a complex rehabilitation program. **Material and methods.** We describe the evolution of a 20-year-old case, victim of a severe traumatic brain injury due to physical aggression, with spastic tetraplegia, extended ischemia in the left cerebral hemisphere, mixed aphasia, post-traumatic encephalopathy, left eyelid ptosis, right paresis of nerve III, post remitted status of left subdural hematoma, post remitted status of right fronto-parietal subarachnoid hemorrhage, severe joint stiffness (right elbow and fist, bilateral hips and knees), cachexia and SARS-COV-2 infection. In our clinic the patient followed medical, complex kinetotherapeutic treatments and was functionally assessed using the following scales: modified Ashworth, Penn Spasm Frequency Scale (Penn), Life Quality Assessment (QOL), Montreal Cognitive Assessment (MoCA), FAC International Scale, Glasgow Outcome Scale-Extended (GOS-E), modified Rankin scale (mRS). **Results.** During the hospitalization, the patient presented a favorable late evolution with a great improvement of motor and neurological deficit, aphasia in remision, improvement of eyelid ptosis and joint stiffness, fact also confirmed by the increasing scores from the evaluated scales. **Conclusions.** Consequently in traumatic brain injury the proper medication, personalized rehabilitation program, ergotherapy, speech therapy, a great deal of involvement and documentation of current information is required to improve the patient's quality of life.

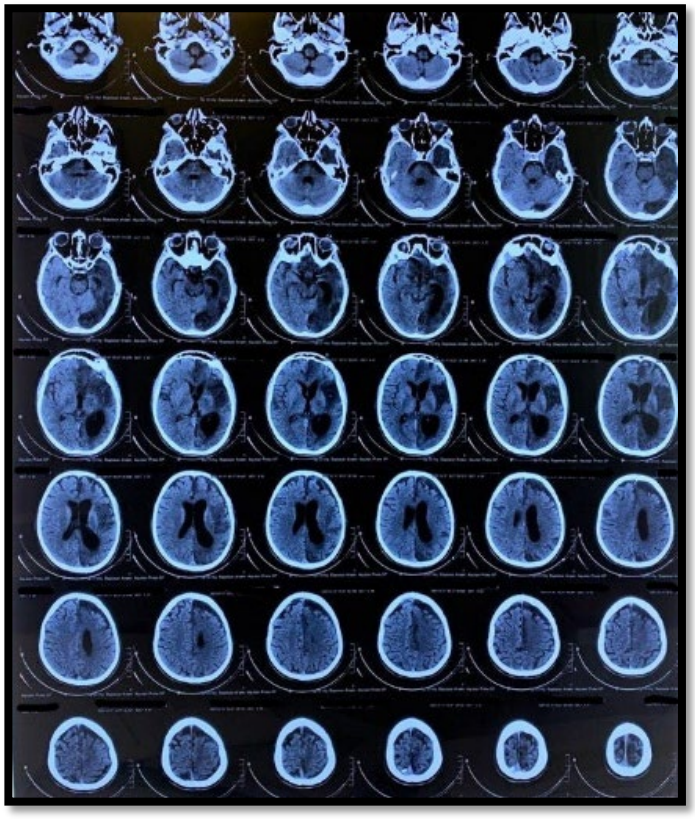
Keywords: *traumatic brain injury, neuro-rehabilitation program, spastic tetraplegia*

1. INTRODUCTION

Traumatic brain injury (TBI) stands as a major public health problem and one of the most important challenges for neurological rehabilitation, (1) it requires dramatic, heroic therapeutic measures in the acute phase; involves complex, long-term, sophisticated and expensive medical recovery programs in the subacute and chronic phases (2) Aggression is one of the most common consequences of traumatic brain injury (TBI) (3). The intensity of the recovery treatment is individually adapted (4) Recovery phase involves gaining as much independence as possible, improving the quality of life so that the patient can be reintegrated into society (5-11).

Materials and Methods: This paper presents the case of a 20-years-old patient, victim of a physical aggression in November 2020 with severe traumatic brain injury, brought to a territory hospital with a serious, comatose general condition GCS=6 and spastic tetraplegia. Dragging evolution in ICU with prolonged febrile syndrome, inflammatory syndrome, infectious syndrome, sinus tachycardia. Dynamic brain CT showed the withdrawal of subdural hematoma and subarachnoid hemorrhage but the maintenance of ischemia in the left hemisphere. Carotid doppler examination ruled out carotid lesions (carotid dissection). Then she transferred to the neurology department. The patient is initially fed on the gastrostoma, later the swallowing disorders are alleviated and the gastrostoma is suppressed. It was necessary to mount orthoses at the right elbow and right tibiotarsal joint. Motor deficit such as spastic tetraplegia is maintained but also important, painful joint stiffness that prevents the patient's mobilization. In March 2021 she was hospitalized at TEHBA Neurosurgery IV where the case was considered to have no neurosurgical indication, then transferring to our Neuro-Muscular Recovery department. At admission, at the clinical examination, the patient had a mediocre general condition, cachexia, pale, dry skin and mucous membranes, bilateral calcaneus ulcers grade I-II, postoperative scar right hypochondrium, excavated chest, SpO2=96% spontaneous; BP=110/60 mmHg; HR= 125 bpm rhythmic; important joint stiffness at the level of right upper limb: elbow joint 85 degrees, fist 105 degrees; and of right lower limb: knee 60 degrees; controlled micturition in adult diapers. Neurological examination: conscious patient; disoriented temporally, spatially and in person; answers monosyllabically to questions, not always correct, answers frequently " I don't know"; psychoemotional lability with phenomena of negativity (refusal to eat, refusal to mobilize limbs on command); paresis of left nerve III; right anisocoria>left anisocoria; spastic tetraplegia with predominance of right hemiplegia; apparent hyperpathy without objective sensivity disorders; significant amyotrophy in all limbs. Paraclinical examinations and interdisciplinary consults: CT in dynamics showed relief of hemorrhagic lesions, but maintaining the area of extensive ischemia of the left cerebral hemisphere.

Carotid doppler examination ruled out carotid traumatic lesions that exaplain ischemia. Cardiac Ultrasound ruled out the presence of intracavitary thrombi.



Radiography of the pelvic joint showed demineralization of bone segments, discrete narrowing of the bilateral coxo-femural joint space and bone productions in the vicinity of the great trochanter and of the posterior acetabular contour on the right side.

Clinical diagnosis : Spastic tetraplegia with predominance of right hemiplegia, mixed aphasia, deteriorating psychoorganic syndrome, paresis of left nerve III, all in remission, post severe TBI in a polytraumatic context (aggression) with left subdural hematoma and right fronto-parietal subarachnoid hemorrhage, left cerebral ischemia, sinus tachycardia in treatment, cachexia, severe joint stiffness right elbow and fist, bilateral hip and knee, post SARS-COV-2 infections status.

The neuro-muscular rehabilitation program:

The objectives of the recovery program:

1. Improving the quality of live
2. Posture correction
3. Recovery of locomotive capacity as much as possible
4. Improving the capacity for coordination, control and balance

RESULTS BASED ON HOSPITALIZATION SCALES AND AFTER THE RECOVERY PROGRAM		
BEFORE RECOVERY PROGRAM	**AFTER RECOVERY PROGRAM**	**EVOLUTION**
mAshworth = 4	**mAshworth** = 3	**mAshworth = -1**
Penn **L** UP = 2 **R** UP = 4 **L** LL = 2 **R** LL = 4	**Penn** **L** UP = 1 **R** UP = 2 **L** LL = 1 **R** LL = 2	**Penn** **L** UP = **-1** **R** UP = **-2** **L** LL = **-1** **R** LL = **-2**
QOL = 28 / 112	**QOL** = 61 / 112	**QOL** = **+ 33**
MoCA = 2 / 30	**MoCA** = 16 / 30	**MoCA** = **+ 14**
FAC = 0	**FAC** = 0	**FAC** = 0
GOS-E = 3	**GOS-E** = 3	**GOS-E** = 3
Modified Rankin scale (Mrs) = 5	**Modified Rankin scale (Mrs)** = 4	**Modified Rankin scale (Mrs)** = **-1**

5. Improving joint mobility, endurance and muscle strenght
6. Reintegration into society

The patient underwent medication treatment with injectable anticoagulant, brain trophic, decotracting, B and C vitamins, iron preparations, symptoms, hydro-electrolytic rebalancing, physical therapy (kinesiotherapy), speech therapy and psychotherapy. The patient followed an individualized medical recovery program. Initially it was achieved with great difficulty due to the patient's physical and mental condition. Subsequently was performed : passive, passive-active and active joint gymnastics of the upper and lower limbs at the patient's bed; progressively mobilized with the bed, at the edge of the bed with help; progressive mobilization in a wheelchair and performing exercises at the physiotherapy

room: for the lower limbs exercises with movable plate, pedalboard; for the upper limbs exercises with dumbbells and in the end verticalization at the trellis.

Results and discussion: Slow favorable evolution, the patient during hospitalization: conscious, more cooperative, with a slight improvement of the motor deficit, with the persistence of joint stiffness in the right lower and upper limbs, with good tolerance in a wheelchair, with gradual increase in range of motion, with increased tolerance to pain, with obvious improvement in speech disorders and psycho-emotional lability. During the hospitalization the patient was diagnosed with SARS COV-2 positive and she was being hospitalized in a covid support hospital with a medium form.

As complications, due to the prolonged immobilization in decubitus, the above-mentioned joint stiffness appeared with a slowly favorable evolution through kinesiotherapy but with the need for orthopedic evaluation and necessity treatment.

The case presented being a polytrauma through aggression implies neurological, orthopedic and psychoemotional involvement.

As a particularity of the case we mention the presence and necessity of the recovery treatment of both hemorrhagic and ischemic lesions at the cerebral level. If hemorrhagic lesions have resolved with conservative treatment, the extensive ischemic lesion of the cerebral hemisphere still requires medical treatment and monitoring as well as physical therapy and speech therapy.

Conclusion: In conclusion, the presented case had an undulating evolution specific to severe neurological lesions that required initial prolonged immobilization in bed, later compensated by the intense recovery program. This was possible only through teamwork, the collaboration of the patient and the belongings and with the multidisciplinary medical team.

Conflict of interest No conflict of interest declared.

This study has approval of the Ethics Commission of the Clinical Emergency Hospital " Bagdasar-Arseni" (N.O. 24389/28.06.2021)

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Case presentation

Features of complex therapeutical rehabilitation management with favorable evolution in a patient with right hemiplegia, mixed aphasia and optic atrophy post surgical removal of be-nign intraventricular tumor (central neurocytoma)

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ABSTRACT: Central neurocytoma (CN) is a benign brain tumor located intraventricularly and classified as grade II by the World Health Organization in 2000 (classification of tumours of the central nervous system). CN is frequently found in young adults and may increase intracranial pressure causing obstructive hydrocephalus, manifested by neurological symptoms such as headaches and vision problems. CN has a relatively good prognosis, provided a complete surgical resection is performed. **Materials and Methods**: In this presentation, we describe the case of a 21-year-old patient with a personal history of headache, vomiting and decreased visual acuity in both eyes, who was admitted to the Neurosurgery Clinic III of THEBA. Following clinical and paraclinical assesements, the patient was diagnosed with a left lateral ventricular tumor with extension in the right lateral ventricle and the third ventricle. The neurosurgery team decided a total resection of the tumor would be the best approach in this case. The biopsy report revealed that it was a central neurocytoma. After the surgery the patient's neurological status improved and she was admitted in the Neuromuscular Rehabilitation CinicalDivision with flaccid right hemiplegia and mixed aphasia. The patient was functionally assessed using the following scales: Functional Independence Measure (FIM), Montreal Cognitive Assessment (MOCA), modified Ashworth, Penn Spasm Frequency Scale (Penn), Life Quality Assessment (QOL), FAC International Scale, Glasgow Outcome Scale-Extended (GOS-E), modified Rankin scale (mRS), Aphasia Screening Test (AST-Whurr). **Results**: The patient showed a favorable evolution with remitted aphasia and walking traing with self-support in tertrapod walking stick. At the same time, the patient can use the plegic upper limb in performing feeding activities. **Conclusion:** It should be noted that neurosurgical intervention and pharmacological treatment, associated with an individual rehabilitation program consisting of: physical, occupational and speech therapies and also rehabilitation nursing interventions in a patient diagnosed with flaccid right hemiplegia and mixed aphasia after total surgical resection of the intraventricular central neurocytoma has improved the control of symptoms and the patient's quality of life.

Keywords: *benign brain tumor, central neurocytoma, hemiplegia, rehabilitation*

1. INTRODUCTION

Central neurocytoma (CN) comprises 0,1%-0,5% of all brain tumors. It was firstly described by Haussoun et al. in 1982 (1) and was classified as grade II by the World Health Organization in 2000 (tumors are relatively slow-growing but sometimes recur as higher grade tumors).(3)

Epidemiology: CNs are most prevalent among young adults, and nearly 25% of all cases involve individuals in their thirties. About 70% of affected individuals are between the age group of 20 and 40 years, both sexes are almost equally affected, with a male-to-female ratio of 1,02:1.(2)

Some studies have indicated higher incidences of CNs in Korea, India, and Japan, which is possibly attributed to genetic differences among racial groups that make certain individuals more prone to CNs than others . The higher incidence in these Asian countries, make this tumor an important consideration when dealing with intraventricular tumors in these populations.(2)

Tumor location: CN is classically located in the lateral ventricle and/or the third ventricle with the septum pellucidum attachement to be one of the features of the tumor. However, the most common site is the anterior portion of one of the lateral ventricles followed by combined extension into the lateral and third ventricles. However, recently, they were also found in an intra-axial location (cerebral, cerebellar, brainstem, or spinal parenchyma) and termed as "extraventricular neurocytoma" (EVN). "Cerebral neurocytoma" is the term usually used to designate both CN and EVN.(4)

Clinical manifestations: CN may increase the intracranial pressure by obstructing the interventricular foramen, which can lead to hydrocephalus. Patients may also experience nausea, vomiting, headache, seizures, decreased consciousness, weakness, and memory or vision problems (2). In rare cases, intraventricular hemorrhage may also occur. Patients with EVN present with similar symptoms, in addition to weakness and numbness in the limbs (5). These symptoms are typically present for approximately 3–6 months, although the duration of symptoms can vary from a few days to many years. The duration seems to be mostly related to tumor location, and does not seem to be correlated to the aggressiveness of the tumor (2).

Hystopathological analysis: The characteristics of light microscopic examinations include predominantly benign lesions with morphological features similar to the so-called ependymoma of the foramen of Monro, of the oligodendrogliomas and of the neuroblastomas (2). Although oligodendroglioma presents very similar features on light microscopy, on electron microscopy central neurocytoma cells are found to contain numerous synapses and to exhibit neuronal differentiation. Jerdan et al.(6) noted neuronal differentiation in similar adult intraventricular tumors but, because of the absence of synapses, designated them "differentiated cerebral neuroblastomas"(8). Immunohistochemistry and electron microscopy confirmed the diagnosis in each case, showing expression of neuron specific enolase and synaptophysin and containing microtubuli, neurosecretory granules, and presynaptic vesicles. In agreement with the literature, the authors stress the benign behaviour of most of these tumors and the need for systematic immunohistochemical and ultrastructural study. (6)

Radiological features: CN can appear as a dense mass in computerized tomography (CT) scans indicating calcifications, which occur in up to 50% of all cases, and present a patchy and coarse appearances (Fig. 1) (2). The tumor can also be heterogeneous because of the hypodense areas related to cystic degeneration . In contrast-enhanced CT scans, CNs have mild to moderate enhancements. Unfortunately, there is no estab-lished criterion to distinguish between CN and other tumors such as oligodendrogliomas on CT scans and MRI (2).

Fig. 1. Axial CT demonstrating a large hypodense central neurocytoma. Moderate, heterogenous hyperdensities are consistent with calcifications. (2)

Surgery: Surgical management with a gross-total resection is currently the gold standard treatment for CNs, which often has excellent prognosis and minimizes the chances of CN recurrence. Gross-total resection is achieved in nearly 30–50% of all CN

patients. In comparison, individuals who had surgery with only subtotal resection had an 86% five-year survival rate. Subtotal resection of CN increases the rate of recurrence and decreases the rate of survival (2).

Radiotherapy: Radiotherapy and radiosurgery are non-invasive adjuvant treatments, but the toxicities from radiation are still being weighed against the benefits of tumor control (9). Because CNs usually have excellent prognosis when gross-total resection is achieved, radiation is not always indicated (2). Radiotherapy and radiosurgery have been adopted as an adjuvant treatment when gross-total resection cannot be achieved, the patient is inoperable, or the tumor is aggressive . A recent report suggests that fractionated radiotherapy after subtotal resection had a statistically significant higher tumor control rate and improved survival in adults (2). A higher 5-year progression free survival has also been shown for patients who received adjuvant fractionated radiotherapy after subtotal resection (67%) than patients without fractionated radiotherapy (53%) (10).

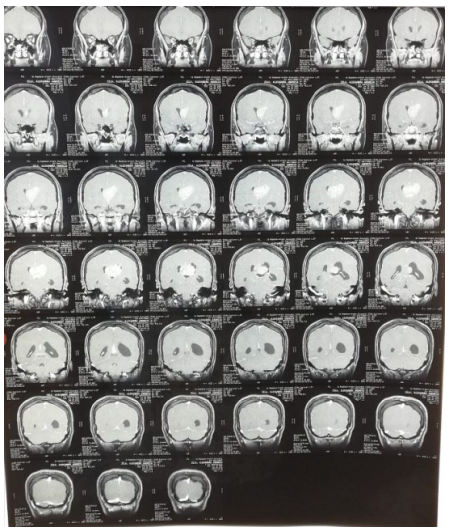
Prognosis: CN is a benign tumor, so it has an excellent prognosis. Surgery with gross total resection is the most preferable, correlated with the best long-term survival rates and local tumor control. Adjuvant radiotherapy may be considered for residual CN following subtotal resection, large CN size, or CNs near inoperable regions. Radiotherapy or chemotherapy the primary treatment for CNs has not been thoroughly examined.(2)

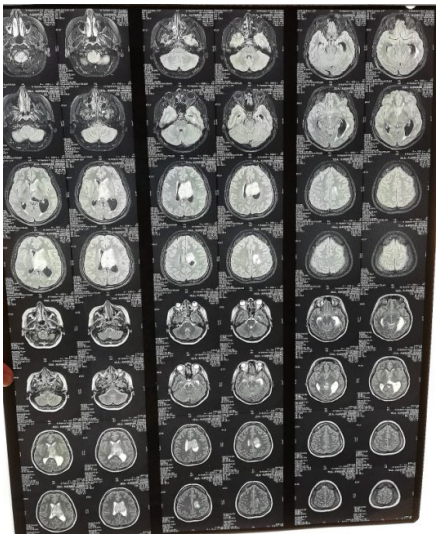
CASE PRESENTATION

This paper presents a case of a 21-year-old patient (having the approval of the Bioethics Commission no. 24389/ 28.06.2021) a personal history of headache, vomiting (appeared 2 weeks ago) and decreased visual acuity in both eyes was admitted on 07.09.2020 to the Neurosurgery Clinic III of THEBA. The patient was investigated both clinically and paraclinically.

IRM before surgery (09.09.2020) (Fig. 2, Fig. 3, Fig. 4.) revealed an extra-axial replacement process of space, developed intraventricular V III with extension in LLV and involving of the left foramen of Monro. The maximum dimensions are 52,6/39,3/25,4 mm (AP/TRA/CC). Mass effect on the lateral left ventricle that is dilated. The formation is MRI compatible with a thrid ventricle eppedimoma.

In 15.09.2020 total resection was performed, the patient having a favorable clinical evolution .





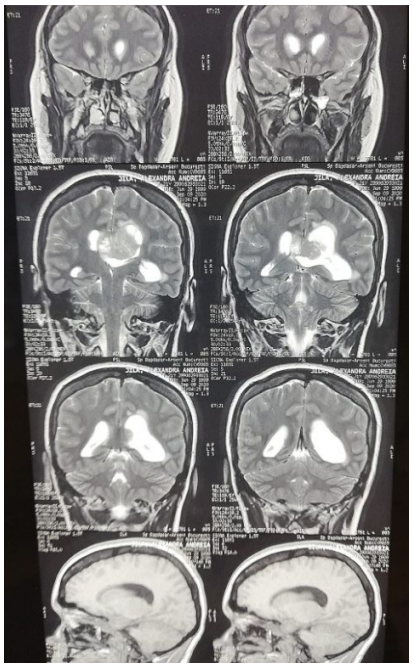


Fig. 2,3,4 IRM examination of our patient (from THEBA Neurosurgery Clinic III)

The anatomo-pathological examination revealed fragments of neoplastic tissue consisting of a proliferation of round cells, monotonous in appearance, solid in disposition, with nucleus with granular chromatin ("salt and pepper" appearance), without the presence of mitoses, zonal with clear cytoplasms with the appearance of a perinuclear halo . The cells are supported by a fibrillar stroma with the presence of isolated dendritic glial cells. Immunohistochimical tests: Synaptophysin - positive diffuse in tumor cells, NSE - positive diffuse in tumor cells, Neurofilament - negative, GFAP - negative in tumor cells, positive in glial cells in stroma, Ki 67 - nuclear proliferation index of about 2%, EMA -negative.
Conclusions: Histopathological aspects and IHC tests support the diagnosis of central neurocytoma.
After the surgery the patient's neurological status improved and she was addmited in the Neuromuscular Rehabilitation Clinical Division 05.10.2020-07.01. In our clinic, the patient initially followed a complex nursing program and subsequently a rehabilitation adequate program.
The reasons for admission included stage rehabilitation treatment, motor deficit of flaccid right hemiplegia, speech disorders of mixed aphasia, sphincter disorders.
Objective examination upon admission: she was normal weight, afebrile, with a good general state. The blood pressure was 100/60 mmHg, heart Rate 60/min and oxygen saturation 99% spontaneously , important muscular hypotonia on right limbs, post-operatory plague at frontal level, controlled urinary.
Neurological examination: temporal-spatial oriented, conscious, cooperative (execute some simple commands), motor deficit of right hemiplegia, mixed aphasia, central facial right paresis, decreased osteo –tendinous reflexes on right side, plantar skin reflexes are not obtained.
The patient was assessed functionally using the following scales:

- Spasticity = 0 on Ashworth modified scale
- Glasgow Outcome Scale-Extended (GOS-E): 3 points
- modified Rankin scale (mRs) : 5 points
- FIM (Functional Independence Measure): motor 36 points; cognitiv 6 points
- Functional Ambulation Categories(FAC) International Scale (Fig. 5): 0
- QoL (Life Quality Assessment Quality of Life), Montreal Cognitive Assessement (MOCA), Aphasia Screening Test (AST-Whurr) – NT (mixed aphasia)

From functional point of view, the patient was immobilized in bed.

Nr.	Categorie	Caracterizare
0	Nefuncţionalitate	Pacientul nu poate merge sau necesită ajutor de la 2 sau mai multe persoane
1	Dependenţă - nivel 2	Pacientul necesită sprijin ferm şi continuu din partea unei persoane
2	Dependenţă - nivel 1	Pacientul necesită sprijin continuu sau intermitent din partea unei persoane pentru ajutor cu echilibrul sau coordonarea
3	Dependenţă - supraveghere	Pacientul necesită coordonarea verbală sau ajutor potenţial din partea unei persoane fără contact fizic
4	Independenţă - pe teren plan	Pacientul poate merge independent pe teren plan, dar necesită ajutor la scări, pante sau suprafeţe denivelate
5	Independenţă	Pacientul poate merge independent oriunde

Fig 5. FAC (Functional Ambulation Categories) international scale – utilised in our clinic devision

Clinical and paraclinical evaluation

During hospitalisation, the patient presents short episodes of: anaemia normocrome corrected by medication, left anterior epistaxis treated under guideliness specified by ENT doctor, inflammatory phenomena in the left genian region treated specific antibiotics according to guideliness specified by OMF doctor (increased inflammatory markers) and the patient has been a contact with one person SARS-COV2 positive, so the patient was clinically evaluated and tested, the result being negative.

Computed tomography performed on 07.12.2021 (Fig. 6) shows: Examination performed for evolutionary control. Postoperative porencephalic cavity that communicates with the left lateral ventricle, which are large. No signs of tumor recurrence.

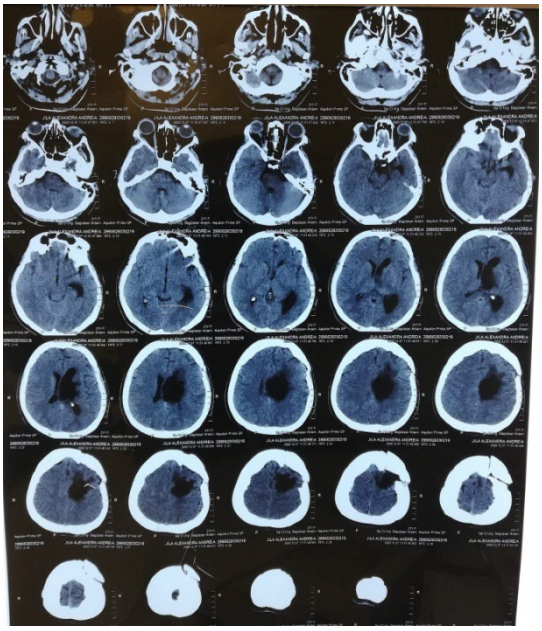


Fig. 6. Control CT examination on 07.12.2020 (from THEBA Neuro -Rehabilitation Clinic Devision)

Interdisciplinary evaluation

- ORL examination Left anterior epistaxis (vascular stain). Dapping with gelospon. Recommendations: blood count, blood coagulation. Avoid hot foods. Tarosin 4 cp / day. Emofix nasal ointment twice a day
- Ophtalmological examination: Eye bottom examination shows proeminent papillae discolored with blurred outline, emergence of vessels covered by edema extending peri- and parapapillary. Diagnsotic: papilloedema, optic atrophy, astigmatism, myopia. Recommendations: Mirtilene ginkgo 1 tb/day, Epinerv 1 tb/day, Acetazolamide 1 tb/day for 1 month after 1 tb/2 days for 1 month, Multiminerals 1 tb/day
- BMF examination: the left genian cellulite with starting point 26. Recommendations: Antibiotics: Amoxiplus 1,2 g/12 h iv for 5-7 days, Metronidazol 1g/12 h iv for 5-7 days and NSAID 1tb of 400 g x 2/day. Rigorous oral hygiene (brushing teeth after every meal).

Diagnosis

Based on the anamnesis data, on the clinical examination,and parclinical investigation the diagnosis is the following:

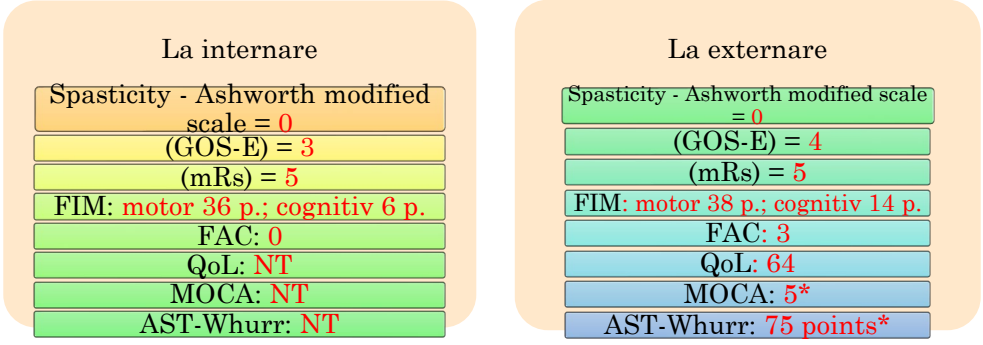
- *Right fllacid hemiplegia,*
- *Mixed aphasia after*
- *Surgical removal of left lateral ventricular tumor with extension in the right lateral ventricle and the third ventricle*
- *Partial optical atrophy*
- *Left genian cellulite*

Treatment

During hospitalization, the patient received complex treatment with: drugs (Injectable anticoagulant, anticonvulsant, cerebral anti-oedema, cerebral trophic, antibiothics, anti-inflammatory, symptomatics), physiotherapy: initially only in bed with a personalised program : passive movement at the joints level, active ones, active with left limb resistance, correct positioning in bed for prevention of vicious joints positions or thrombophlebitis, and after that at the physical therapy room: exercises at MotoMed bycicle, exercises for upper limb at pully (cuffs) and MotoMed, vertical support at wall bars, walking training with self-support in tetrapod walking stick, occupational and speech therapies, psychotherapy.

Evolution and clinical-therapeutical / recovery results

Regarding the clinical-therapeutic evolution, following the complex program of neuromuscular recovery, the patient presented a favorable evolution as can be seen from the comparative analysis we performed below through the evaluation scales, scales that allowed quantification. spasticity, motor deficit, ability in daily activities, ambulatory capacity, but also language disorder. It is noted that the 3 scales related to quality of life and language disorder, untestable at hospitalization, could be further tested subject to the fact that the patient has right hemiplegia and optic atrophy, which prevented her from obtaining a maximum score at written.



Evolution

The two photos (Fig. 7, Fig. 8) outline the patient's evolution. The first, the one on the left, was performed in November 2020, when the patient was mobilized in a wheelchair at the physiotherapy room. The positioning of the right upper limb in order to prevent edema is noted here. In the second photo, the one on the right, the patient also practices walking in a tetrapod-type cane, with the mobilization of the right upper limb, an exercise better highlighted in the videos that will follow.

Fig 7, 8. Evolution of our patient (November 2020 and June 2021) (from THEBA Neuro -Rehabilitation Clinic Devision)

CT examination 9 months after surgery (Fig.9) reveals a left frontal operative flap. The cortico-subcortical and deep porencephalic area is highlighted, which determines ventricular asymmetry with moderate left ventricular dilation - in a postoperative context. No signs of local tumor recurrence.

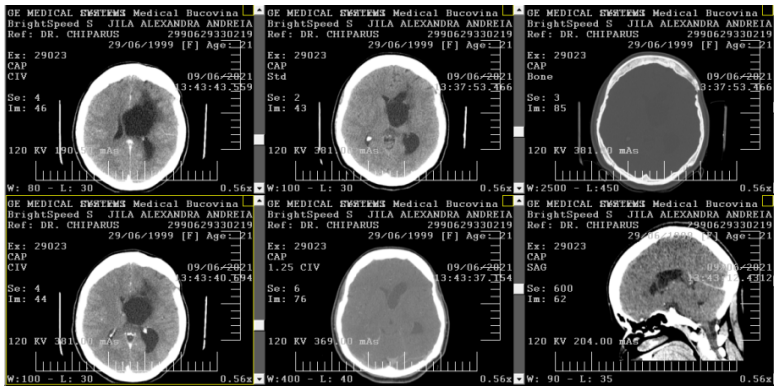


Fig. 9. CT examination at 9 months after surgery (from the patient's imaging investigations)

The patient had 3 admissions in our Clinic division (05.10.2020-04.11.2020, 06.11.2020-18.12.2020 and 21.12.2020-07.01.2021) where she benefited from a complex therapeutic program carried out by a multidisciplinary team presenting a favorable evolution proven especially after the evaluation through the scales mentioned above, with aphasia in remission and neurological improvement, being possible practicing walking with a tetrapod-type walking stick with supervision from another person. At the same time, the patient can use her right upper limb to perform feeding activities. Returned to the control 9 months after the operation in the Neurosurgery and Neuromuscular Recovery Clinics, we

mention the fact that a series of objectives were achieved such as the integration of the patient in the family, the possibility of household chores, but also the patient's contribution to the child's education process.

Prognosis

In our case the prognosis is favorable, except the at laborem prognosis who is reserved because the patient is currently practicing walking with a tetrapod-type walking stick, with the supervision of another person.

Ad vitam and ad functionem prognosis are favorable, provided that the recommendations from the discharge will be respected (drug treatment: anticonvulsant, antiaggregatory agent, cerebral trophic, recommended treatment by ophtalmologist, symptomatics, hygienic-dietary diet , avoiding emotions and conflicting states and limiting the use of telephone and television, she will continue the recovery treatment learned in the hospital (physiotherapy, speech and occupational therapy) (11-15).

Conclusion

It should be noted that neurosurgical intervention and pharmacological treatment, associated with an individual rehabilitation program consisting of: physical, occupational and speech therapies and also rehabilitation nursing interventions in a patient diagnosed with flaccid right hemiplegia and mixed aphasia after total surgical resection of the intraventricular central neurocytoma has improved the control of symptoms and the patient's quality of life

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Case presentation

Case report and related comments in a relatively young male patient with right hemiplegia after left thalamo- mesencephalic hemorrhage and a consequent Parinaud syndrome – interdisciplinary therapeutic – rehabilitative approach

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ABSTRACT: Thalamo- mesencephalic hemorrhage is a devasting event, with a increased morbidity and mortality rate. Parinaud's syndrome, also known as the dorsal midbrain syndrome, is characterized by a supranuclear vertical gaze disturbing, resulting from an insult to the mesencephalic tectum. **Matherial and Method**. We report the case of a 45-year-old man with personal antecedents of arterial hypertension, obesity and type 2 Diabetus mellitus, who was first admitted in the Neurology Clinic Division of the Teaching Emergency Hospital Bucharest with a sudden onset of complete right hemiplegia, mixed aphasia and right central– type facial palsy on 17.04.2021, being diagnosed – following complex paraclinic investigations -with a left thalamo- mesencephalic hemorrhage. **Results and discusssion**. The patient followed a neuro- muscular rehabilitation program in our Neuro- Rehabilitation Clinic Division with favorable outcomes, the case representing a real challenge regarding the complexity of the factors involved. **Conclusions.** The clinical outcomes and the quality of life of patients suffering from thalamo- mesencephalic hemorrhage depend both on the prompt diagnosis and the efficient treatment, followed by an appropriate rehabilitation program.

Keywords: *neuro-rehabilitation, thalamo-mesencephalic hemorrhage, Parinaud syndrome*

1. INTRODUCTION

Hemorrhagic stroke is bleeding in the brain parenchyma, due to a ruptured normal or abnormal blood vessel, determining the sudden reduction of blood supply in the brain area (stroke) and the accumulation of blood in the brain tissue (hemorrhage/hematoma) with consequent events (1): mechanical damage associated with the mass effect, cytotoxicity of blood, hypermetabolism, excitotoxicity and oxidative stress and inflammation.
Clinically, most common symptoms and signs are: headaches, oculomotor disturbances, sensitive deficits, cerebellar involvement (ataxia, dysmetria, dysarthria), mental status disturbances (drowsiness, stupor, coma), dysphagia and motor deficits.
Brain vascular malformations are the leading cause of intracerebral hemorrhage (ICH) in young adults (2). Other secondary mechanism for ICH include: oral anticoagulants: warfarin/ coumarin derivates overuse, brain trauma, brain tumor complications. (3)
Primary causes are arterial hypertension, cerebral amyloid angiopathy. Cerebral amyloid angiopathy refers to the accumulation of β-amyloid in the media and adventitia of mostly cortical vessels, which can lead to leakage of blood through the vessel wall (4).

Vascular risk factors for developing an ICH are: smoking, alcohol abuse or diabetes mellitus. Intracranial vascular malformations (IVM) are: arterial aneurysms, brain arteriovenous malformations (BAVM), cavernous malformations (CM), dural arteriovenous fistula (DAVF).

Intracranial vascular malformations (IVM)			
Arterial aneurysms	Brain arterio-venous malformations (BAVM)	**Cavernous malformations (CM)**	Dural arteriovenous fistula (DAVF)

Table 1: IVM

Most common VM underlying ICH are BAVM and CM. Cavernous malformations (CM) are low-flow vascular (BAVM=high flow) lesions that are made up from sinusoidal spaces lined by a single layer of endothelium and separed by a hyaline matrix (without interposed brain tissue). (3,5) Regarding the natural history, CM occur in sporadic or familial forms.(6)

Most cavernous malformations have a benign natural history, but they may produce clinical symptoms such as: seizures, headache, focal neurological deficits and even hemorrhagic strokes. (3)

Comparing CM to other AVM in hemorrhagic stroke, in a recent study (2) the results have shown that intracranial hemorrhages caused by CMs occurred at younger ages and were less disabling than those produces by other VM (BAVM/ DAVF) and were also, purely intracerebral without intraventricular involvement.The authors concluded that a few other studies described patterns of hemorrhagic extension due to CMs rupture.

Parinaud's syndrome (7)

It is also known as dorsal midbrain syndrome and it consist of: paralysis of upgaze and accommodation, eyelid retraction (Collier sign), loss of pupillary reflex to light/ distance and convergence- retraction nystagmus. Patients complain of difficulty looking up, blurred near vision, diplopia and neurological symptoms. (8,9)

Syndromes of the midbrain have many potential etiologies, but Parinaud's syndrome occur mainly due to tumors compressing structures around the midbrain. (9)

Treatment is focused on the underlying cause and may require surgery or medication. (8)

MATERIAL AND METHODS

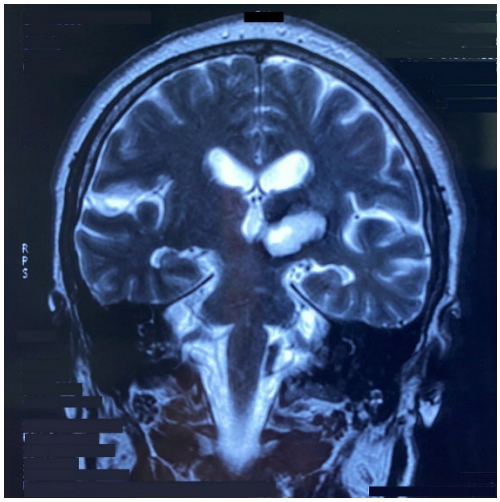
Having the patient's consent, this paper presents the case of a 45-year-old male with cardiovascular risk factors (arterial hypertension, type 2 diabetes mellitus treated with oral hypoglycaemic drugs, class III obsesity) admitted in our Neuromuscular Rehabilitation Clinical Division with: mental status disturbances (cerebrasthenia), slight dysarthria, right central facial palsy, right hemiplegia (complete brachial and crural motor deficit) and severe selfcare and locomotor dysfunction.

This case presentation received the TEHBA Ethics Committee approval No 24389/28.06.2021.

From his personal pathological history, there are to be mentioned: arterial hypertension, type 2 diabetes mellitus treated (oral hypoglycaemic drugs) and class III obsesity.

The patient was also, diagnosed with left thalamus and midbrain hemorrhagic stroke 4 weeks before the admission in our Clinical Divison (CT-examination) and followed antiplatelet drug, two antihypertensive drugs, beta-blocker and oral hypoglycaemic drug.

General examination: At admission, he was afebrile, in poor general state, with dehydrated skin, conscious but with altered mental status (cerebrasthenia), class III hyperplasic type obsesity, normal stetacustic respiratory and cardiovascular examination, BP=120/75 mmHg, HR=72 b/min, SpO2 (peripheral oxygen saturation) = 93%, without signs of neurogenic bladder/bowel: delayed intestinal transit time, normal micturition.
Neuro- mio- arthro- kinetic examination: the patient was temporo- spatial oriented, without signs of meningeal irritation, the cranial nerves examination revealed oculomotor disturbances: vertical eye movements palsy, horizontal eye movements with nystagmus, decreased pupillary light reflexes bilaterally (right eye almost abolished), dyplopia, right central facial palsy. No dysphagia. He had right hemiplegia with complete loss of motor control (0/5 MRC upper and lower limbs), external rotation of the right lower limb, no hypo/anesthesia, no proprioceptive or nociceptive impairments.
Functionality: He had the ability of self-transfering into sitting posture, with balance and tolerance for few minutes with hand support.
Laboratory findings: hyperuricemia : 7.7 mg/dL (RI=3.5-7.2 mg/dL), Iron deficiency anemia: iron: 60 µg/dL , Hg=13.4 g/dL (RI=65-175 mcg/dL ; RI Hg=14-18 g/dL), inflammatory syndrome: CRP = 0.57 mg/dL, ESR=42 mm/h(RI CRP=0-0.5 mg/dL RI ESR=3-8 mm/h), hypertriglyceridemia : 216 mg/dL(RI=0-149 mg/dL), hypo-HDL: 18 mg/dL (RI=40-60 mg/dL).
Brain MRI findings: Left thalamus and midbrain intraparenchymal hematoma (blood in the methemoglobin stage) with peripheral hemosiderin ring in T2 signal, maximum dimensions of 18.6 / 25.3 / 18.4 mm, present minimal neighborhood edema, discrete mass effect on the left lateral ventricle, without shift of the midline.
SWAN sequence (susceptibility-weighted angiography) revealed multiple round-oval images, with infra- and supratentorial topography, the largest (4 mm) in the right pons – cavernomas



1. Left thalamus and midbrain intraparenchymal hematoma: (blood in the methemoglobin stage), with a peripheral ring (hemosiderin), and maximum dimensions of 18.6 / 25.3 / 18.4 mm.
2. Multiple subcentric and supratentorial cavernomas. The largest (4 mm) right pontine - cavernous.

Fig 1: MRI aspect at admission

Functional assessment: the patient was clinically and functionally assessed, according to the standardized protocols implemented in our clinic by means of the folowwing assessment grading scales:

- Cognitive assessment: MOCA (Montreal cognitive assessment) scale (10)
- Disability: modified Rankin score (11), extended GOS (12)
- Muscle spasticity: modified Asworth scale (13) ; Penn spasm frequency scale (14)
- Ambulation capacity: FAC scale (15)
- Activities of daily living: Barhel index (16)
- Quality of life: QOL (modified after Flanagen) (17)

During hospitalisation, the patient underwent a complex recovery program which included pharmacological treatment: antiplatelet drug, two antihypertensive drugs, beta-blocker, oral hypoglycaemic drug, neurobiotrophic drugs oral + i.v, urinary anstiseptic drugs, physical treatment (kinesiotherapy) and ergotherapy.
The main general objectives of rehabilitation program were: patient's psycho-cognitive/ mental and emotional status improvement, speech disorder improvement, therapy of associated diseases, improvement of QoL and familiar and social integration.
Kinesiotherapy objectives included: motor deficit improvement: progressive neuromuscular reeducation and muscle control increase, management of muscle spasticity, gait training strategies, improving of functional hand ability: repetitive task training and ocupational therapy, cardiorespiratory rehabilitation and improvement of self-care.
Furthermore, the therapeutic approach bases on the hygienic- dietary regime consisting in low-sodiu, low- carbohydrate, and low-lipid diet, rich in vitamins and minerals and maintainance of adequate nutrition and hydration (1,5-2l/ day). Our patient should avoid skin contact with any hot liquids or objects.

Physical therapy

Until full mobilization, we recommended a kinetic bed-side programme: body positioning and passive - prolonged stretching / passive-active / active exercises for upper and lower limbs. After complete mobilization, he performed passive- active (Motomed) and active exercises (with various instruments) for training of trunk, scapular and pelvic girdles, every segment of upper and lower limbs (sinergies).
Rehabilitation is the key to regain the ability to walk after stroke, working by stimulating the brain with various physical exercises under the supervision of the therapist. For example: walking exercises with hand support and also from physical therapist, for our patient, helped him in progressive restoring movement.
Ergotherapy is an important part of rehabilitation and involves re-learning of daily activities. It consists in passive/ passive-active mobilization of the upper limbs; active exercises for plegic upper limb segments: shoulder abduction, adduction, flexion and extension, elbow flexion and extension, wrist flexion and extension, hand supination/ pronation, finger and hand gripping exercises.

Evolution

After 1 month from hospital admission, he had weak movement (1/5 MRC) of right thumb, finger flexion (2/5 MRC), forearm / arm flexion and extension (2/5 MRC), right upper limb muscle strenght (2-3/ 5 MRC) in the proximal segments and (2/5 MRC) in the distal segments.
The patient was trained, as well, with verticalization exercices at the stall bars, (he had a weak hip flexion 1/5 MRC), he walked between parallel barrs with support from physical therapist (his right lower limb muscle strenght was 3/5 MRC in the proximal segments and 0/5 MRC in the distal segments) and walked with support in tripod cane.
There are to be noticed also, the improvement of dysarthric speech, a better pshychological state, a good central facial paresis recovery: wide smile possible.
However, the spasticity remained 2/4 mAshword scale at right upper and lower limbs.
After 3 month from acute stroke: regarding the motor deficit, he had a 3/5 MRC at right upper limb and 4/5 MRC at right lower limb, with a spasticity of 2/4 mAsword at right limbs.
Oculomotor dysfunction evolution: we could notice oculomotor disturbances improvement: upward eye movements were possible asocciated with nystagmus, horizontal eye movements with nystagmus, present although low - right eye decreased pupillary light reflexes (normal left eye reflexes), dyplopia was in remission, very discrete right central facial palsy.

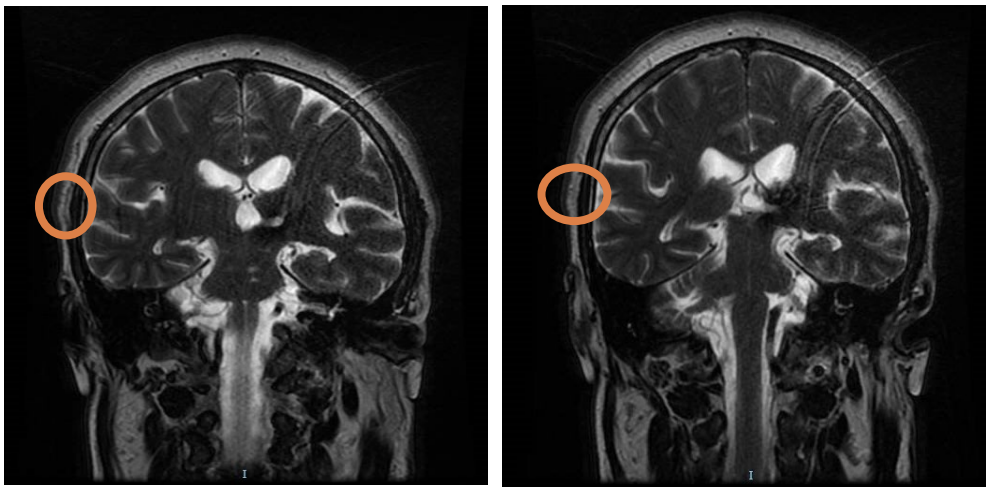


Fig 2: MRI aspect after 3 month from acute stroke

Results after first hospital admission

Cognitive asessment	Spasticity	Muscle strenght	Disability	Ambulation	Activities of daily living
MOCA scale	mAsworth scale	Total MRC right limbs	mRankin scale	Functional ambulation categories	Barthel index
14/25 **(56%)**	1/4 right upper and lower limbs	Upper limbs 0/25 → **13/25**	5/5 → **4/5**	0/5 → **2/5**	15/100 → **50/100**
		Lower limbs 0/25 → **6/25**			
	Penn scale		GOS-e scale		
	1/4 right upper and lower limbs		3/8 → **4/8**		

Cognitive asessment	Spasticity	Muscle strenght	Disability	Ambulation	Activities of daily living
MOCA scale	mAsworth scale	Total MRC right limbs	mRankin scale	Functional ambulation categories	Barthel index
27/30 **(90%)**	2/4 right upper and lower limbs	Upper limbs → **15/25**	→ **3/5**	→ **4/5**	→ **70/100**
		Lower limbs → **19/25**			
	Penn scale		GOS-e scale		
	2/4 right upper and lower limbs		→ **5/8**		

DISCUSSION

Patient's 3 month evolution was favourable, regaining good walking abilities with normal cane and having a complete independence for toilet use and personal hygiene. From the point of view of hand functionality, he became independent in eating and basic self-care.

Further neuro-muscular rehabilitation is needed in order to complete walking abilities (without hand support), to improve balance and coordination and as well, hand functionality.

Our patient had many vascular risk factors: arterial hypertension, obesity, diabetes mellitus and suffered a thalamic and midbrain hemorrhagic stroke. The young age highlighted the need for further investigations. CMs were observed supra and infratentorial brain areas and the biggest was noticed in the right pontine area, near the location of the hemorrhagic stroke.

In a clinical retrospective study (18) including patients with brain stem cavernomas and ICH, "most haemorrhagic recurrences occured within 5 years, with a clear tendency to be more frequent in the first two years" and "lesion size > 18 mm was associated with major risk of rebleeding".

Although the patient's ad functionam prognosis is good so far, regular medical visits are needed in order to detect any form of neurologic aggravation such as seizures or headache.

Vascular risk factors that need to be monitored and controlled are: blood pressure, diabetes mellitus, and the alcohol abuse (the patient denies alcohol consumption). Cholesterol levels seem to be associated with lower risks ICH. (19,20,21)

Further genetic investigations are needed to diagnose a possible familial form of CM: CCM genes (I-III). MRI screening of the kins (especially children) might be neccesary in order to clear/confirm the same lesions and acces an informed medical advice.

CONCLUSIONS

Hemorrhagic strokes account for a minority of the total strokes, still they are associated with high morbidity and the risk of reccurence (22-28).

In young patients VM, particulary CMs, predispose to serious neurologic comorbidities: seizuires, focal deficitis, hemorrhagic strokes.

Studies point out that hemorrhagic strokes caused by CMs are less disabling than those produces by other VM (6), still the risk of recurrence is high in the first two years after such an accident (18). These recurrences may be more frequent if the lesion size is large (> 18 mm) (18) and are influenced by uncontrolled BP, diabetes mellitus, smoking, alcohol abuse.

Surgical treatment options are indicated if the risks of bleeding are high, but are limited only to superficial brain areas. (18).

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Research article

Frequency of musculoskeletal disorder of upper limb in Type 2 Diabetes patients

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ABSTRACT: Diabetes is a frequently occurring chronic metabolic disease that is characterized by a high blood glucose levels. If left unchecked, it can lead to severe functional impairments such as blindness, renal failure, and coronary artery disease. Approximately 463 million adults (20-79 years) are living with diabetes; by 2045 this will rise to 700 million. **Material and method:** A cross-sectional survey was conducted in National Institute of Diabetes and Endocrinology, Dow University Hospital, Ojha campus. Patients who had T2DM, and were above 35 years of age were included in the study. Anthropometric measurements were recorded, and the remaining data was collected via a self-reporting questionnaire. **Results and discussions:** In this study n=55(36.2%) participants were male and n=97(63.8%) were female, with the average age of 52.9 years, and an average BMI of 29.5kg/m^2. The mean HBA1C of those diabetic patients was 8.8, and average duration of diabetes of our sample was 6.7 years. Prevalence of MSK disorders was 55.3%. **Conclusions:** There is a high prevalence of musculoskeletal disorders among diabetic patients. There was poor knowledge that upper limb musculoskeletal problems could occur due to diabetes, and a small percentage of patients sought physical therapy treatment for these disorders.

Keywords: *diabetes mellitus, musuculoskeletal diseases, upper extremity*

1. INTRODUCTION

Diabetes is a frequently occurring chronic metabolic disease that is characterized by a high blood glucose level (1). It can result in many musculoskeletal complications, which has been shown to proceed to severe disability in 36-75% of diabetic patients 2-8 and has a high rate of morbidity and mortality (9) . It is one of the most commonly occurring non communicable diseases, and has a greater epidemic in low and middle income countries. Diabetes generally occurs in people aged forty and above (1). If left unchecked, it can lead to severe functional impairments such as blindness, renal failure, and coronary artery disease.

The predominance of Type II Diabetes Mellitus (T2DM) is greater than that of Type I Diabetes Mellitus, due to increasing waistlines, a drop in physical activity levels, owing to industrialization of nations (9). T2DM is a hereditary, metabolic disease that causes lifetime neuromusculoskeletal abnormalities 10. This needs proper nursing care and self-management by modifying lifestyles, as well as taking different medications to manage the disease.

Approximately 463 million adults (20-79 years) are living with diabetes; by 2045 this will rise to 700 million. The proportion of people with T2DM is increasing in most countries. 79% of adults with diabetes were living in low- and middle-income countries. 1 in 2 (232 million) people with diabetes were undiagnosed.
The goal of this research was to find determine the most prevalent musculoskeletal disorders in T2DM patients, present in Karachi, Pakistan.

Material and methods
A cross-sectional survey was conducted in National Institute of Diabetes and Endocrinology, Dow University Hospital, Ojha campus.
The population in this study comprised of T2DM patients. Convenience sample was used to recruit participants.
Patients who had T2DM, and were above 35 years of age were included in the study.
People with type 1 diabetes, gestational diabetes, any history of trauma, or active malignancy were excluded from the study.
A self-designed questionnaire was used for data collection. Participants were explained the components of the questionannires, and further help was provided by the investigators if there was any confusion regarding the presence of disorders. Measurements were recorded of height, and weight. These were then used to calculate the Body Mass Index (BMI). To record pain intensity of musculoskeletal disorders, Visual Analog Scale (VAS) was used. Weight was measured using an electronic weighing scale (Senior Model DB-6020 - accurate to 0.1kg). Participants were weighed wearing light clothes and no shoes. Standing height was measured with shoes removed and the participant facing away from the wall, with the heels, buttocks, shoulders and head touching the wall and the participant looking ahead. Height was measured using a tape measure (accurate to ±1/2cm). After receiving briefing regarding the use of VAS, participants were asked to label the intensity of their pain.
OpenEpi calculator was used for the estimation of sample size. Taking a confidence interval 95%, and margin of error 7.5 % for a reported prevalence 32.9% (11), the estimated sample size was calculated at 152.
The investigation was done after obtaining authorization from ethical committee, Dow University of Health Sciences. All information was gathered by the researchers. Participants were briefed regarding the study, and the potential benefits that would be gained from developing an understanding of the common musculoskeletal disorders that ail T2DM patients.

DATA ANALYSIS
Information was evaluated through SPSS v21. Quantitative factors like age, body mass index, duration of diabetes, as well as HBA1C levels for normally distributed data mean and standard deviation were calculated. Categorical variables e.g. (gender, socioeconomic status, severity, areas) have been described using frequencies and percentages, and association between categorical variables were further explored using Chi-square test to check the proportion among different abnormalities of upper limb. P -values 0.05 or less are considered significant.

Results
In this research n=55 (36.2%) participants were male and n=97 (63.8%) were female with the average age of 52.9 years, and an average BMI of 29.5kg/m2. The mean HBA1C of those diabetic patients was 8.8, and average duration of diabetes of our sample was 6.7 years. Prevalence of MSK disorders was 55.3%. Participants had an average working day of 5 hours. Independent t-test was applied to our data set. MSK disorders were compared with different variables. Age of participants, BMI, duration of diabetes, were highly significant (p-value of 0.028, 0.035 and 0.015 respectively).

No strong association was found between MSK disorders with working hours per day, and HBA1C (p-value of 0.556 and 0.469 respectively).
The site of pain of the most patients was shoulder with 49.3%, elbow with 20.4%, wrist with 17.1% and least was finger with 4.5%.
Complications include paresthesia (53%), muscle weakness (44.7%), movement difficulties (25%), stiffness (34.2%), inflammatory disorder (11.2%) and cramps (2%).
The highest percentage observed regarding duration of MSK dysfunction people with less than 6 months was 30.3%.
Most patients relied on medication (96.6%), with only 19.1% undergoing physiotherapy treatment and 18.4% receiving both medical and physiotherapy intervention.
Among the participants who were receiving physiotherapy treatment, 2.6% had positive results, pain increased in 12.5% of patients, and no change in 5.3% patients.

Discussion

This research was conducted to determine the prevalence of MSK disorders in upper limb among type 2 diabetic patients in OJHA campus, Dow University of Health Sciences.
A majority of participants in our study experienced pain or discomfort, with the most common severity of moderate pain with 40.8%.
A similar study was done in Bangladesh, with a large majority suffering from moderate and severe pain (74%). One difference from our study was that there was a lower prevalence of upper limb disorders in this study (12).
The most common disorder we observed was frozen shoulder (24.3%). Other disorders included: carpal tunnel syndrome (5.9%), osteoarthritis of hand (4.6%), trigger finger (3.9%), cubital tunnel syndrome (1.3%), Dupuytren's contracture (3.9%), and other MSK disorders (9.2%).
A similar study was conducted in Pakistan in 2013 by Saera et al. Common disorders in their study were frozen shoulder, tendonitis, trigger finger, carpal tunnel syndrome and Dupuytren's contracture; with frozen shoulder the most prevalent (11).
Another study done in Turkey by Ardic et al had a high prevalence of frozen shoulder and Dupuytren's contracture (13).
Another study conducted in Bangladeshi correlates with our findings of BMI and duration of diabetes, but did not have significant results in relation to age (14.
Although our study did not find significant changes in pain experienced in T2DM patients, this could indicate that those who are suffering from long term diabetes require a blended approach of physical therapy and medical intervention, in order to limit the complications of the disease, and improve the quality of life.

Conclusion

There is a high prevalence of musculoskeletal disorders among diabetic patients. There was poor knowledge that upper limb musculoskeletal problems could occur due to diabetes, and a small percentage of patients sought physical therapy treatment for these disorders. The shoulder joint was mostly affected, with frozen shoulder the most common among all the musculoskeletal disorders. There was also a positive association of MSK disorder with duration of diabetes, age and BMI. The complications that come with diabetes are often overlooked and neglected, which eventually lead to disabilities. Proper care and rehabilitation are necessary components for people who have long term diabetes.

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Research article

Successful rehabilitation program after AIS/Frankel C paraplegia through a recently operated lumbar disc hernia

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ABSTRACT: Intervertebral disc herniation is the pathological process by which fragments of the nucleus pulposus tear the fibers of the annulus fibrosus and come into contact with the root of the spinal nerve (1). The most significant functional damage generated by the lumbar disc herniation is paraplegia and can be ameliorated by an early and staged specific rehabilitation program.
Materials and Methods: This paper presents the case of a 56-year-old patient who was admitted to the Neurosurgery Clinic (NCH) III of SCUBA for low back pain and motor deficit, AIS Frankel C paraplegia. The left lower limb was more affected than the right one. It occurred following a thoraco-lumbar medullary compression and a paramedian lumbar disc herniation L3. The patient was treated surgically. Subsequently, the patient was transferred to the Neuro-Muscular Recovery Clinic of SCUBA for the specific rehabilitation treatment, with indication for mobilization. He was dynamically evaluated using the following scales: quality of life assessment (QOL), modified Ashworth scale, Functional Assessment Classification, FAC, Activities of daily living (ADL), Spinal Cord Independence Measure (SCIM), evaluation of muscle strength on Medical Research Council, MRC, scale, evaluation of American Spinal Injury Association Impairment Scale (AIS).
Results: The patient benefited from a complex program of neuro-muscular rehabilitation, having a favorable evolution with an improving score of the evaluating scales and finally gaining his gait balance, including ascending and descending stairs (instrumentally assisted for left plantar dorsiflexion movement with orthosis walking). At discharge the patient's neurological deficit was reclassified as AIS D paraplegia, with the neurogenic bladder and bowel having been remitted.
Discussions: The disc herniation at L3 level generated a cauda equina syndrome, which initially generated a paraplegia. When the inflammation remitted it became clear that the left L4 root was affected, with a complete deficit of plantar dorsiflexion. In conclusion it was not a case of spinal cord syndrome (as the spinal cord ends at L2 level) or conus medullaris syndrome.
Conclusions: The interdisciplinary therapeutic approach together with a specific, customized rehabilitation program for a patient with AIS C paraplegia after a surgically treated disc hernia is successfully improving the neuromuscular deficit and upgrading the patient's quality of life.

Keywords: *rehabilitation, disc hernia, low back pain, paraplegia*

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1. INTRODUCTION

Low back pain is a prevalent symptom, as approximately 80 % of the population sustains an episode once in their lifetime. (1) Within the many differentials of low back pain, the most common cause is the intervertebral degeneration which leads to lumbar disc herniation and degenerative disc disease. (2) One of the most corelated risk factor to herniated disc and particularly lumbar disc hernia is abnormal activities and weightlifting associated with spine twist. (3) It is shown that repetitive bending, lifting and twisting movements of the back increases the pressure on the disc, thus injuring it. (4) Repetitive wrong

movements or activities and incorrect back posture in the early life can lead to regression of the disc nucleus, thus reducing the pressure. (3) Also working in fields where physical load is a daily activity corelates with developing Lumbar Disc Herniation (LDH). (4)
Some theories suggest that the higher incidence of LDH in male patients is a direct correlation with the harder labor that these perform in day-to-day activity and workplace. (5)
Spinal disc herniation is the pathological process in which a disk fragment comes from the nucleus pulposus, tears the fibers of annulus fibrosus and affects the adjacent nerve root at different grades: irritation, phase III stage I – pain; compression, phase III stage II – pain and paresthesia; interruption, phase III stage III – paralysis or paresis. (6, 7)
A spinal disc herniation phase III/stage III can cause a lower limb motor deficit as paralysis or paresis. If the prolapse is massive and paramedian, the compression of the roots is bilateral and can result in a bilateral lower limb motor deficit. (7)

MATERIAL AND METHODS.
Having the patient's consent and the approval of the Ethics Committee of "Bagdasar-Arseni" Clinical Emergency Hospital, N.O. 24386/28.06.2021, this article presents a case of a 56-year-old patient admitted in our clinic (13.05.2021) for the following complaints: motor deficit AIS C paraplegia (neurological level L2); the left lower limb was more affected than the right one. The cause was a high effort which determined a paramedian lumbar disc herniation L3 and set a thoraco-lumbar cord compression, accompanied by severe low back pain, locomotor and self-care dysfunction.
The patient is known with: operated right ankle fracture (osteosynthesis with metal material), intestinal occlusion (1995) and craniofacial trauma (1998). In 10.05.2021 the patient was admitted to the Neurosurgery Clinic and operated for left median and paramedian disc herniation at L3 level and for a fragment of the disc that migrated inferiorly. It was a L3-L4 approach with ablation of L3-L4 disc fragment.

Clinical examination:
The patient is conscious, cooperative, oriented temporo-spatially with nonspecific facial expression and postoperative lumbar scar in the process of healing with sutures present. *Cardiovascular system*: normal heart sounds, without pathological murmurs, HR = 64b / min, BP = 130/70 mmHg. *Respiratory system*: present bilateral vesicular murmur, without signs of respiratory failure, SpO2 = 96% spontaneous. *Digestive system*: supple abdomen, painless at superficial and deep palpation, liver and spleen within normal limits. *Urogenital tract*: nonpalpable kidneys, neurogenic bladder, carrier of Foley fixed urinary catheter.

Local examination:
Examination of cranial nerves: normal.
Muscle tone: upper limb – normal; lower limb – diminished.
Sensitivity: -subjective paresthesia in the lower limbs distally.
Reflexes: - normal for upper limbs; absent knee reflex for the lower limbs, bilateral; plantar reflex: present in flexion for the right lower limb.
Functional: the patient has indication for mobilization.

Examination of spine (7)
Static vertebral syndrome: diminishing of the lumbar curvature, dextro-scoliotic attitude.
Dynamic vertebral syndrome: cervical - mobility within all range of movements (flexion, extension, inflexion right and left); lumbar: limited extension, inflexion left >> right.
Muscle and Ligaments Syndrome: left paravertebral thoraco-lumbar muscular contracture >> right.
Dural syndrome: lower limbs Lassegue positive, bilateral.
Root syndrome: absent rotula reflex, bilateral; paraplegia motor deficit (bilateral L4 and left L5 root lesion); diminished tonus in lower limbs.

Psycho-emotional syndrome: afirmative.
The patient was dynamically evaluated using the following scales: Quality of life assessment (QOL),score QOL:96/112; Modified Ashworth scale; Functional Assessment Classification, FAC, score:2/5; Activities of daily living (ADL), score=3 points; Spinal cord independence measure (SCIM); Evaluation of muscle strength on Medical Research Council, MRC scale; Evaluation of American Spinal Injury Association Impairment Scale AIS: American Spinal Injury Association, ASIA motor exam: Upper limbs: 50/50 points; Lower limbs: 31 /50 points and ASIA sensory exam: light touch score: 96/ 112 points; pin prick score: 96/112 points.
Paraclinical examination
Lumbar spine radiography: narrowing of the intervertebral space L4-L5, L5-S1
Thoracic and lumbar column IRM (before surgery, see figure 1): right paramedian disc hernia L3-L4 with fragment migrated inferiorly, posterior to the L4 body, with fragment displaced at the posterior part of the spinal canal, compressing and displacing the dural sac.

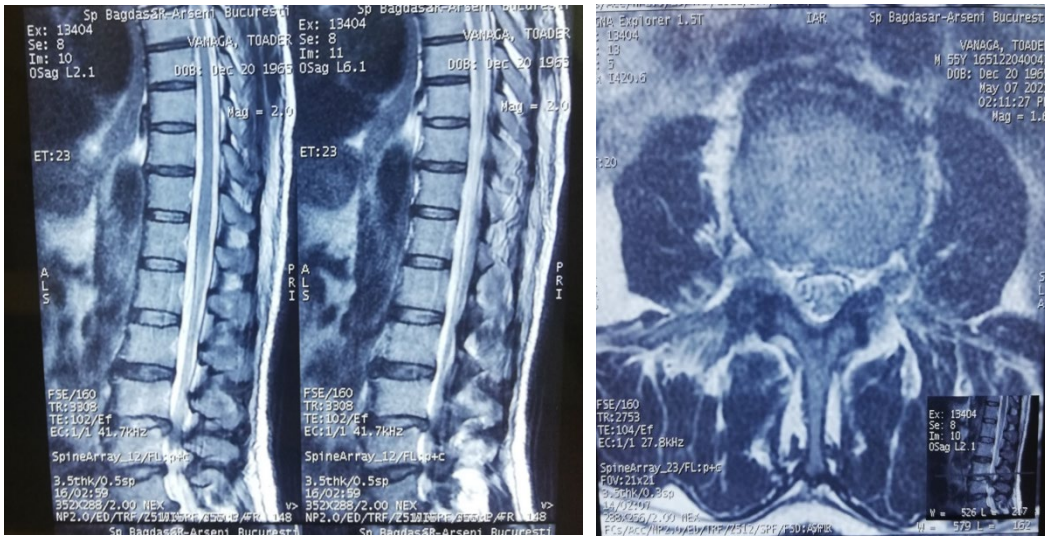

Figure 1 Spine IRM of patient

Diagnosis: AIS C paraplegia due to a paramedian and median lumbar disc herniation at L3-L4. Neurogenic bladder with Foley catheter. Neurogenic bowel.
Rehabilitation program.
General objectives:
1. Fighting neuropathic pain
2. Recovery of static, dynamic disorders and possible distal root muscle functional deficiencies
3. Regaining functionality that allows the patient self-care and locomotion
4. Improving the patient's psycho-cognitive, mentally and emotionally status
5. Socio-professional, family reintegration and improvement the quality of life

Means:
Diet and hygiene: rigorous hygiene of the post op wound; avoidance of soft drinks, of food that ferments (beans, cabbage, green peas etc.); normal intestinal transit, adequate hydration. Medication in this case was anticoagulation, neurotrophic and neuroprotectors, analgesia, hydro electrolytic equilibration.
Physiotherapy treatment:
Electrical stimulation (Exponential current) assisting the left plantar dorsiflexion pulse duration=500 ms, pause duration=4500ms, frequency of stimuli=12 imp/sec, total session duration= 2-4 minutes
LASER for the plantar level and lateral left calf, 4 points, doses 3j/cm2, frequency 5Hz, probe area 1cm2, power 62mW, time 1min/point.

Kinesitherapy whit the following kinetic objectives:

1. Improving posture and alignment of the body
2. Improving muscular tonus
3. Maintaining the articular mobility
4. Promoting motor function of the intermediate and distal segment of lower limb
5. Obtaining a good stability at the load-bearing articulations
6. Training of the orthostatism
7. Promoting gait and train it

Kinesitherapy means:

1. Reestablishing posture and alignment of the body: assisting plantar dorsiflexion with orthosis

Fig4: installation of the plantar orthosis in order to execute the kinetic program

2. Improvement of muscular tonus (hypotonia): with neuro-muscular facilitation techniques
3. Improving mobility: active, active-passive, passive mobilizations, including exercises with ergometric bike
4. Improving/promoting motor control (from proximal to distal): Kabath method
5. Improving muscular strength: active mobilization with resistance, isotonic
6. Promoting/establishing of orthostatism: exercises at the espalier training the knee blocking
7. Recovering the gait: exercises at the parallels; walking whit walking frame; walking whit forearm crutches

RESULTS

The patient benefited from a complex program of neuro-muscular rehabilitation and had a favorable evolution with an improvement of the final score of the evaluating scales. He regained the gait and the ability to climb stairs - assisted by the orthosis at left plantar dorsiflexion. At the discharge the patient has an AIS D diagnosis. Final ASIA motor exam: upper limb:50/50 points; lower limb: 47/50 points.

Evaluation of muscle strength on MRC scale (table1)

Table 1 Evaluation of muscle strength on MRC scale

INITIAL FORCE MUSCLE		**FINAL FORCE MUSCLE**
LOWER LEFT LIMB	**L2=5/5**	**L2=5/5**
	L3=3/5	**L3=4/5**
	L4=0/5	**L4=4/5**
	L5=0/5	**L5=4/5**
	S1=3/5	**S1=5/5**
LOWER RIGHT LIMB	**L2=5/5**	**L2=5/5**
	L3=5/5	**L3=5/5**
	L4=3/5	**L4=5/5**
	L5=3/5	**L5=5/5**
	S1=4/5	**S1=5/5**

DISCUSSIONS

Case particularity: The symptomatology caused by the disc herniation at the L3 level was, initially, suggestive of a cauda equina syndrome with neurogenic inflammation which generated a paraplegic motor deficit. After the remission of the inflammatory syndrome, it became clear which root has been affected, the left L4 root, which was generating a complete deficit of plantar dorsiflexion. The complex rehabilitation program (8) following the surgical intervention (9) contributed together for the good results emphasized for a patient diagnosticated with paramedian disc hernia. The patient did not have a cord section syndrome (the spinal cord ends at the L2 level) and neither conus medullaris.

CONCLUSION

The interdisciplinary therapeutic approach, together with a specific, customized rehabilitation program for a patient with AIS paraplegia after a surgically treated disc hernia, had successfully improved the neuromuscular deficit and upgraded the patient's quality of life.

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Research article

The recovery management of patients with operated extramedullary spinal arteriovenous fistula, evolution and socio-professional reintegration: case report and review of the literature

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ABSTRACT: Adequate therapeutic intervention performed in the case of extradural spinal AVM and an intensive recovery program allow the amelioration of neurological manifestations in a very high percentage. With the ultimate goal of practicing a trade, a good biological recovery is needed for social recovery. The effectiveness of strategies for professional integration and reintegration depends largely on the patient's experiences before the onset of the disease. The paper aims to review the treatment, the evolution of patients with extradural spinal AV and the possibilities of socio-professional reintegration. **Methods and analysis**. A case presentation of a patient diagnosed with extradural spinal AV fistula is proposed, along with a review of the current literature on the treatment of this pathology, the evolution and the possibilities of vocational recovery. The studies will be analysed and selected in two stages, in the first stage the titles and abstracts, in the second stage, the articles with full text will be analysed, selected and a narrative synthesis of the included studies will be made. **Summary case.** The 51-year-old urban patient, a professional driving instructor who underwent endovascular and surgical treatment for extradural spinal AV fistula, is hospitalized for a moderate motor deficit, such as paraparesis, back pain, mechanical pain in the knees and gait disorders. The objectives of recovery are represented by neuromotor recovery and socio-professional reintegration. **Conclusions**. Spinal EAVFs are rare lesions with a low risk of bleeding; the clinical manifestations are determined by the compression of the bone marrow; these being significantly improved after the endovascular and surgical treatment. Studies show a good long-term prognosis, which is determined by the absence of recurrences. An essential role in the integration of patients with disabilities in the socio-professional life is the identification of their deficiencies and their reorientation according to the outstanding abilities, the stimulation of the preserved skills.

Keywords: *rehabilitation, disc hernia, low back pain, paraplegia*

1. INTRODUCTION

Spinal cord irrigation consists of four arteries, with a path parallel to the axis of the spinal cord, 2 anterior and 2 posterior spinal arteries (1). Their starting point is the vertebral artery. The root arteries leave the spinal arteries, with a metameric distribution. Between the two vascular systems, anterior and posterior, there are numerous anastomoses. The

veins are also represented by two vascular systems, the intramedullary system and the perimedular system. They drain into the anterior and posterior internal vertebral venous plexus from the epidural space. Venous plexuses also have numerous anastomoses.

Spinal cord malformations are a fairly rare cause of spinal cord compression. There are no valves in the venous plexuses (internal and external), so the blood flows back into the plexuses if the pressure in the jugular veins increases. Spinal arteriovenous malformations (AVMs) have a low incidence of about 4% of all tumours at this level (2, 3). They are the prerogative of adulthood. Over time, several MAV classifications have been made (4). These classifications are based on the location of the condition, the imaging techniques used, the treatment methods. From 1967 to 2015, seven classifications were reported. Spinal vascular malformations (MVS) are classified according to location (intramedullary, perimedular, radicular, extradural) and type of flow (high flow, low flow, without arteriovenous shunt) (5). An essential aspect in the classification is the differentiation of shunt lesions from non-shunting lesions (spinal cord cavernous). In shunt lesions, the classification specifies the supply artery, the type of transition between the artery and the vein (plexiform or nidus type) as well as the large or small volume of the fistula (2). This classification is important for the therapeutic approach to AVM (6). High-flow MVS are generally congenital lesions diagnosed in children and young patients without gender predominance. They have hemodynamic disorders, mass effects or bleeding, but can also be discovered by chance. Low-flow SVMs tend to be acquired lesions that occur in older men with progressive myelopathy caused by spinal venous hypertension. They are rarely associated with vascular syndromes but may accompany prothrombotic conditions. Extradural arteriovenous fistulas (EAVFs) are the direct connection between an extradural artery and a vein, resulting in a high-flow fistula that communicates with the epidural venous system. Myelopathy is caused by direct compression or retrograde venous hypertension (7). Dural fistulas are the most common, accounting for 70% of total AVM. According to literature, only 15% are symptomatic. The most common location was the thoracic spine (61%), followed by the cervix (22.7%), lumbar (14.5%) and sacral (1.8%). Spinal extradural AVFs are much rarer than other types of spinal AVM.

The clinical picture may be, in the early stages non-specific (8), dominated by up to 85% of cases of low back pain (51.8%), in evolution with sensitivity disorders and paresis of the lower limbs (75.5%), with slow evolution (months - years), paraesthesia's (60%), intestinal / bladder dysfunction (41.8%) and myelopathy (36.4%) (9). Between 10 and 20% of cases may present with sudden onset myelopathy, especially in patients under 30 years of age, due to bleeding malformation, bleeding that may occur, depending on the location of the malformation, hematomyelia, subarachnoid haemorrhage or extradural spinal hematoma. It describes a particular syndrome, called subacute necrotic myelopathy (Foix-Alajouanine syndrome), characterized by paraplegia with anaesthesia below the level of the lesion and loss of sphincter control. Imaging, the medullary ischemia caused by spontaneous thrombosis of the malformation is detected (in cases with fulminant, irreversible evolution). Table 1 shows the classification of AVM, incidence, type of shunt and symptoms.

From an imaging point of view, the following are used: dynamic magnetic resonance angiography and three-dimensional angiography with computed tomography (CTA), necessary to establish the method of treatment is the method of choice; MRI can detect certain types of spinal vascular malformations with results close to angiography, in the case of high-flow sounds, but with unclear sensitivity in the case of low-flow sounds (6); myelography, can highlight the vascular trajectory (5).

Table 1. Classification of arterial-venous malformations

Type of malformation/ Incidence/ Age	Characteristics / Localization	Symptomatology
Type I: Dural arteriovenous malformations (Dural fistulas) /70-80%/elderly	Fed by a root arteriole which forms an arteriovenous shunt at the level of the spinal root located in the intervertebral foramen and which subsequently drains into a dilated vein in the posterior part of the spinal cord (10)/ Thoracolumbar	Lumbar pain and progressive myeloradiculopathy by affecting the nerve root at the level of the foramen and the spinal cord below the level of vascular malformation by medullary venous congestion secondary to high venous pressure existing in the drainage vein.
Subdural malformations		
Type II: intramedullary arteriovenous malformations/ 15%/any age	Consisting of a compact vascular nest fed by medullary arteries and may associate as in the case of cerebral arteriovenous malformations aneurysms located at the level of the medullary arteries/ Cervical-thoracic-lumbosacral	Low back pain, tenderness, and paresis of the lower limbs
Type III: juvenile spinal arteriovenous malformations/-/any age	Consisting of a voluminous vascular glomus that encloses the spinal cord and adjacent vertebral bodies thus producing / Cervical-lumbosacral, Predominantly thoracic (11)	low back pain, tenderness, and paresis of the lower limbs
Type IV: subdural, extramedullary/-/any age	These are direct arterio-venous fistulas between a perimedular artery (most commonly Adamkiewicz' s artery) and a drainage vein; they appear at a younger age compared to type I / Thoracic spine (61%), cervix (22.7%), lumbar (14.5%) and sacral (1.8%)	They can be deduced by massive haemorrhages in the spinal subarachnoid space, causing paresis/plegia (75.5%), paraesthesia's (60%), pain (51.8%), bowel/bladder dysfunction (41.8%) and myelopathy (36.4%) (9).

Catheter angiography remains the gold standard for assessing spinal vascularity and disorders. The application of the 4D-CTA method in spinal cord injuries is limited, it is the third choice for non-invasive angiography, after dynamic ARM and three-dimensional CTA, highlighting the accuracy of the diagnosis in the Dural spinal fissures (5, 12).

Therapeutic management consists of a surgical or endovascular approach. Diagnostic angiography may be associated with embolization in the same session (13). Endovascular treatment is primarily intended for Dural fistulas. Type II may benefit from endovascular and surgical treatment. Type IV benefits from multimodal treatment (embolization and then surgical treatment), while type III is outside the current therapeutic resources (Table 2).

Table 2. Treatment indicated according to the type of spinal arteriovenous malformation

Type MAV	Surgical Treatment	Endovascular Treatment
Type I	Second intention	First intention
Type II	First/Second intention	First/Second intention
Type III in addition to therapeutic resources, multiple recurrences	After embolization	First intention, association with surgical treatment
Type IV	Multimodal treatment, after embolization	First intention

Initially affected by high recurrence rates due to inadequate embolization material, endovascular techniques are nowadays a viable alternative to surgery, mainly due to the introduction of liquid embolic agents (13).

This proposed review focuses on the identification of therapeutic interventions in patients diagnosed with spinal malformations with extradural arterial-venous fistula, the evolution, and the possibilities of vocational reintegration.

Studies referring to the clinical manifestations determined by the presence of extradural AV malformations, the treatment methods approached, the evolution of patients and the possibilities of socio-professional reintegration will be eligible and included in the evaluation. To identify the possibilities of socio-professional reintegration, we identified the studies that were addressed to patients with neurological impairment, such as tetraparesis and paraparesis. No age or sex restrictions will be imposed.

We have included all research published from 1983 to December 31, 2021, that refer to the proposed objectives, not restricting the studies by any type of settings (using as well books and documents, clinical trials, meta-analysis, randomized controlled trials, reviews/systematic reviews, etc. No language restrictions were applied, but most of the studies were in English.

For data collection, the PubMed platform was accessed, being searched different literature sources (i.e., extensive papers, dissertations, abstracts, conference papers, posters, and reports, etc.).

The search terms have been modified and refined to achieve the proposed objectives: spinal arteriovenous fistula, spinal arteriovenous fistula extradural, spinal arteriovenous fistula extradural treatment, vocational reinsertion, vocational neurological reintegration (Table 3).

Table 3. Search strategy for PubMed from 1983 – December 2021

Search items	Identified no. of papers
Spinal arteriovenous fistula extradural	72
Spinal arteriovenous fistula	1,417
Spinal arteriovenous fistula extradural treatment	60
Spinal arteriovenous fistula extradural treatment, free full text	16
Spinal arteriovenous fistula extradural treatment Reviews/Systematic Reviews	13
Meta-analysis	2
Clinical trials	1
Reinsertion vocational	49
Vocational reintegration neurological	58

As references management tool, EndNote was used to insert bibliographies and references. Duplicate articles will be identified and removed from the EndNote library.

RESULTS AND DISCUSSION

A centralized analysis of PubMed databases on the incidence and clinical manifestations of patients with AVM shows that 1% of lesions were incidental; 93% of patients had neurological deficits and 36% of cases started with bleeding. Some studies show an increased incidence among male patients (14). A study performed exclusively on patients with extradural AV fistulas shows that the patient's average age was 45.9 years and that there was no significant sexual predilection. Only 3% of the lesions were incidental, while 10% occurred in patients with bleeding (15). Studies performed on a total of 321 patients with extradural spinal AV fistula who received endovascular and surgical concomitant treatment show a neurological improvement of between 89 and 97.7%. Rangel-Castilla, in a study of 110 patients with AVM, of whom 44 had extradural spinal AV fistulas, reported gaining independence in 97.7% of patients included in the study with a recurrence of 13.6% in patients with extradural (Table 4).

Table 4. Summary of study treatment and evolution

Study	Patients No.	Treatment Surgical / endovascular	Remote clinical outcomes
Huang et al (15)	101	Associated Treatment, Complete cancellation 91% of cases	Neurological improvement 89%, Stationary 9%, 2% worsening
Akgun et al (8)	78	Associated Treatment, Complete cancellation 97.4% of cases	Improvement
Vázquez (16)	3	Associated Treatment, Complete cancellation	Improvement, no recurrences
Singh (11)	74	52.7% embolization, 21.6% surgery, Associated 5.4%	Neurological improvement in 26 patients, 25 stabilized, the rest transferred.
Clarke (17)	6	Associated Treatment	Neurological improvement
Zhang et al (18)	1	Associated Treatment	Neurological improvement
Takai (19)	14	Combined treatment, regardless of location, customized surgical technique depending on venous drainage	Improvement, no recurrences
Rangel-Castilla (9)	44/110	42% embolization Resection 86.4% 12.7% embolization only	97.7% independent for those with extradural, 86.4% other MAVs; No deaths Recurrence 13.6% in patients with extradural, 15.2% in MAV

Several strategies have been implemented in Europe, classified into "Policies", "Systems" and "Services", which aim to integrate and reintegrate people with chronic illnesses into work. The policies consist of national strategies spanning 5 or 10 years. The systems are represented by pension programs, incentives, allowances. The services address the specific needs of people with a certain deficit. The unemployment rate for people with disabilities is high and incomes are lower compared to people without chronic illnesses (20). Work has a positive impact on health and well-being (20).

Any recovery process aims at obtaining biological recovery, along with the social one. adaptation of the person to the workplace, ensuring professional security (21). According to the official data of the National Authority for the Rights of Persons with Disabilities, Children and Adoptions, as of June 30, 2020, the total number of persons with disabilities was 853,465, representing 3.85% of the Romanian population (21).

Handicap means the automatic limitation of the person to social life. In recent years, special emphasis has been placed on the rehabilitation of people with disabilities. They are often considered maladapted and stigmatized. The socio-professional reintegration of these people is a general problem, the unemployment among them is double compared to the general population, active (22). The European Strategy on Social Inclusion presents a series of measures and proposals for the preservation and identification of jobs for people with disabilities. The incomes of these people are lower than the general population. Until the * 80s, the medical model was approved, which ensured a minimum financial income, following the replacement of this model with the social one.

Chronic neurological pathologies cause a series of functional deficits with repercussions in the fulfillment of ADLs and the profession, especially since the onset is at a younger age. Therapy of any kind is of utmost importance (22, 23). The psycho-social consequences of the neurological patient (24), paraplegic or tetraplegic, are dependent on the level of injury, the patient's profession, family support, age and social environment at the onset of disability (23, 25). In 1997, Germany had 48 institutions dedicated to

the vocational rehabilitation of people with physical disabilities, sensory disabilities, and developmental disabilities.

Of the 651 paraplegic patients who went to socio-professional rehabilitation centres, 80% are men, 45% have returned to their previous activity or started another paid activity (23). Socio-professional reintegration is becoming easier with the development of technology. Requests to vocational reorientation centres are lower for people over 30, from married people. 86% of applicants are unmarried (table 5).

Table 5. Results of studies on vocational reorientation of paraplegic patients.

The study published by P. Calmels (27), performed on 58 patients with SCI (50 men), with a mean age of 41.38±13.55 years, the average score of the Barthel index being on average 73.88 ± 21.87, shows that the return to a professional activity is correlated with age, degree of independence, Barthel Index, ASIA score, level of training, family support.

Of particular importance are the occupational therapy and vocational therapy workshops, the presence of a mechanism to finance the (re) integration of people with disabilities (28). It is also appropriate to raise awareness of work-related issues among people with disabilities, to increase the motivation and educational level of these people.

Driving does not appear to be important in some studies (29), but some authors show the importance of driving to increase the quality of life (27).

SUMMARY CASE

Material and method. Patient, 51 years old, from the urban environment, professional driving instructor, diagnosed with paraparesis after extramedullary arteriovenous spinal fistula D5 operated, neurological lesion ASIA C, motor level D12, neurogenic bladder, neurogenic colon, hospitalized for the moderate motor deficit, paraparesis type, back pain, mechanical pain in the knees, gait disorders.

Informed consent statement: informed consent was obtained from the patient for the publication of this case report.

Disease history. The current disease started suddenly, two years ago, with paraesthesia's in the lower limbs and sphincter disorders. In the next three days, the functional deficit appears in the upper and lower limbs, the patient being completely immobilized. He was referred to the neurosurgery clinic, where, at the neurological examination, spastic paraparesis 2/5 gr, hypoesthesia under the bilateral D5 dermatome, thermal anaesthesia and fine proprioceptive below the level of the right D6 dermatome, ROT live lower limbs, without clonus, Babinski ,,+ " bilateral. On MRI examination of the cervical spine, dorsal congestive myelopathy was described, extensive vascular dilatations subdural extramedullary at the level of the vertebral body D5, which extends to the lumbar level, with the character of subdural spinal fistula. To elucidate the diagnosis, spinal angiography was performed, which revealed at the D5 level an arterio-venous fistula with extended extramedullary subdural venous drainage. Following the interdisciplinary clinical evaluation, the MRI and angiographic examination decided the surgery, which consisted of bilateral laminectomy D5-D6, durotomy, coagulation of the arterial feeder of the fistula and resection of the fistulous area. Control MRI examination revealed a reduction in the size of the venous dilatations, with no other signs of spinal cord compression. Control spinal angiography performed by injection of the D5 artery no longer showed the venous dilatations present in the anterior arteriography.

Clinical examination at discharge reveals paraparesis grade 2/5 predominantly left, improving sensitivity under dermatome D6. At discharge, neuromotor recovery, analgesic treatment, change of bladder catheter at 14 days are recommended.

The patient followed a sustained recovery program, 3 courses/year, in specialized centres and physical therapy at home, 2-3 sessions/week. He is currently addressing the outpatient recovery office for: motor deficit in the lower limbs, sphincter disorders. The objective examination reveals: wheelchair ambulance, possible walking with two brachial crutches over short distances; muscular hypotrophy in the gluteal muscles and lower limb muscle groups, osteotendinous hyperreflexia MI, lower limb vascular-trophic

disorders, pain in the mobilization of the knees with instability in orthostatic and gait, urination by catheterization, neurogenic colon.

For the evaluation of spasticity, the Ashworth scale and the modified Ashworth scale (MAS) have been used, with values between 0 and 4 (0 = without accentuating the tone, 1 = slight accentuation of the tone, manifested by grip and release, or by minimal resistance to flexion and extension, (1 +) = slight increase in grip, followed by minimal resistance in the range of motion, 2 = increase in muscle tone in the range of motion, but the affected limb is easily mobilized, 3 = considerable increase in muscle tone, passive movements are difficult, 4 = the affected joint is rigid in flexion and extension) (30).

The neuro-sensitive evaluation was performed, with the ASIA score which is considered as being the gold standard (31, 32).The motor score was achieved by testing the muscles with functional importance on each myotome, right-left, on a scale from 0-5; the figures add up to the overall engine score. This score is clinically essential, it is objective, allowing the clinician to assess the patient' s progress between two consecutive evaluations, with an important role in the prognosis. The motor level is defined by "key muscle" (C5 – Biceps, C6 – Long and short radial extensor of the carpus, C7 – Brachial triceps, C8 – Deep flexor of the fingers, D1 – Abduction of the finger V, L2 – Iliopsoas L3 – Quadriceps L4 – Anterior tibial, L5 – Long extensor of the toe + extension of the fingers, S1 – Plantar flexion of the ankle), depending on the muscle testing, it must have a value of 3, and the muscles of the overlying segment must have values of 4-5. The sensitive level is achieved by testing the painful, superficial sensitivity on each dermis right and left. As in the case of determining the motor score, in determining the sensory score key points can be used for each lesion level: occipital protuberance, supraclavicular fossa, acromioclavicular joint, antecubital fossa, police, Medius, auricle, axillary tip, intercostal spaces, xiphoid appendix, sciatic tuberosity, perianal area, distal femoral shaft, popliteal area, medial malleolus, lateral heel.

The examined patient presents both active and passive mobility normal limits on the muscle groups of the upper limbs, ADL-normal limits, normal grip, evaluation of digital dexterity normal limits. Regarding the evaluation of the lower train, the following data can be mentioned: maintain the position at the edge of the bed, unassisted transfer, possible verticalization and short distance walking with 2 brachial crutches resulting in ASIA motor-50 score for upper limbs (28 for lower limbs and sensitivity level L4). According to the Aminoff-Logue Disability Scale (ALS), the patient had a G4M3 score at the time of evaluation. The recovery objectives are the following: Improving neuropathic pain; Decreasing spasticity of the lower limbs; Improving motor deficit; Re-educating sensitivity; Improving functional status; Increasing quality of life; Prevention of urinary tract infections; Socio-professional reintegration of the patient.

The ability to walk is the target of neuromotor rehabilitation (21). The patient followed a complex recovery program, consisting of physiotherapy and hydrokinetic therapy, electrotherapy (Huffschmidt currents), massage. The objectives of physical therapy are combating vicious attitudes, limiting motor deficit, and increasing mobility in all joints, maintaining muscle strength in the upper train, increasing stability in orthostatism, initiating gait, improving ADL, cardio-respiratory re-education. The walking training was performed with the Lokomat robotic (21) device that uses a physiological gait model. This, through its programs, brings several benefits, namely: increased independence, improved gait and muscle tone, increased mobility, and gait (33).

Another means of recovery used to achieve the proposed objectives was the Virtual Reality Assistance Device used for upper and lower train training (34). Creating goals in the virtual world that reproduce real-life ensures the re-learning and regaining of lost physical skills and functions and increases the success rate of rehabilitation programs that use the complexity of virtual reality. The peculiarity of the case consists in myelopathy suddenly installed, at the age of 49, this mode of onset being specific to patients under 30 years. Another peculiarity is the slow recovery, with the paraparesis type

sequelae. After 2 years from the onset of the disease and intensive recovery treatment, the ASIA C classification is maintained, although studies mention neurological independence in the percentage between 89 and 97.7% (27). Also, the patient returns to the previous activity, following the adaptation of the vehicle.

CONCLUSIONS

Spinal EAVFs are rare lesions with a low risk of bleeding; the clinical manifestations are determined by the compression of the bone marrow these being significantly improved after the endovascular and surgical treatment (15). Studies show a good long-term prognosis, which is determined by the absence of recurrences (16). An essential role in the integration of patients with disabilities in the socio-professional life is the identification of their deficiencies and their reorientation according to the outstanding abilities, the stimulation of the preserved skills. This is possible with the support of competent institutions, depending on occupational requirements, health status and previous cognitive impairment (2), in close relation to the education, skills, motivation of the patient (35). Currently, the possibilities of complex recovery, together with occupational therapy, occupational therapy, psychotherapy, manage to obtain outstanding results, which lead to the reinsertion of a significant number of patients. A systematic review of the PATHWAYS literature has shown that multidisciplinary involvement, ergonomic interventions, part-time work, active labour market policies to promote employment will promote the integration into the work of patients with chronic diseases (35).

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Review

Rehabilitation of severe neurological complications post SARS-CoV-2 infection

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ABSTRACT: Medical rehabilitation is a multi-professional / interdisciplinary process aimed at enhancing and restoring functional ability (activity and participation) and quality of life to people with impairments or disabilities. Rehabilitation is applied throughout the continuum of care. COVID-19 patients may develop a myriad of acute medical problems (linked to the virus per se, or as consequences of the invasive procedures), which can cause acute, post-acute and long-term consequences requiring rehabilitation. Information about short and long-term sequelae of COVID-19 indicate an increasing need for rehabilitation. The paper is focused on two main aspects: rehabilitation of the severe neurological disabilities that occurred during the acute phase and continuing in the chronic phase (i.e., different neurological sensory-motor and cognitive deficits secondary to stroke, encephalitis, seizures, encephalopathies). The other main issue is generated by the disruption of regular rehabilitation in people with neurological disabilities and chronic diseases (people living with sequels after stroke, Parkinson's disease, multiple sclerosis) due to quarantine, social isolation, movement restriction, and other healthcare systems 'disruptions. **Methods** Internet literature search (Lit Covid and PubMed) using the following keywords (Covid-19, Coronavirus, neurological complications, rehabilitation). During 2020-2021 were published 88 papers (in 2020 = 54, and in 2021= 54), with 21 reviewes (2020 = 15; 2021 = 8), and 2 systematic reviews, refearing neuroreabilitation in Covid-19 subacutre and long-term cases. **Discussion** REH-COVER Cochrane Rehabilitation WHO initiative ("Rapid Living Systematic Reviews Second Edition, called 2020"), contains the main cornerstones for a tailored rehabilitation programme, the best (current) available rehabilitation evidence on recovery interventions, for the patients living with sequelae of COVID-19. **Conclusions** More than two years since the outbreak of the COVID-19 pandemic, it is obvious that rehabilitation services play a crucial role in post-COVID recovery trajectories. A further achievement of research and evidence focussed on the clinical management, comprehensive treatments, and efficacy need to be targeted on short and long-term (neuro)-rehabilitation service models of care, for COVID-19 survivors.

Keywords: *Covid-19, rehabilitation, neurological disabilities, SARS-CoV-2*

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1. INTRODUCTION

Coronavirus (CoV) represents a large family of RNA viruses found in different animal species including birds, livestock, and mammals. These viruses are known to affect different human systems including the respiratory, hepatic, nervous, and gastrointestinal systems.

Subtypes of CoV which are known to be pathogenic to humans, usually cause mild clinical symptoms except for two subtypes: severe acute respiratory syndrome related coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV).(1)

An internet literature search (Lit Covid and PubMed) using the following keywords (Covid-19, Coronavirus, neurological complications, rehabilitation). During 2020-2021 were published 88 papers (in 2020 = 54, and in 2021= 54), with 21 reviews (2020 = 15; 2021 = 8), and 2 systematic reviews, referring neurorehabilitation in Covid-19 subacute and long-term cases.

The catastrophic proportions of this pandemic is reflected in over 5.5 million deaths all over the world (fig 1) (2)

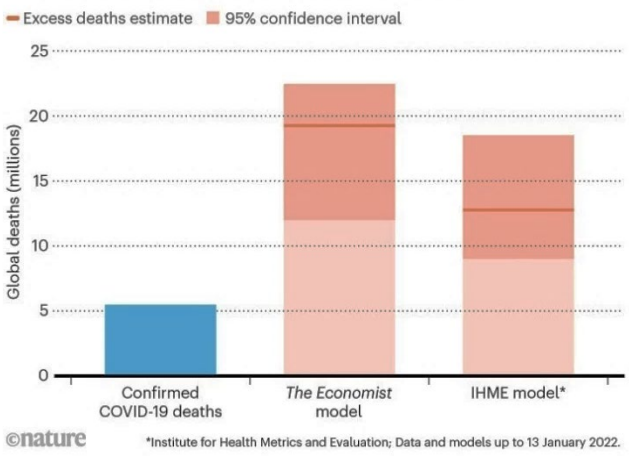

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Fig. 1 The total number of deaths from the beginning of the pandemic seems to be underestimated (28)

Covid-19 neurological manifestations and physiopathological mechanisms in the acute infectious phase are summarized in table I-II

Acute Neurologic Complications Of Coronavirus Infections

Para-infectious syndromes
Encephalopathy
Central hypoventilation
Viral meningitis
Anosmia and ageusia
Encephalitis
Stroke
Acute necrotizing hemorrhagic encephalopathy
Myositis

Postinfectious syndromes
Acute disseminated encephalomyelitis
Brainstem encephalitis
Transverse myelitis
Guillain Barre syndrome
Sensory neuropathy

PARAINFECTIOUS COMPLICATIONS

Stroke. Patients with SARS-CoV-2 and SARS-CoV-1 infection
- Hypercoagulable syndrome
- Elevated D-dimer levels and increased PT and aPTT
  - arterial and venous occlusions in the brain vasculature
  - DIC cases
- Elderly patients with other underlying cardiovascular risk factors
  - vascular occlusive syndromes
  - including stroke and deep vein thrombosis (Tsai et 2005)
  - myocarditis, which may be another risk factor for stroke
  - However, strokes are being reported an individuals who have no other risk factor other than COVID-19
  - cerebral vasculature presence viral receptor ACE2

Infection can cause neurologic symptoms such as headache, anosmia, ageusia, cerebrovascular accident,confusion, agitation, impaired consciousness, and encephalitis or encephalopathy, seizure, ataxia, neuropathies. (2- 4)

Dizziness and headache were the most common central nervous system (CNS) manifestations, found in 11.9% respectively 11.8% (5), followed by confusion/ decreased cognitive level (8%).
Common peripheral nervous system manifestations are taste and smell impairments found in 5.6% and found in 5.1%, respectively.

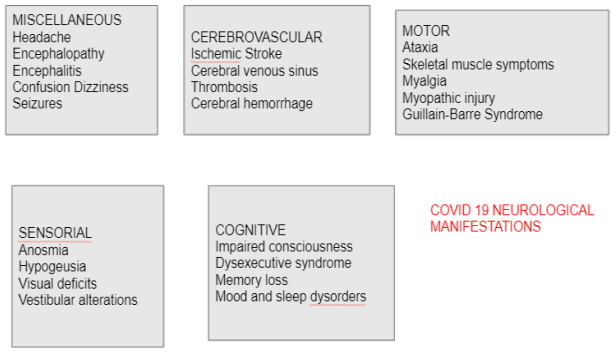

Fig 2, Neurological manifestations in coronavirus disease 2019 (COVID-19 (6)

In the acute stage multifocal areas of inflammatory encephalopathy can manifest with disturbance of consciousness, focal sensory-motor deficits, seizures. An illustrative case is depicted in fig 3

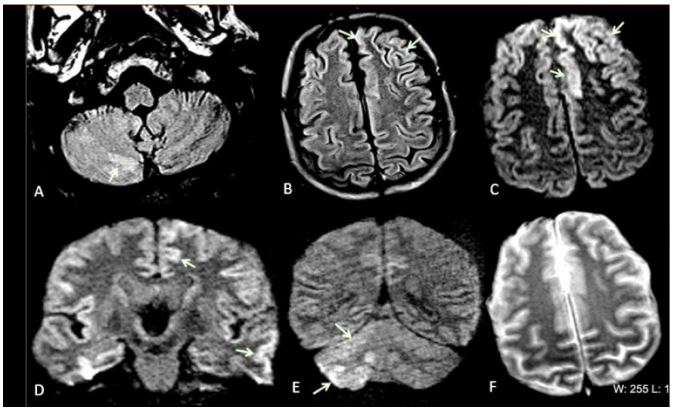

FIG 3 A 69 years-old-man presented with acute encephalopathy and seizures. (7) (A-B) Multifocal areas of FLAIR hyperintensity in the right cerebellum (arrows in A), left anterior cingulate cortex and superior frontal gyrus (arrows in B).
(C-D) Restricted diffusion in the left anterior cingulate cortex, superior frontal and middle temporal gyrus (arrows in D) and right cerebellum (arrows in E), consistent with cerebellar diaschisis. F) No hemosiderin deposits in gradient echo sequences((Modified and adapted from *How COVID-19 Affects the Brain in Neuroimaging* *https://www.itnonline.com/article/how-covid-19-affects-brain-neuroimaging*))
Thrombotic, hypotensive, and hypoxemic consequences of the viral infection can also contribute to longstanding, potentially painful neurological sequelae and disabling post-stroke neuro-psychomotor impairments.
Neurological acute and residual post-infectious complications may result from widespread neuropathological disturbances targeting major white matter bundle tracts, cortical gray matter, and subcortical gray matter. (8)
Direct or indirect invasion of the SARS-CoV-2 into CNS is involved in genesis and propagation of neurodegenerative processes via its systemic effects(9):

- migration and infiltration of peripheral leukocytes to the brain induces production of
- pro-inflammatory cytokines, activates microglia
- decline in ACE-2 activity, which acts as a neuroprotective factor

- acute respiratory distress syndrome (ARDS)-induced hypoxemia along with
- sepsis-induced hyper-coagulation generate hypercoagulable state and micro-thrombosis in brain vessels, leading to oxidative stress and neurodegeneration

SARS-CoV-2 can preferentially infect astrocytes explaining some of the neurological symptoms associated with COVID-19, especially fatigue, depression and 'brain fog', which includes confusion and forgetfulness.

Astrocytes might be vulnerable even if they are not infected by the virus.

A recent study compared the brains of eight deceased people who had COVID-19 with the brains of 14 controls. The researchers found no trace of SARS-CoV-2 in the brains of the infected people, but they did find that gene expression had been affected in some astrocytes, which were not working properly.(10)

Neuroinflammation may induce central GABA-ergic dysfunction, representing a common denominator for neuropsychological alterations neuromotor and cognitive fatigue, executive deficits, and apathy in post-COVID (11)

Chopra et al (2021) noticed that 33% of hospitalized patients had persistent symptoms at a 60-day follow-up after COVID-19. Residual effects from SARS-CoV-2 virus include fatigue, dyspnea, chest pain, persistent loss of taste and/or smell, cognitive changes, arthralgias, and decreased quality of life. (12)

About 87.4% of COVID-19 patients reported the persistence of at least one symptom, with fatigue being the most common reported symptom, followed by dyspnea (13)

Persistence or appearance of new symptoms after the recovery affects a multitude of organs. Systemic residual complications may extend beyond the duration of the initial illness during rehabilitation interval of SARS-CoV-2 infection.This persistent sequelae/ symptomatology is obvious multisystemic targeted and can be classified as(14):

(1) post-acute symptoms at 1-month after acute COVID-19 (short term),

(2) persisting and new clinical manifestations between 2 and 5 months after infection (intermediate term), and

(3) clinical manifestations present at least 6 months after COVID-19 (long term/ long haulers).

Most patients who survived after severe or even mild infection, had persisting (up to 12 weeks) of multiple disabling symptoms generically called postacute syndrome/long term covid. Persistence of post-acute disabling symptoms was noticed in half of Covid 19 survivors, mostly in those with mild form of infectious disease(15)

Aproximately 35% of patients with mild COVID-19 did not return to the baseline after recovery(16)

Long-Covid is outlined as a multisystemic post infectious complication/ entity, who summarizes(17):

- symptoms fatigue (92%),
- loss of concentration or memory (74%),
- weakness (68%),
- headache (65%)
- dizziness (64%)

Regardless of their direct neuroinvasive capacity SARS-CoV-2, like SARS and MERS, induce painful parainfectious neurological disease, polyneuritis, Guillain-Barre syndrome (potentially lethal).

COVID-19 infection is associated with painful symptoms, including myalgia, arthralgia, abdominal pain, headache, and chest pain (even in those not admitted to critical care environments) and may require even opioids for symptom management.(18)

Medical rehabilitation is a multi-professional process aimed at enhancing and restoring functional ability (activity and participation) and quality of life to people with impairments or disabilities. (19)

Hypoxia, systemic inflammation, sedation, fluctuations in level of consciousness, and neuromuscular blockade have negative repercussions on prognosis in acute care units

(ICU). Early neurorehabilitation begins in the ICU and is associated with improved outcomes, respectively longer-term neurologic recovery in patients with severe COVID-19 and disorders of consciousness. (20)

Rehabilitation of long-haulers (long Covid survivors) in our Clinic is an integrated, interdisciplinary medical endeavor, aimed mainly at respiratory and neurological sequels.

The physical kinetic rehabilitation of patients after COVID-19 infection cannot be separated from specialized medical assistance, focused on respiratory, neurological, and post-infectious pathologies.

The rehabilitation program requires a holistic approach that responds to the needs of the individual. Rehabilitation concerns several fundamental aspects/ objectives:

(a) Respiratory function and increase of cardio-pulmonary endurance, associated with

(b) postural hemodynamic rehabilitation

The first rehabilitation objective is to re-educate the patient`s postural cardio-vascular and respiratory parameters, from supine to lateral decubitus (rolling activity), then in sitting posture. These postures should be selected based on thoracic/CT imagery, ultrasound, clinical auscultation, and SpO2.

(c) Neuromotor rehabilitation techniques are aimed at restoring static and dynamic balance, and walking. These programs contain physical rehabilitation / re-education for peripheral muscle function (physical training at mild, moderate intensity, then aerobic training and strength.

The COVID-19 pandemic imposed social/physical distancing, lockdown measures and forced reorientation of the neurorehabilitation programs for people with neurological disabling sequels.

Telemedicine has turned virtual space into a new reality and may compensate for the restrictions imposed on face-to-face meetings. The regular and individualized physical-kinetic rehabilitation program can be achieved even in pandemic conditions, using modern telecommunication techniques. The European Foundation for health and exercise provides iPad and iPhone applications for telehealth and remote physical-kinetic motor rehabilitation in Parkinson's disease, for tbe therapists and patients. (https://apps.apple.com/us/developer/european-foundation-for-health-and-exercise/id473641733)

Further studies are necessary to identify the optimal web-based model of care, expand access to video-based care services (ie, remote consultation, patient education, and ongoing monitoring), establish best practices worldwide, and equitable access to this modern concept of neurorehabilitation. (21)(22)

Ozone therapy showed positive results in COVID-19 patients, besides its miscellaneous other benefic therapeutic applications, briefly summarized below:

-Non-healing wounds and ulcers, diabetic ulcers, surgical wound infections
-Circulatory disorders like varicose veins, Ischemia, atherosclerosis
-Skin conditions like eczema, infections, bedsores, ulcers
-Supportive treatment in cancer
-Gynecological infections (candida, endometriosis), and infertility
-Ear Nose Throat infections, sinus infections, bronchitis etc.
-Arthritis, Rheumatism, Backaches, Spondylitis
-Liver diseases, cirrhosis, hepatitis
-Brain disorders, Parkinson's, memory impairments, etc.
-Chronic infections due to viruses, bacteria, fungi, and other germs
- Neurological disorders (neuropathic pain, and hyperalgesia, headaches and facial pain)

A study of 46 patients (11 intubated and 35 non-intubated) showed that in 39 (84%) of the patients, respiratory improvement was obtained after ozone administration. (23)

In spite of the promising background data, indicating the effectiveness of ozone, there is still not enough evidence to confirm this as a viable treatment option for COVID-19. Its pathophysiological mechanism of action consists of influencing different hypoxia-inducible factors and cellular adaptation to hypoxia leading to activation of trophic proteins and specific biological processes, including erythropoiesis and angiogenesis.
Hyperbaric Oxygen Therapy (HBOT) is controversial. It seemed to be safe and effective in hypoxemic patients with COVID-19, but recent deadly accidents in some well known mass-media people in Romania questioned its efficacy and safety in (some ?) post-Covid patients.
Most studies used less than 1.5–2 absolute atmospheres (ATA) for 90 min sessions and thereafter sessions were decreased to 60 min. Trials demonstrated that most of the patients recovered after receiving HBOT, and blood oxygen saturation increased after several sessions of HBOT.
However, there is limited knowledge and evidence regarding the effects and mechanism of HBOT in COVID-19 treatment, and further evaluations require extensive well-designed studies. (24) Randomized controlled studies are mandatory (25)
The best (currently) available rehabilitation evidence on recovery interventions, for the patients living with sequelae of COVID-19 was synthesized in WHO initiative REHCOVER Cochrane Rehabilitation (Rapid Living Systematic Reviews Second Edition, 2020), contains the main cornerstones for a tailored rehabilitation program.(26)
The final pieces of the complex puzzle of rehabilitation interventions aim at improving autonomy, quality of life and reintegration of the individual into family and community / society. These aspects must be holistically integrated in a complex bio-psycho-socio-economic context. Somatic disabling symptoms (such as chronic pain post SARS-CoV-2 infection) may be exacerbated by multiple environmental barriers/ factors, including social threats, discontinuation of therapy, reduced access to treatments and concerns about health outcomes (27-31)
Conclusion Rehabilitation is applied throughout the continuum of care and is indicated in acute, subacute stages and in long covid survivors.
After two years since the outbreak of the COVID-19 pandemic, it appeared that rehabilitation services play a crucial role in post-COVID recovery trajectories.
A further achievement of research and evidence focussed on the clinical management, comprehensive treatments, and efficacy need to be targeted on short and long-term (neuro)-rehabilitation service models of care, for COVID-19 survivors.

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Review

Sarcopenia, a major clinical problem in old age, potential causes, clinical consequences and therapeutic possibilities

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ABSTRACT: Sarcopenia or degeneration of skeletal muscle tissue with aging, is responsible for functional decline and loss of independence in older adults. The purpose of this article is to review the current definitions of sarcopenia, its potential causes, clinical consequences and the potential for prophylactic and curative intervention. Sarcopenia is recognized as a major clinical problem for the elderly, and the research in this area is growing exponentially. One of the most important recent developments has been convergence in the operational definition of sarcopenia that combines muscle mass, strength and muscle function. In 2010, the European Working Group on Sarcopenia in Oder People (EWGSOP) published a definition of sarcopenia aimed at promoting progress in the identification and care of the elderly. In early 2018 (EWGSOP2) he met again to update the original definition to reflect the scientific and clinical evidence that has been built over the past decade. The cause of sarcopenia is considered to be multifactorial: hormonal changes, neurological decline, sedentary / immobilization for a long period, chronic diseases, obesity, all these factors contribute to the onset of sarcopenia. Prophylactic or curative interventions are essentially aimed at nutrition and exercise. Although pharmaceutical agents are developed that target several biological pathways, proper nutrition and specific physical exercises remain the gold standard for therapy. Through this review, we want to draw attention to the need to implement complex analyzes of the elderly patient, regardless of the acute problem with which he presents himself at the consultation. These analyses should contain tests, measurements, questionnaires that identify in time a possible musculoskeletal degeneration. The results did not show any significant difference between the perception of sarcopenia, the way of approaching it and the prophylactic or therapeutic treatment. We focused on this pathology because sarcopenia is relatively newly observed, defined, it is not fully investigated and a clinical skill has not been formed for the evaluation of the elderly patient.

Keywords: *Skeletal muscle, elderly, sarcopenia, degeneration, exercises*

1. INTRODUCTION

With aging, the mass and strength of skeletal muscles are involuntarily lost. Studies have demonstrated that, starting with the 4th decade of life, skeletal muscle mass and skeletal muscle strength decrease to 50%, this continuing until the 8th decade of life (1). Considering that muscle mass represents up to 55% of body mass, any pathological change in this muscle tissue leads to severe consequences on the elderly. The consequences of sarcopenia are often severe, they can contribute to several negative health outcomes, including loss of function, disability and fragility (2,3,4,5).

A 2002 report by the United Nations (UN) World Assembly on aging, presented the particular importance in health of early identification of age-related muscle loss, but not only. The report predicted that the world's population of over 60 years of age would exceed threefold between 2000 and 2050, with the population over 80 years of age increasing fivefold. The main theme of this UN assembly was how to provide elderly people with care and medical care, including prevention and rehabilitation.

At the initiative of the European Commission, since 2012, the European Year of Active Ageing and Solidarity between Generations has been proclaimed, which offers new opportunities for collaboration and synergy, intending to bring to the fore the contribution of older people to the development of society, and encouraging governments and society as a whole to take measures to promote active aging and to increase solidarity between generations. These measures would prevent the degeneration of the biological systems of the elderly and would maintain the general homeostasis of the organism, maintain a good quality of life and increase the degree of independence (6). Taking into account the relatively recent attention to this pathology, through this work we wanted to bring to the attention of clinician's reflections in terms of etiology, methods of diagnosis/evaluation, prevention and treatment of sarcopenia. The assessment of body composition usually refers to the quantification of body fat and muscle mass and is most frequently evaluated by medical imaging (7,8). Over the past decade, the importance of muscle mass has been emphasized and has become a focal point for clinical research (3). In 2016, sarcopenia itself was classified by the International Classification of Diseases (ICD-10-CM), with the code M62.84 [9]. Sarcopenia, a term first introduced in 1984 by Rosenberg, refers to age-related loss of muscle mass, thus being a type of geriatric syndrome (10). Studies in elderly patients have proven his relationship with physical deficiencies, low quality of life and increased costs of medical care. Recently, the concept of sarcopenia has been extended to various diseases, beyond the fact that it was considered only as a geriatric syndrome (11). Detection of sarcopenia in cases of osteoporosis in postmenopausal patients, or immobilized patients can significantly influence the prognosis of sarcopenia. Sarcopenia manifests itself in "cascade", namely: Reduced muscle mass and strength, limited physical performance, increased risk of falling, all these associated with decreased bone strength, characteristic fragility in osteoporosis, resulting in a poor health condition, mortality, which recommends maximum importance in prophylaxis, early detection and treatment of sarcopenia (12-13).

Our goal as researchers was to gain a better understanding of the etiology, epidemiology, diagnosis, prophylaxis and treatment of sarcopenia, understanding the complex biological mechanisms that lead to age-related loss of muscle mass. We want to review the imaging modalities available for the non-invasive evaluation of skeletal muscle.

METHODS

Through this paper we have carried out a sustained review of the studies that presented information and results specific to this pathology – sarcopenia. Following a rigorous search for the Databases PubMed, Medline, Scopus, Cochrane Database, between November 2020 and October 2021, we studied 73 articles, we considered that a total of 27 studies met the inclusion criteria.

Epidemiology

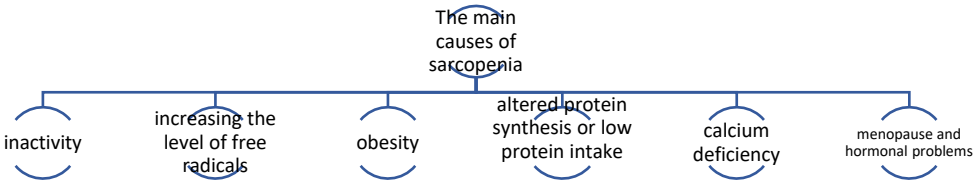
The process of decreasing muscle mass is increasingly accelerated after 60-65 years (14). One of the most pronounced changes in the elderly is the loss of mobility and physical capacity, deteriorating the quality of life. These changes occur due to progressive loss of skeletal muscle mass and function, a process known as sarcopenia (15). After the age of 25, muscle mass decreases by 3% to 10% per decade and reaches a rate of decrease of 1% per year at older ages (16,17). This decline in skeletal muscle is independent of ethnicity, age, morbidity, income or health behaviors and is a major global public health

problem. Moreover, changes in skeletal muscles can lead to other diseases that occur during aging, such as decreased metabolic rate, increased insulin resistance and bone loss (18,19).

Etiology

The main causes of this condition are considered: inactivity, through sedentary lifestyle is lost between 3-5% of muscle mass per decade, increased free radicals' levels, obesity, alteration of protein synthesis or low protein intake, calcium deficiency, menopause and hormonal problems, reduction of testosterone in men (table 1), decrease in GH secretion and consecutively, of the level of IGF-1 (20). John Morley states that the most dominant cause of sarcopenia is inactivity, both in the elderly and in the rest of the population (18).

Table 1. The main causes of sarcopenia



Inactivity leads to (wasting) muscle cells. The principle of "maintain it or lose it" explains one of the main causes of sarcopenia.

In addition to all these causes, the blood flow of the muscles plays an important role in maintaining muscle mass. A poor blood flow causes the muscles to weaken, and the nutrition of and correct, can no longer perform the role of stopping the damage to the muscles. The musculature consumes a large part of the body's energy and is in a process of continuous deterioration, which increases during sleep and between meals. During a meal, insulin released from the pancreas helps to keep the muscles in a good working condition (21,22).

An important element for the functioning of muscles is potassium. Potassium deficiencies are associated with the weakening of the muscles and their decrease (23). Magnesium, calcium, phosphorus also helps maintain the health of the muscular system. Also once, vitamin C is necessary for the formation of collagen and elastin fibers, essential components of the muscle structure.

Deficiencies of vitamins of the B complex are associated with muscle problems, such as lack of coordination and loss of balance, increasing the risk of falls. Smoking hastens the process of muscle damage due to the fact that harmful substances in cigarettes destroy vitamin C and other key elements necessary for the proper functioning of muscles (24).

Another cause that leads to muscle degeneration is reactive oxygen species (ROS) are chemically active molecules that contain oxygen. It is naturally produced by all tissues of the body during aerobic metabolism, ROS helps regulate cell homeostasis and cellular messages. When ROS is overproduced (because there is a functional deterioration of the mitochondria, generating energy to the cells), they can attack other molecule cells, especially in muscles (25). It is believed that ROS will play a key role in the development of sarcopenia. This makes sense, given that the skeletal muscle is the body's largest consumer of oxygen and is vulnerable to the accumulation of ROS. ROS can cause oxidative damage to mitochondrial proteins, cellular members and even DNA. Apoptosis of a cell also results from an accumulation of ROS in the mitochondria (25). Recent evidence has suggested that sarcopenia can occur not only due to aging, but also as a result of other pathologies associated with aging. Despite these new considerations, the definitions of sarcopenia are now focused on establishing the loss of muscle function more than the loss of muscle mass as a potential predictive model of fragility in the

elderly (26). Some authors have been particularly interested in late-life interventions to prevent the symptoms of sarcopenia or to improve the markers and results of sarcopenia, in this regard it has been described that calorie restriction and some pharmacological interventions can improve physical capacity only when a time interval for intervention is identified (27,28). Sarcopenia can be caused by a decrease in contractile elements (29), by reducing the total number of muscle fibers, by decreasing the size of type II muscle fibers or by losing motor units (30). However, the mechanisms behind these changes have only been partially understood. Thus, the cellular and molecular mechanisms underlying the functional loss in the muscle of the aging skeleton must be studied in detail. Some of the changes at the cellular level seen in aging muscle cells include the accumulation of intra or extracellular lipids; wrong distribution of structural and contractile proteins and mitochondrial dysfunction (31). Current evidence suggests that the decrease in mitochondrial respiratory enzymes, especially the IV complex (32) the decrease in mitochondrial content and also the increase in carbonic anhydrase associated with mitochondria (33) appear to be key factors in the process of muscle aging, as demonstrated by the reduction of both children's DNA and the activity of tricarboxylic acid cycle enzymes (34,35). One of the main theories of cell aging establishes that there is a strong positive correlation between age and oxidative damage (36,37,38). In this regard, recent studies have shown that oxidative stress contributes to mitochondrial dysfunction, but is not related to the atrophy of muscle fibers, which separates oxidative stress from the loss of muscle mass in sarcopenia (39). Other studies have documented that event of mitochondrial dynamics can respond to different stimuli that promote or decrease bioenergetics and mitochondrial metabolism (40). However, it remains to be revealed the association between mitochondrial morphology and aging. Nowadays, there is significant evidence (41,42). A decrease in mitochondrial muscle volume, density and function have also been observed with age, but other studies support the fact that maintenance or even a tendency to increase mitochondrial density occurs during the aging process; In addition, changes in mitochondrial enzymes and differential glycolytic have been reported in different types of fiber. Overall, existing evidence suggests that there is a relationship between mitochondrial morphology and aging, which may even depend on the type of muscle fibers and which has not been completely elucidated, and is still a matter of controversy (42,43).

Diagnostic methods

Currently, there are various methods for the evaluation of muscle mass by imaging; computed tomography (CT), nuclear magnetic resonance (MRI), ultrasonography, dual-energy x-ray absorptiometry (DXA), bioelectrical impedance analysis (BIA), and these methods must be standardized. The use of imaging techniques in relation to sarcopenia is of particular importance in terms of its detection and evaluation. We want to review the imaging modalities available for the non-invasive evaluation of skeletal muscle. CT has become the most widely used cross-sectional imaging modality and is available worldwide. In particular, CT has become the standard diagnostic tool in many clinical states for procedures such as the treatment of sarcopenia and its evaluation (44). CT can accurately differentiate between fat and muscle tissue, using the specific attenuation of each type of tissue, providing very detailed anatomical information. Due to the accuracy of measurement of adipose tissue and muscles, CT was considered the gold standard for investigating their quantitative and qualitative changes, especially for the trunk area where DXA is limited (44,45). In addition, the reliability of CT to assess quantitative and qualitative changes in adipose tissue and muscle mass, has been well documented over the past 25 years (45). Beyond the simple quantification of muscle mass, CT can assess the quality of the muscle based on identifying the portion of adiposity in the muscles. For example, a decrease in attenuation indicates an increased fat portion in the muscles; the gross infiltration of fats can be separated from muscle fibers. This aspect of CT also

makes it suitable for evaluating the infiltration of adipocytes into the muscles, known as myoseatosis (45,46). However, CT is limited in that it cannot directly measure lipid content or distinguish between intra-celled and intermuscular fat. Taking into account the high costs and radiation exposure in high doses, it is very restricted to use CT solely to assess the composition of the body. Body evaluation is possible when CT is used for the treatment of an associated disease or during the evaluation period of the disease (46).

Table 2. Diagnostic methods

No.	Diagnostic method	Advantage	Disadvantage
1.	CT- Gold standard	accurately differentiates adipose and muscle tissue, identify myosteatosis	high costs of high dose radiation exposure
2.	MRI	accurately measures body fat and muscle mass, quantify muscle volume and quality, highlights edema, inflammation, fatty infiltration, fibrosis and atrophy, provides superior anatomical CT details, does not radiate	high costs and limited accessibility or availability
3.	Magnetic resonance spectroscopy	provides information on tissue metabolism and biochemical structure	high costs
4.	Ultrasonography	low cost, portability and lack of radiation exposure may provide information about the presence of inflammation, fibrosis and fat infiltration	does not show
5.	DXA	low cost	there is no consensus for diagnosis

MRI uses differences in the radiofrequency pulse sequence to distinguish between adipose tissue and fat-free mass. Just like CT, MRI is also a cross-sectional imaging modality that allows to accurately measure body fat and muscle mass. Unlike CT, MRI has the advantage that it has no exposure to radiation, which makes it more suitable for long-term monitoring. In addition, MRI can assess the structure and composition of detailed tissues, facilitating the quantification of muscle volume and quality in individual muscle groups. In particular, MRI can also provide information about edema, inflammation in the muscles, fatty infiltration, fibrosis and atrophy (47,48). In terms of assessing muscle quality and myostosis, MRI demonstrates the best contrast between adipose and muscle tissue (10) and has recently been shown to have a higher sensitivity for detecting early fatty replacement of muscles, with better visibility of anatomical details than CT (11). Currently, the most common benchmark used in studies of sectional body composition is the L3 level of the lumbar vertebra. At this level, the field of view includes the large muscles and the main functional muscles of the human body, which are the psoas, paravertebral muscles (spinal erector, lumbar square) and abdominal muscles (abdominal transverse, external and internal obliques and abdominal rights), which recommended it for the analysis of skeletal muscles. In several studies, a single L3 scan was the best place of compromise to assess total tissue volumes of skeletal muscles, visceral adipose tissue and subcutaneous fat (48). However, the MRI is limited by high costs and limited accessibility or availability. Its limitation also includes a long time of image acquisition and operational complexity. Therefore, the assessment of the composition of the body at MRI is carried out when there are clinically obtained MRI images obtained during the treatment or follow-up of the disease. There are imaging techniques that are not yet fully validated, namely: magnetic resonance spectroscopy, which provides information about the metabolism and biochemical structure of tissues, so that the imaging doctor can determine the type of tissue present, can make the difference between intramyocellular and extra-myocellular fat (47).

Ultrasonography, can be a good option for an initial assessment of the quality and quantity of muscle mass. Its major advantages compared to other ways are low cost, portability and lack of radiation exposure. In particular, its portability is particularly advantageous: unlike other assessment techniques, the lack of portability of which limits their

use in large epidemiological studies, portability produces a significant advantage in clinical settings, which explains its increasing importance in the study of skeletal muscle (49,26). Since radiation is not required, ultrasound can be used for all patients. Another important advantage of ultrasound is that it allows real-time visualization of the target structure, and through echogenicity, it can provide information about the presence of inflammation, fibrosis and fat infiltration (49). Advantages and disadvantages of diagnostic methods of sarcopenia are presented in table 2.

Evaluation methods for sarcopenia have been developed, through questionnaires that establish its impact on the patient. There was a similarity between osteoporosis and sarcopenia, a questionnaire similar to the one used for osteoporosis called the FRAX score was developed. The SARC-F questionnaire, which was validated in terms of the impact on risks and health status in the population (19). For each item, the corresponding score is awarded, with a minimum of 0 and a maximum of 10 points, respectively, in total. A score between 0-3 denotes a healthy person and one above 4 is considered symptomatic of sarcopenia.

Prophylaxis and treatment

Studies have proven that proper nutrition leads to decreased hospitalization periods, complications and even mortality, nutrition being a key point for the preservation of muscle mass as well. "We are what we eat," says a universal proverb. This is true even in the third age (52). Food and eating habits are reflected in how we feel, we look and in our overall health. A balanced diet adapted to the needs of the body, can help a lot. Low-calorie foods, but rich in nutrients are beneficial in maintaining optimal body weight, but also for maintaining a good muscular system. A rich intake of antioxidants (fruit vegetables) is required. Water intake is vital, it may be that at old age it is diminished. The intake of minerals and vitamins to replace any deficiency, such as calcium, vitamin D, vitamin B12, zinc, iron, etc. It is the importance of calcium in maintaining the health of the bone system. As we age the strength of the bone decreases, its integrity is affected. Along with what calcium vitamin D contributes to bone formation and to the maintenance of their health. The administered dose of vitamin D for people over 71 years of age the dose is 800 IU / day (54).

Scientists state that maintaining an adequate level of calcium in the blood could prevent the body from removing it from the bones. Vitamin B12 is synthesized in the gastrointestinal tract, and then it is absorbed into the body, it is concentrated in the tissue, therefore it is found only in food of animal origin. Foods's rich in vitamin B12 (μg/100g) include liver, also beef and lamb, sheep, eggs and dairy products. Vitamin B12 is a particularly important vitamin for women of childbearing age and the elderly, however, an adequate state of vitamin B12 is required throughout the entire life cycle for optimal health. The effects of subclinical deficiency are not fully known and many aspects of the absorption of vitamin B12, bioavailability and metabolism are not yet to be determined. Identifying sensitive biomarkers of vitamin B12 status will help elucidate the relationships between vitamin B12 and chronic disease and help identify those at risk of clinical and subclinical deficiency (57). The more sedentary we are, the lower the caloric intake should be, otherwise we risk getting fat. But beware, reducing calories doesn't mean a decrease in the nutrients on your plate! In addition, those "empty calories" should be avoided, that is, drinks or foods that are high-calorie, but that do not provide too many nutrients, as is the case with alcohol, cakes, chips, etc. To get an idea of the calorie requirement depending on the degree of physical activity performed, the US National Institute of Aging (58) recommends the following proportions: in women: about 1600 calories for those who do not have an active life, about 1800 calories for those who have an average active lifestyle, about 2000-2200 calories for those who have intense physical activity. In men: about 2000 calories for those who do not have an active life, about 2200-2400 calories for those who have an average active lifestyle, about 2400-2800 calories for those who have intense physical activity.

For the prevention of the occurrence of sarcopenia, specialists recommend resistance physical exercises at any age because they have the role of increasing the synthesis of muscle fibers. Resistance exercises cause muscle contractions against external resistance. In this regard, it is recommended to lift weights, push-ups, crunches, lunges, climbing stairs or exercises of climbing and lowering on a step. Exercise increases protein synthesis, promotes anabolism. Mechanisms are based on the release of fibroblast growth factor (IGF1) and mitochondrial synthesis. In addition to relieving oxidative stress and increasing the body's immunity, physical therapy also has recognized biological effects, favoring the reduction of inflammatory markers (IL-6, TNF, C-reactive protein) (59). All these benefits obtained through aerobic or endurance exercise, recommended 3-4 times a week, causing an increase in muscle mass and strength, will increase the balance and decrease the risk of falling, which is also increased due to medication administered to control the associated pathology.

It is important that the selection of physical exercises is made according to the general state of health and taking into account the degree of coverage of all muscle groups, respectively, those of the arms, back, chest and lower limbs. Another aspect to keep in mind is that physical exercise should not be carried out in excess, until exhaustion or over a long time. The optimal interval between exercises is 2-3 days to allow the muscles to recover.

As methods of treating sarcopenia, it is recommended to treat such pathological conditions as hypertension, diabetes, weight surplus or other metabolic disorders. In cases where the muscular system is very weakened, orthopedic equipment may be needed to support the body in the process of displacement, at least temporarily, until the muscle condition is restored or improved (60).

DISCUSSION

It is explicit that sarcopenia is a prevalent and immobilizing condition with several causes, effects and counteractions. The onset of sarcopenia itself is not hereditary, however, many hereditary diseases and dysfunctions prevalent in the coming years can lead to a sedentary lifestyle, which leads to sarcopenia. After the age of 50, there is a progressive loss of 1%-2% of muscles per year. Muscle strength decreases by 3% every year after the age of 60 (20). A diet rich in foods containing antioxidants - such as fruits and vegetables - is recommended (52). Sarcopenia affects most of the glycolytic fibers of type II with double speed, unlike the slow-bonding type I oxidative fibers (20). The characteristics of fragility, elderly affected by sarcopenia are the usual fatigue and the inability to walk around the house or climb stairs (16). There are no doverds to support the specifics of the genre in sarcopenia. It is very related to inactivity, older adults with high low levels of physical activity are more likely to develop sarcopenia. Moderate and high-intensity cardiovascular exercise and resistance training can counteract neuronal degradation and produce the antioxidants needed to fight reactive oxygen species. An exercise program together with a proper nutritional plan offers a significant strategy that can make the difference between debilitation and a healthy and active lifestyle. Moderate and high-intensity exercise will promote the production of powerful antioxidant enzymes that combat ROS (25).

Dennison and Sayer summarize the literature indicating that diet has an important influence on sarcopenia as well, with the most consistent evidence indicating the roles of protein, vitamin D and anti-oxidant nutrients (43).

Taylor J Marcell and Jeremy, states that the onset of sarcopenia would act as a vicious cycle: since with aging physical activities on a regular basis are greatly reduced, there is a downward regulation of physiological systems that adapt to reduced levels of effort/stress. As the reserve functions of skeletal muscles are reduced, this contributes to an increased relative perception of effort for absolutely similar load compared to when an individual was younger. Depending on the perception of the difficulty of the tasks to

be performed, this will lead to the avoidance of physical work and the performance of the physical exercise will be in regression contributing to physiological decreases and to the reduction of the functional reserve capacity of the individual (28,29).
Kristin Franzon in the published study, concludes that, only muscle function and muscle mass, have been associated with independent aging (it refers to the preservation of the capacity of daily ADSL activities) in very older men. For the study he used the updated definition EWGSOP2, severe but not probable or confirmed sarcopenia was associated with loss of independent insufpracy. Otherwise, none of the present definitions of sarcopenia according to EWGSOP has been associated with independent age (36,37).
The assessment of muscle mass, muscle strength and functional capacity has important clinical implications in the therapeutic approach. Early identification of sarcopenia plays an important role in prognosis and evolution. Prevention measures such as nutritional intervention and physical activity could help to decrease the number of people with sarcopenia and maintain the independence of the elderly. An adequate intake of vitamins and proteins are nutritional interventions recommended in the treatment of sarcopenia.
The evaluation of sarcopenia is complex both in medical practice and in research. By establishing well-defined interventions and by collaborating with all specialists in the medical fields involved in the pathology of the elderly, we can prevent and delay the onset of this syndrome (48-51).
Eleven out of 12 studies assessed the impact of sarcopenia on mortality. The results showed a higher rate of mortality among sarcopenic subjects (pooled OR of 3.596 (95% CI 2.96–4.37)). The effect was higher in people aged 79 years or older compared with younger subjects ($p = 0.02$) (60).

CONCLUSION

The scientific studies draw attention to the impact of sarcopenic degeneration, skeletal muscles on the quality of life, greatly reducing the functional potency, independence, or may even influence the survival rate of the patients affected by it. Sarcopenia is associated with old age and people with comorbidities. The process of degeneration of skeletal muscles could be slowed down or even stopped by implementing a personalized treatment, rigorously applied. Skeletal muscle degeneration has a multifactorial cause, it is a mechanism both intrinsic and extrinsic of its triggering and progression. The research has challenged us to deepen in the future the association of rheumatological diseases with the sarcopenic alteration of skeletal muscle mass, the probability is supported by the increased level of inflammation indicators.
Through proper nutrition and mineral, hormonal and sustained physical activities, the process of stimulating muscle proteins with a role in repairing degenerated muscles can be influenced. We believe that this knowledge that we have brought to your attention will raise awareness of clinical practitioners, and the impact will be to save human lives.
I concluded that sarcopenia is a priority for the public health system. It is imperative to implement early identification techniques and clinically significant thresholds for the three components affected in sarcopenia (strength, mass and skeletal muscle function). It is important to work even more to establish the criteria for identifying sarcopenia at the international level.

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Research article

Influence of melatonin on systemic inflammatory status and bone histopathological modifications in female rats with surgically induced menopause

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ABSTRACT: Background. Melatonin, N-acetyl-5-methoxy-tryptamine is the major secretion product of the pineal gland with important anti-inflammatory and antioxidant properties, also being an important marker of bone remodelling associated with menopause. **Objectives.** The aim of our study was to evaluate the effect of the co-administration of melatonin and estrogen on systemic inflammatory status and bone histopathological modifications in surgically induced menopausal female rats. **Materials and methods.** The study was performed on a number of 40 female rats, Wistar breed, which underwent bilateral surgical ovariectomy. Within 14 days postoperative, hormone replacement therapy with estrogen or estrogen with melatonin was initiated, in different doses. The treatment was administered for 12 consecutive weeks. At the end of the treatment we measured the serum levels of IL-6 and TNF-α. The femoral bones were harvested after sacrificing the animals and the thickness of the cortical bones was measured and histologically analysed.
Results. Serum values of inflammatory markers were negatively correlated with melatonin administration, the differences being more important at higher doses of melatonin (for both IL-6 and TNF-α the difference between group E_2M with estrogen substitution and melatonin in double dose and control group W, without hormone replacement, was highly statistically significant with $p < 0.0001$). Bone diameters improved in the case of female rats that received hormone replacement with estrogen and higher dose of melatonin ($p = 0.0004$ between group E_2M, with hormone replacement and group W, control group). **Conclusions.** Melatonin improved inflammatory status and bone histopathological changes in ovariectomized female rats.

Keywords: *melatonin, estrogen replacement therapy, inflammation, low bone density*

1. INTRODUCTION

Bone tissue undergoes a continuous process of remodelling, involving environmental and growth factors, cytokines and systemic hormones such as estradiol, parathyroid hormone and growth hormone (1), as well as vitamins D and K (2).
Recently, the genetic factors involved in bone metabolism have been studied, being admitted the polygenic nature of the phospho-calcium imbalance. Although the results remain inconclusive and controversial both for the general population and for the Romanian population (3,4).

Melatonin is a marker of the bone remodelling process, being inversely correlated with bone histopathological changes associated with menopause (5). Melatonin has a dual action in the bone, on the one hand promoting the differentiation and action of osteoblasts, by increasing the expression of osteoprotegerin in these cells, on the other hand preventing the differentiation of osteoclasts and neutralizing free radicals responsible for bone resorption. Thus, melatonin contributes to the hormonal modulation of bone cells, being more and more often highlighted in the etiopathogenesis of postmenopausal osteoporosis especially since its secretion gradually decreases with the aging of female patients (6). Studies demonstrate the influence of melatonin on bone turnover, leading to increased markers of bone formation and decreased bone resorption in postmenopausal female rats (7), with similar effects among human subjects (8). To validate the effects of melatonin on bone remodelling and bone turnover, adequate concentrations of serum estradiol are required, studies showing that melatonin and estrogen have cumulative effects on bone changes in postmenopausal osteoporosis (9). It is also known that low serum estrogen levels are the main cause of bone histopathological changes in the first 5-10 years after menopause, being responsible for the high turnover of bone remodelling during this period, with the predominance of bone resorption (10,11). Also, the decrease of melatonin secretion is directly correlated with the increase of the risk of falling and implicitly with the appearance of fractures with various locations, accompanied by the decrease of the life quality among the elderly population (12).

Melatonin also has strong anti-inflammatory and antioxidant effects by inhibiting the secretion of important cytokines such as TNF-α and IL-6 (13-15) both molecules being mediators of the acute phase response negatively correlated with bone mineral density values. Both TNF-α and IL-6 destabilize the balance of phospho-calcium homeostasis at the bone level, tilting it in favour of bone resorption (16,17). The mechanisms by which these cytokines influence the degree of bone mineralization are still debated in the literature but the serum level of inflammation markers is higher among patients with low bone mineral densities compared to those with bone mineral densities within normal range (18-20).

Thus, the evaluation of specific markers for inflammation in the case of patients with low bone mineral density becomes important for a correct therapeutic option. IL-6 inhibitors may be an alternative treatment for postmenopausal patients with bone loss in order to improve inflammatory status (21), as well as the administration of exogenous melatonin with a very good safety profile (22) on the one hand for the bone-forming beneficial effects, as well as for the reduction of the serum values of the inflammation markers (7,13).

Objectives

All the above evidence supports the idea that exogenous administration of melatonin under appropriate serum estradiol levels may improve inflammatory status and bone histopathological changes associated with menopause. The aim of our study was to evaluate the effect of melatonin co-administered with estrogen on systemic inflammatory status and bone histopathological modifications in surgically induced menopausal female rats.

Materials and methods

The study was conducted on 40 female Wistar rats according to the norms of ethics, with the approval of the University's Ethical Committee. The animals were housed in a controlled environment as showed in the Figure 1. Human bilateral ovariectomy surgical technique has been adapted for female rats (7).

After the completion of the 14 days post-ovariectomy period, which is required to confirm the status of ovarian failure, hormone replacement therapy (estrogen mono therapy) combined with melatonin treatments was started. The treatment was administrated for 12 weeks, following the veterinary posology. The levels of serum estradiol were measured before and after the bilateral ovariectomy in all study participants.

The ovariectomized rats were randomly separated into 4 groups (W, E, E_M and E_2M) as explained in Figure 1.

All 40 animals maintained clinically healthy, without any post-surgical complications until the end of the experiment. None of them was excluded during the study.

Upon completion of the treatment, the orbital sinuses were punctured for blood samples and the serum levels of IL-6 and TNF-α were anlysed.

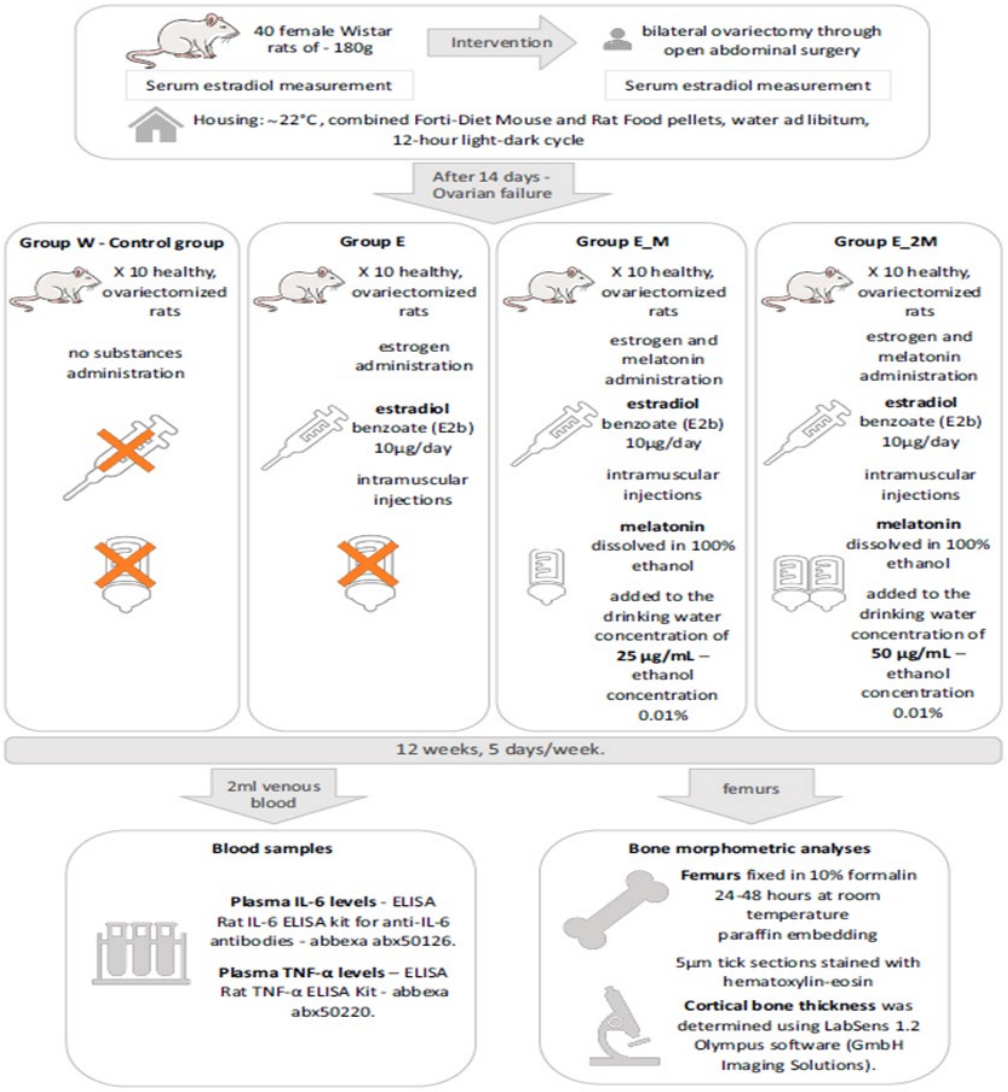

Figure 1. Materials and methods

After rats slaughtering, femurs were harvested, fixed in 10% formalin for 24-48 hours at room temperature and processed for paraffin embedding. 5µm tick sections obtained from formalin fixed paraffin embedded *(FFPE)* blocks were stained with hematoxylin-eosin in order to perform morphometric analyses. Cortical bone thickness was determined using LabSens 1.2 Olympus software (GmbH Imaging Solutions). Two different persons were responsible with the cages labeling and correct treatment administration and the ones responsible with conducting the experiments were not involved in the sampling procedures.

Statistical analyses were performed using MedCalc version 19 software and Microsoft Excel Analysis Tool Pack.

Normal distribution was tested by Kolmogorov-Smirnov test. Data were expressed as means ± standard deviation (SD). Comparison between groups was performed using Student t-test for paired or for independent samples or ANOVA, followed by Bonferroni correction for analysis of more than 2 groups. Analysis of correlations was based on Pearson correlation coefficient. Statistical significance threshold was set at α=0.05.

Results

The mean and standard deviation (SD) for all the variables studied are presented in Table 1 for each study group.

Table 1. *Variables Mean and Standard Deviation (SD)*

Study group	Variables Mean±SD				
	E_pre	E_post	Il-6	TNF-alfa	Diameter
W	37.4±9.8	17.9±2.4	0.0768±0.0049	0.1074±0.0046	57.66244±5.619852
E	36.9±6.3	35.6±1.9	0.0664±0.0042	0.0872±0.0045	65.4165±14.90199
E_M	35.0±5.4	35.8±1.3	0.0577±0.0035	0.0785±0.0047	66.0815±11.57504
E_2M	39.1±4.7	36.0±1.8	0.0469±0.0025	0.0709±0.0035	78.29467±9.552679

W -control group, E -group with estradiol replacement therapy, E_M -group with estradiol replacement therapy and melatonin in simple dose, E_2M -group with estradiol replacement therapy and melatonin in double dose, E_pre -estrogen value before therapy, E_post -estrogen value after therapy.

The serum levels of estradiol in premenopausal female rats did not differ significantly between the 4 groups ($p=0.8$), while the serum levels of estradiol in the postmenopausal period differed significantly in each of the three groups with estradiol substitution (E, E_M, E_2M) compared with the control group (W) ($p<0.0001$), but without differences between groups E, E_M and E_2M ($p>0.05$) (Fig. 2).

Serum levels of IL-6 and TNF-α significantly differed ($p<0.0001$) from the control group in all three groups with estrogen replacement (group E) or estrogen replacement co-administered with melatonin (groups E_M and E_2M), as well as between each of the 3 groups (E, E_M and E_2M) (Fig.3, Fig.4). Thus, melatonin administration beside estrogen replacement brought supplementary dose-dependent benefits in reducing inflammation markers such as IL-6 and TNF-α.

Regarding the values of the femoral bone diameters, they significantly differed between the control group (W) and the group that received estrogen replacement and the simple dose of melatonin (E_M) ($p=0.046$), respectively between the control group (W) and the group that received estrogen replacement and the double dose of melatonin (E_2M) ($p=0.0004$). No statistically significant difference was found between the control group (W) and the group that received only estrogen replacement (E) ($p=0.083$).

When comparison was made between the groups receiving estrogen replacement, there was no statistically significant difference in femoral bone diameters between group E (with only estrogen replacement) and group E_M (with estrogen replacement and simple dose of melatonin) ($p=0.922$). On the other hand, femoral bone diameters were significantly larger in group E_2M (estrogen replacement and the double dose of melatonin) than in group E_M ($p=0.034$) or in group E ($p=0.029$). (Fig. 5). Bone diameter values improved as estrogen and melatonin were administered to the three study groups, the improvement being dependent on the presence of estrogen and the dose of melatonin administered.

The results have shown an increase in bone diameters as the serum values of IL-6 and TNF-α decreased, with an inverse relationship between markers of inflammation and changes in bone structure, but without statistical significance of the correlations.

The histological images of the femoral bones differed between the four groups in the study, the repair processes being more important for group E_2M.

Discussion

In a review published in 2019 which included several in vivo and in vitro studies in experimental animal models the anti-inflammatory effects of melatonin (N-acetyl-5-methoxy-tryptamine) were highlighted in an impressive number of pathologies with damage to various organs, in different circumstances.(13). The involvement of melatonin in angiogenesis, apoptosis, free radicals scavenging and increased imunity has been shown.

Previous studies demonstrated that melatonin has important oncostatic properties. Blood levels of melatonin is inversely correlated with the rate of tumor proliferation in patients with endometrial cancer (23). Melatonin has been shown to have anti-inflammatory properties in several autoimmune diseases such as multiple sclerosis, systemic lupus erythematosus, rheumatoid arthritis, type I diabetes (24) and also cardiovascular and renal protective effects associated with high blood pressure and myocardial ischemia (25). Due to its anti-inflammatory and antioxidant properties, several clinical trials have aimed to monitor the beneficial effects of melatonin administration in patients infected with SARS-CoV2 during the COVID-19 pandemic. In critically ill patients diagnosed with COVID-19, melatonin is an adjunct in reducing the effects of cytokine storm triggers and therefore excessive inflammation; in addition it would decrease anxiety levels and improve sleep in these patients by regulating the sleep-wake mechanism and the circadian rhythm. These studies also recall the high safety profile of melatonin (15,26).

Melatonin proved its anti-inflammatory role in the present study by reducing the serum values of IL-6 and TNF-α inflammation markers in groups of rats with estrogen plus/minus melatonin substitution (E, E_M, E_2M) compared to the control group, without hormone replacement. The differences were also statistically significant between the groups with estrogen substitution (group E) and estrogens with melatonin in different doses (groups E_M and E_2M). The serum values of the two inflammation markers studied were inversely correlated with the doses of melatonin administered being significantly lower in group E_2M as compared to group E_M.

Ren Haiwei et al. noticed in one study the same inverse relationship between serum melatonin levels and markers of inflammation (IL-6, IL-1, TNF-α) in female patients diagnosed with osteoporosis. On the other hand, the same study observed the positive correlation of the levels of inflammation markers with the markers of bone resorption. TNF-α induces stromal cell expression in osteoblasts and stimulates osteoclast activity while interleukins may promote cell proliferation of osteoclast precursors and increase the activity of these cells; all these mechanisms facilitating osteoresorption to the detriment of osteoformation (27).

At the same time, the effects of melatonin on bone turnover are well known, with a favourable influence on bone remodelling in postovariectomy female rats. For the validation of these effects it is necessary, as mentioned, adequate concentrations of serum estradiol (9,28).

With an adequate serum estradiol concentration provided by estrogen replacement in the three study groups (groups E, E_M and E_2M) and without significant differences in estradiol concentration between groups, in the present study melatonin was found to significantly influence bone remodelling. So, even if histological appearance was improved in all 3 study groups (groups E, E_M and E_2M), statistical significance was found only for the two groups with melatonin (E_M and E_2M) when compared to control group. On the other hand, in group E_2M (with estrogen substitution and double dose of melatonin) femoral bone diameters were found to be significantly larger than in group E_M (with estrogen substitution and simple dose of melatonin) and in group E (with only estrogen substitution), respectively.

Similarly to other studies, melatonin-induced bone changes were found to be dose-dependent (29-31).

The values of inflammation markers were inversely correlated with the values of bone diameter but they were not statistically significant. Even in the absence of correlations with statistical significance, it remains important to assess the inflammatory status in case of bone histopathological changes associated to menopause (20,21).

Melatonin remains one of the important hormones involved in bone remodelling. Numerous studies have shown the beneficial effects of melatonin on the proliferation of osteoblastic cells, stimulating the formation of type I collagen and bone proteins such as alkaline phosphatase, osteocalcin, osteopontin, and on the other hand its inhibitory

effects on osteoclast differentiation by decreasing RANK mRNA expression and increasing mRNA and osteoprotegerin levels (24,32,33).
Melatonin also indirectly influences bone metabolism by interacting with various systemic hormones such as estrogen and parathyroid hormone (9,34).
Ladizeski et al. emphasizes the role of estrogen in prolonging the effects of melatonin on bone remodeling in ovariectomized female rats (28).
In addition, melatonin eliminates superoxide anions resulting from the activity of osteoclasts during the process of bone resorption, its antioxidant effect being well known (24,34).
This information highlights the involvement of melatonin in the pathogenesis of menopausal-associated bone changes suggesting its potential value in the prevention and treatment of postmenopausal osteoporosis (35).
Limitations
One limitation of this study is the relative small number of animals and the limited extrapolation to possible effect of melatonin on human bone metabolism. The study also lacks a group of animals to which melatonin was administered exclusively.

Conclusions

Melatonin improved the inflammatory status associated with histopathological changes in menopausal bone and also improved bone remodelling in ovariectomized female rats in a dose-dependent manner.

Abbreviations
COVID-19 - "coronavirus disease 2019"
E2b - estradiol benzoat
ELISA – Enzyme-Linked- Immuno-Sorbent-Assay
IL-1- interleukin 1
IL-6 - interleukin 6
m ARN – messenger ribonucleic acid
SARS-COV-2 - severe acute respiratory syndrome coronavirus 2
TNF-α – tumor necrosis factor – alpha

Authors' contributions

V.M.C, I.M, A.L.P, L.I: Research concept and design; S.Ş, A.D.C, A.L.P: Collection and/or assembly of data; I.M.B, I.M, A.D.C, R.A.U: Data analysis and interpretation; V.M.C, I.M.B, I.M, R.A.U, L.I: Writing the article; V.M.C, I.M.B,L.I: Critical revision of the article; V.M.C, I.M.B, I.M, S.Ş, A.D.C, A.L.P, R.A.U and L.I: Final approval of the article
#All authors had equal contributions with the first author.

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Review

The importance of a multidisciplinary approach to improve the life quality for patients with Parkinson's disease

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ABSTRACT: Parkinson's disease is defined as a complex degenerative neurological disease with progressive evolution, which is part of motor system of the brain disorders, being the second degenerative disease as a frequency after Alzheimer's disease. It is characterized by tremor when muscles are at rest (rest tremor), increased muscle tone (stiffness), slow voluntary movements and difficulty maintaining balance (postural instability). Occupational therapy helps Parkinson's patients improve their ability to perform daily tasks. The intervention consists in assisting patients in developing a self-care routine, taking into account the limitations of functional mobility, encouraging patients to maintain maximum function of daily activities for as long as possible, learning adaptive techniques to reduce tremor. Materials and methods. The devices used for this purpose are commercially available but they are quite expensive, which is why we wanted to make devices made of material as cheap and affordable as possible. Some of the devices can be successfully made of material that every person has in their home. We also took into account the variant of making them without the need to use complicated tools and devices that are not available to patients. Starting from these premises, we thought and made in our occupational therapy laboratory various devices designed to offer patients a variety of techniques and exercises and also a flexible work environment. On a pallet plate we fixed a series of elements such as zippers, snap button, hook-and-eye closure, systems that patients use on a regular basis. We also manufactured a device designed to help patients with household chores such as dish washing. The device is provided at one end with a washing sponge, its handle being a detergent tank. The size and shape have been adapted to the needs of patients with Parkinson's disease. Results and discussions. In order to obtain the devices, cheap materials were used at the disposal of every person eager to make them. It started with simple objects that any patient uses for personal hygiene and more. The technique of making the devices was a very simple one, from the very beginning the steps that must be followed in order to make them were clearly established. Conclusions. Using the devices made during the physiotherapy sessions, significant improvements of the life quality for patients with Parkinson's disease were observed.

Keywords: *Parkinson, Occupational therapy, Devices, ADL*

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1. INTRODUCTION

Parkinson's disease (PD) is the second most important age-related neurodegenerative disorder in developed societies, after Alzheimer's disease, with a prevalence ranging from 41 per 100,000 in the fourth decade of life to over 1900 per 100,000 in people over 80 years of age (1). Parkinson's disease (PD) is one of most disabling disorders of the central nervous system. The motor symptoms of Parkinson's disease: shaking, rigidity, slowness of movement, postural instability and difficulty with walking and gait, are difficult to measure. When disease symptoms become more pronounced, the patient experiences difficulties with hand function and walking, and is prone to falls. Baseline motor impairment and cognitive impairment are probable predictors of more rapid motor decline and disability. An additional difficulty is the variability of the symptoms caused by adverse

effects of drugs, especially levodopa (2). ADLs are characterized as the activities we perform every day such as getting dressed, taking a shower, and cooking. The ability to perform ADL's depends on overall mobility, cognitive capability, and social support, among others and is highly associated with health-related quality of life (QOL). In PD, the ADL-level also depends on response to medication and is a dominant factor in managing daily life with PD. Fluctuations in symptoms due to complex response to medication cause pendulum between periods in which PD patients are able to move smoothly for some hours (On state) and periods with increase of motor symptoms (Off-state) (3).

Occupational therapy (OT) is an allied treatment planned to assure the maximum degree of autonomy to the patient. OT may be useful to enable patients to engage in meaningful roles and activities, adapt the living environment with all the necessary devices and precautions to decrease the risk of falls or accidents, and improve domestic life and functional mobility and mantainance of work abilities. OT therefore may give a significant contribute to the overall management of patients with PD and may have a significant impact on the quality of life of patients with PD (4).

Studies show that one occupational domain negatively affected by PD is instrumental activities of daily living. According to the Occupational Therapy Practice Framework, IADLs are complex activities that support daily life in the home and community and include caring for others, communication management, driving and community mobility, financial management, health management and maintenance, home establishment and management, meal preparation and cleanup, religious and spiritual activities, safety and emergency maintenance, and shopping. Studies have found PD-related limitations in a variety of IADLs, including driving, financial management, medication management, shopping, and household management, even very early in the disease course (5). IADL limitations in people with PD are associated with withdrawal from everyday activities and reduced quality of life. These findings highlight the necessity and importance of interventions to address IADL function among people with PD (6).

In 2019, Fraciotta M conducted a study of 482 patients with Parkinson's disease to assess whether a specific occupational therapy (OT) program is effective in improving the dexterity of fingers and hands and its impact on ADL in patients with PD. All patients underwent 1 h/day OT treatment, 5 days a week. The primary outcome measure was the O'Connor finger dexterity test; secondary outcome measures were the Minnesota dexterity test, UPDRS II, and Self-Assessment Parkinson's Disease Disability Scale (SPDDS). These measures were assessed at admission (T0) and discharge (T1). Based on the Hoehn and Yahr scale (H&Y), patients were divided into two groups: 262 subjects in H&Y stage <3 (early-stage PD patients) and 220 in H&Y stage ≥3 (medium-advanced stage PD patients). As expected, at baseline, all measures were worse in higher H&Y stages. After treatment, both groups experienced significant improvements in all outcomes. Significant differences between early-stage and medium-advanced stage PD patients were observed only for the changes in UPDRS II, with a better improvement in patients in H&Y stage ≥3. In the end, it was found that patients with PD who underwent a rehabilitation protocol, including OT, experienced improvements in finger dexterity and hand function. Our results highlight the relevance of OT in improving autonomy and quality of life in patients with PD (7).

In 2021, Foster and colleagues conducted a review to demonstrate the effectiveness of occupational therapy interventions to improve or maintain IADL function in adults with PD. 22 studies were analyzed, and the results highlighted strong evidence for the beneficial effect of occupational therapy interventions on physical activity and handwriting levels, moderate evidence strength for IADL participation, and drug adherence, and low evidence strength for cognitive rehabilitation. . In conclusion, occupational therapy sessions can improve the management and maintenance of health, handwriting and IADL participation for people with PD, but more research is needed on cognitive rehabilitation (8-15).

Matherial and Methods

The devices used for this purpose are commercially available, but they are quite expensive, which is why we wanted to make devices made of materials that are as cheap and affordable as possible. Some of the devices made can be successfully made from materials that everyone has in the house. We also took into account the option of making them without the need for complicated tools and devices that are not available to patients.
Based on these premises, we designed and developed in the occupational therapy laboratory various devices designed to provide patients with a variety of techniques and exercises, as well as a flexible work environment.

Results and Discussion

We have developed devices to help patients with household chores, such as washing dishes. The devices are provided at one end with a washing sponge, the handle of which is a detergent tank. Their size and shape have been adapted to the needs of patients with Parkinson's disease.
The first is effective both for patients with early Parkinson's disease and for those with severe symptoms. Insert the patient's hand between the handle and the elastic (Fig.1.), Then press the container that will fill the sponge with dishwashing detergent several times with the other hand. The grooves on the handle, made with the soldering gun, help to hold the device as well as possible, so that the patient will not slip his hand during use.

Fig 1. Dishwasher.

The second dishwasher (Fig. 2) is commercially available, but I added a foam tube to it to make it easier to hold. Metal nuts have been inserted inside the tube to reduce the tremor by means of the weight added by them. Both devices can be reused, as dishwashing detergent can be added to each of them.

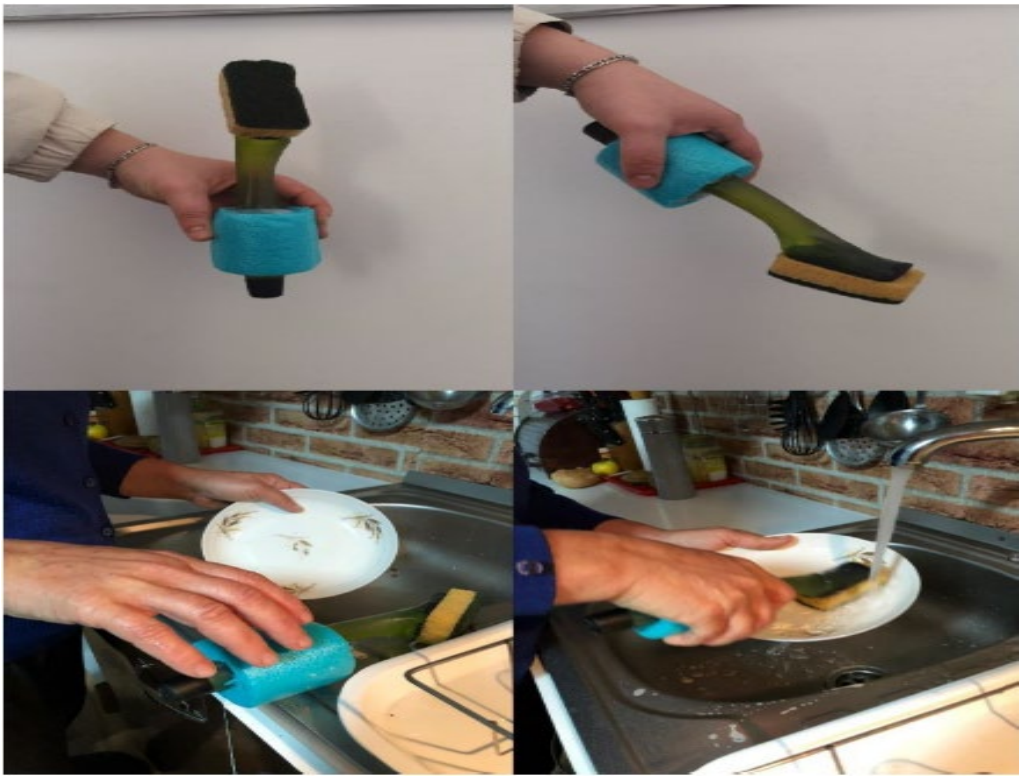

Fig 2. Dishwasher.

Other household activities include cooking, so we developed a device designed to help patients peel vegetables and fruits. The device is very simple and practical, representing a standard vegetable peeler, which can be easily found in the market, inserted in a foam tube, which has inside metal nuts fixed with a soldering gun, to give it something more weight and easier to handle.

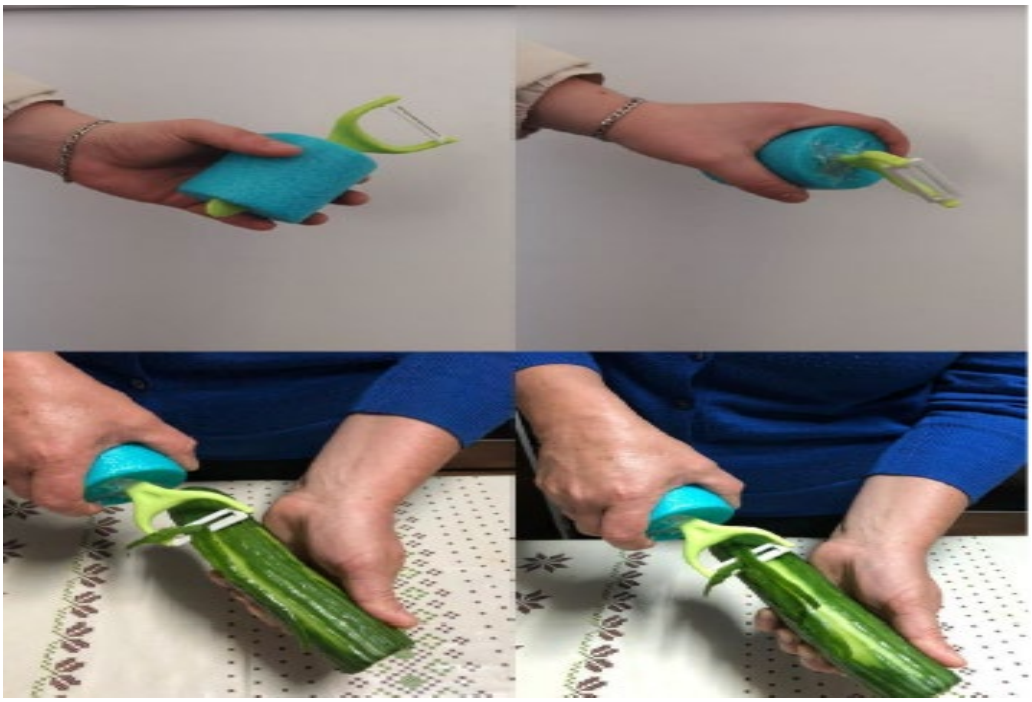

Fig 3. Device for peeling vegetables and fruits.

Personal hygiene is perhaps one of the most important daily activities that an individual must carry out for a healthier lifestyle. So, I designed a simple device, consisting of a toothbrush and a foam tube - the toothbrush was inserted into the foam tube in which I re-inserted metal nuts, fixed with a soldering gun - for to facilitate its handling by patients diagnosed with Parkinson's.

Fig 4. Toothbrush.

In order to achieve good oral hygiene, in addition to the toothbrush, we reinterpreted, through common elements, a device that facilitates the use of toothpaste by distributing an ideal amount of product, as poor grip and reduced muscle strength of Parkinson's patients restrict proper use of the toothpaste bottle. So, on a baking sheet, I evenly distributed balls of toothpaste and then sprinkled baking soda so that they would keep their shape, solidify on the outside, maintaining their effectiveness. After the paste reached its final shape, the balls were placed in an empty container of candy, found commercially. A piece of foam tube was attached around the container, using the soldering gun, inside which were metal nuts, inserted in order to facilitate grip and reduce tremor, through the stability conferred by the added weight.

Fig 5. Toothpaste.

As we get older, it becomes more and more difficult for patients to take care of household chores, so we have created a device that combines the useful with moderate physical activity. In the middle of the length of a microfiber sponge I sewed a piece of elastic fabric on either side of it, a device that can be used by patients to clean the floors, using the lower limbs and giving them the opportunity to perform a low to medium intensity physical effort, but with a fairly significant positive impact on patients' quality of life. Patients can perform both flexion / extension and abduction / adduction movements.

Fig 6. Sponge for cleaning surfaces.

As with many of the devices created, I added pieces of foam to a kitchen tong to handle the grip.

Fig 7. Kitchen tongs.

Also for cleaning the surfaces and to combine the useful with the moderate physical activity, we sewed two kitchen towels together, in order to facilitate their handling. The two cloths form a glove, with which the patient can easily clean both flat surfaces and objects, but can also be used for personal hygiene.

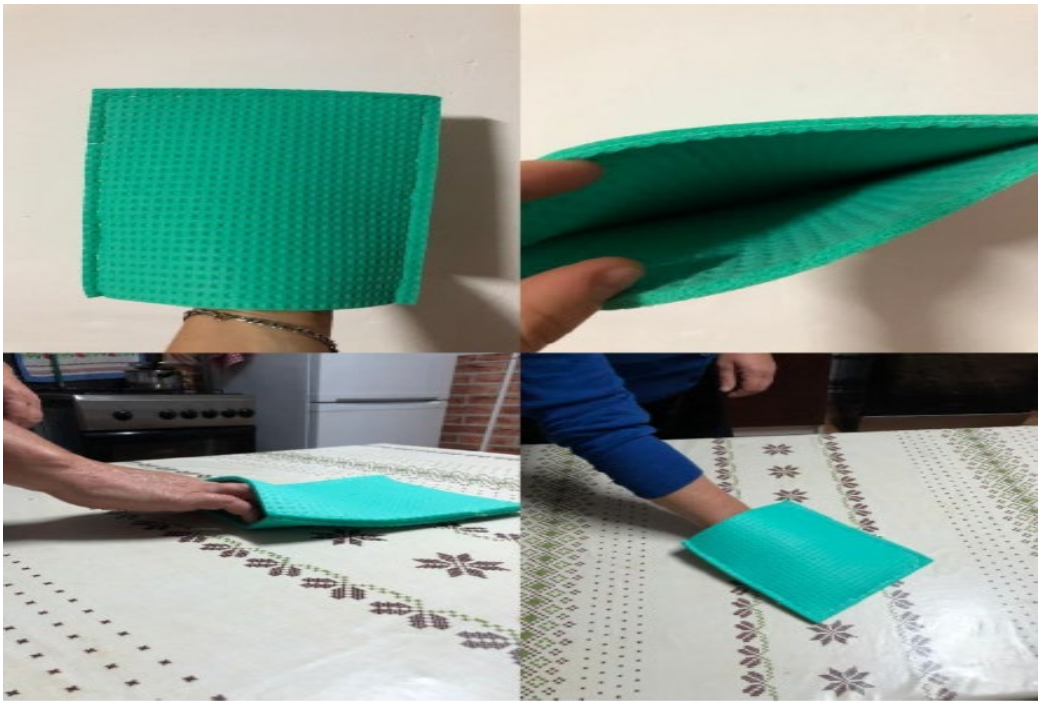

Fig 8. Double washbasin.

Body hygiene is often a challenge for patients with Parkinson's disease, which is why this device has been designed to make it easier to wash both the back and the hard-to-reach places with a minimum of effort. So, I put a bath sponge on the entire length of a shaping belt. After positioning, the belt was folded in half and sewn to keep the sponges in place. The material of the belt has a moderate abrasiveness and is suitable for the type of use for which it was created.

Fig 9. Body hygiene device.

Serving meals can be a real challenge for patients with Parkinson's disease, so we thought of a device to make this task easier for them, freeing them from the fear that they might spill the food bowl in public. At the bottom of a plastic container I glued a lid of the same material that I filled with metal nuts, to give as much stability as possible in the patient's hand. The good thing about this device is that its weight can be changed by removing a few nuts from the bottom of the device which is even completely removable.

Fig 10. Food storage device.

Conclusions

Using the devices developed in the occupational therapy laboratory, significant improvements in the quality of life of patients with Parkinson's disease were observed.

The therapeutic approach in the recovery of Parkinson's patients must be complex, must address all pathophysiological links and requires associated means of recovery: medication, physical-kinetic and hygiene-education. Following the occupational therapy program, there has been a significant increase in quality of life.

Our goals were to reduce tremor and stiffness, reduce bradykinesia, prevent neurological complications, increase and improve the quality of life by easing the movements of daily life but also by increasing patient motivation.

The movement of the body entails a good blood circulation and the functioning in normal parameters and of other organs with the maintenance of a good psychic tone. In everything that means rehabilitating the patient with Parkinson's disease, a fundamental role is played by training the owner and the family in general for care. This element is proven in daily practice where we realize that the good evolution of a patient with Parkinson's disease is closely correlated with the support he has from the family, the high mental tone of the family and the effort to integrate into active, physical and mental life.

Through the results obtained, I managed to emphasize the importance of occupational therapy in the life of the Parkinson's patient.

#All authors had equal contributions with the first author.

Conflicts of Interest: The authors declare no conflict of interest.

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Review

Study on the impact of the therapeutic swimming on elderly women diagnosed with osteoporosis

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ABSTRACT: Introduction The adult woman has a complex of endocrine metabolic changes that can influence and cause various disorders in the body regarding the decrease of functional and regulatory capacities. The involuntary changes in a woman's aging highlight both the appearance and the functionality. In this sense, we intend to conduct a study on morphological changes, parameters that represent risk factors in the development of osteoporosis. Studies by Kanis (1) and Munshi (2) show that maintaining adequate bone mass as well as ensuring adequate muscle tone can prevent osteoporosis, and a pronounced incidence of the onset and development of chronic degenerative pathologies can promote fractures. **Material and method.** In connection with the elucidation of this aspect, we will use the Frax estimation method, which is based on the introduction of values obtained from medical evaluations. Regarding the study, we propose to the subjects a therapeutic swimming program to avoid the occurrence of osteoporotic fractures. **Results and discussions.** Regarding the field of factors favoring the estimation of a fracture in the items regarding cortisone treatments, alcohol consumption, digestive problems, minor traumas, the investigated subjects answered with No 100%.In order to obtain objective results, the study will continue for a period of 1 year, the intermediate tests will be performed after 4 months from the beginning of the work program and at the same time the program will undergo changes, depending on the results obtained from the evaluations. **Conclusions.** The implementation of this water exercise program will lead to adaptive changes in the direction of limiting the unevolutionary processes of senescence.

Keywords: *elderly women; osteoporosis; estimate; physical activity, therapeutic swimming*

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1. INTRODUCTION

The modern concept proposes the optimal health term for all age groups, by practicing various physical activities, which beneficially influence the body in order to maintain and improve the quality of life. Regular physical activity can maintain or optimize morpho-functional abilities at optimal physiological parameters. The health effects of exercise, especially in water (3), lead to positive changes in both the somatic and psycho-emotional fields. Bone health is characterized by a permanent process of remodeling, achieving a balance between destruction and bone formation. During menopause in women, the balance changes by reducing the formation of new bone, indicating bone loss, with a risk of osteoporosis and fractures (4).

Intrinsic factors (genetics, bone condition in young people) and extrinsic factors (physical activity, nutrition, drug use) are involved in decreasing bone mass. Osteoporosis prophylaxis begins in adolescence. Exercise, body weight control, bone health, healthy eating are important for the future adult. If we talk about minerals, calcium is an important element because the skeleton contains 99% of the total calcium in the body, the rest being in plasma and extracellular fluid (5).

There are studies in the literature (6), which show that there are reference intervals, by age groups, regarding the serum concentration of magnesium. A diet rich in magnesium may play a role in preventing, along with aging, weight loss, muscle strength (7).

Another element that intervenes in biological systems is iron, an essential trace element. It is found in a high percentage in hemoglobin, which has the role of transporting O2 and CO2 between the lungs and tissues, and in regulating blood pH. Iron plays an important role in metabolic processes, especially when there is a balance between the two oxidation states (Fe 2+ and Fe 3+) (8).

In addition to calcium, vitamin D and iron, there are other micronutrients (copper, selenium) that help prevent osteoporosis. Bone health can be influenced by increasing the amount of intake of fruits and vegetables, which contain micronutrients and are useful for bone remodeling. Ensuring a balanced diet supplemented with exercise also have a prophylactic effect on osteoporosis (5,9). Alkaline diet correlates with age, physical activity and protein intake to help prevent muscle loss (10).

Ensuring an optimal intake of calcium, through diet or medication, can have a positive effect on bone mass and thus can reduce the risk of falling and fracture (11).

In our society, the attention paid to the elderly in the direction of prevention, estimation of health status is not sufficiently addressed. In connection with the elucidation of aging processes, experts note that the involution of the human body depends on a number of factors (genetic, environmental, pathological).

Dr. Mircea Dumitru states in his book that there is an "early aging between 40-60 years and accelerated aging after 60-65 years", and the WHO specifies the age category between 60-74 years as elderly (12).

Menzel's study suggests that bioactive molecules released by adipose tissue (adipokines) may provide a possible link between bone health and adipose tissue. Although it is initially thought that leptin may influence osteoblast differentiation in bone marrow stromal cells, recent studies suggest that the new adipokine or chemerin or gene 2 may influence bone health (13).

With age, there is an increase in "fatty tissue, changes in the joints due to osteoarthritis, brittle bones due to osteoporosis, muscles are affected by degenerative processes that change their trophicity and muscle mass" (14). Regular exercise in adults and the elderly has an anti-inflammatory and antioxidant effect on the autonomic nervous system, a fact demonstrated by Matei D. et al. in 2022 in a systematic review of the literature of the last 10 years. The recommendations for moderate-intensity exercise for most individuals are 30 min / day 5 days / week, they improve physiological and functional abilities as it increases the expression of antioxidant enzymes in serum levels (15). The number of diseases with known inflammatory etiology in the elderly is constantly increasing, including asthma, osteoporosis, cancer, atherosclerosis, type 2 diabetes, obesity, cardiovascular and neurodegenerative diseases. Onu I. et al. demonstrated in a 2011 systematic study that serum biomarker values in regular exercise addicts change, showing that chronic inflammation is limited due to activation of the immune system that will increase the level of anti-inflammatory myokine IL-6. They concluded that exercise in adults and the elderly is a clinical tool, due to improved cardiorespiratory, metabolic, musculoskeletal function, thus stimulating immunity and antioxidant capacity, resulting in reduced incidence of acute and chronic inflammatory diseases (16). Author Gabriela Negrișanu considers that lack of exercise is manifested by "bone not subjected to physiological use quickly loses BM", also "sedentary lifestyle and lack of exercise contribute to the decrease of BM (bone mass)" (17).

In the same context, the author Mihai Constantinescu presents in "Kinesiotherapy in Geriatrics Gerontology", among the theories of aging, the theory of connective tissue: connective tissue contains collagen, elastin and pseudo-elastin (it is a degrading factor). With age, the amount of elastin decreases, which plays an important role in tissue elasticity. Due to the dehydration of aged tissues, calcification of elastin occurs in the elderly "(18).

There are studies that have found that physical activity contributes to healthy aging, reducing disability (19). The results of Su's study suggested that swimming can have an

effect on bone mineral density in postmenopausal women if the swimming time is between 3 and 6 hours. Therapeutic swimming can stimulate osteoblasts through muscle movement and the effect of water pressure on the bone (delays bone loss), stimulates increased estrogen secretion, can increase bone mass and can promote osteogenesis, reducing bone loss (20).

There are also studies who confirmed that the practice of therapeutic swimming influences bone density as well as the level of bone turnover markers, such as CTX, a bone resorption marker. (21). Schoell 's study confirms that weight loss in older adults is associated with reduced bone mineral density in the femoral neck (22).

A randomized study published in 2015 evaluated the effect of physical activity on morbidity in an elderly population, highlighting the preventive effect for chronic diseases and their role in improving the quality of life and ensuring active aging (23). As shown in one study, the FRAX score may provide data on a possible risk of fracture that could occur at the vertebral and invertebral level in the next 10 years.

Determining the risk of fracture is also useful in identifying patients in need of therapy, as well as in assessing the cost-effectiveness of applied therapy (24). Current research shows that in untrained people, if they start exercising two, three times a week, even in combination with stretching or myofascial release techniques, after a certain time there is an obvious improvement in morph abilities and parameters functional, issues confirmed by (25).

As physical capacity begins to decline from the age of about 45, then there is a risk of installing pathogenic mechanisms on various devices and systems in the body.

Hypothesis: We will start from the premise that by implementing an aquatic program as well as the evaluation with the help of the Frax program, in the life of the elderly, we will prevent the eventual traumas at the level of the locomotor system.

The aim is to estimate fractures by the Frax method, to develop a model therapeutic swimming program for a group of elderly women to prevent and reduce bone thinning.

Material and method: The clinical study was carried out on an outpatient basis at the Railway Hospital Iasi - Specialty Ambulatory of Suceava, the patients being under the guidance of PhD. S. Silișteanu, the patients underwent the evaluation of bone densitometry with an Osteo-densitometer, and the practical part was performed at the Swimming and Physiotherapy Complex Suceava, under the guidance of physiotherapists E. Vizitiu and M. Constantinescu. The proposed research sample consisted of 10 patients following the regulation of the SARS COV-2 pandemic context. The period in which the first part of the study took place was from 01 10 2021 - 05 02 2022. To carry out this study we aimed at:

- inclusion criteria are: patients aged 60-75 years; diagnosed with osteoporosis; without decompensated diseases (respiratory, cardio, neuro, digestive, renal)
- exclusion criteria: persons under 60 years of age and over 75 years of age; with comorbidities; uncooperative.

The evaluated parameters were: weight, height, BMI, Frax estimation method. The following tools were used for this purpose; scale, thali-meter, BMI table, Frax estimator.

The patients received osteoporotic treatment according to the specialist's instructions. In the study we used means of therapeutic swimming, for 4 months 3 sessions per week, starting from the first stage, the first stage of the program includes a duration of 35 minutes, and in the third, 60 minutes. In order for the work schedule to be a therapeutic means, it is important to select, adapt, dose and rhythm of performing the exercises. In the first stage of the program, auxiliary materials were used, giving them up until the third stage, respecting the principle from simple to complex, from easy to difficult. In order to obtain positive results, we will take into account the observance of certain basic rules and principles in which the subjects must have, a suitable equipment for the

activity, to participate consciously and actively in all movements, to have continuity in carrying out the work schedule. the proposed exercises.
The objectives of the program.
1.Identifying aspects regarding predisposing / etiopathogenic factors in the one-minute test items;
2. Identify how patients responded to the incidence of risk factors regarding the estimation of the fracture;
3. Identification of the health elements of therapeutic swimming on elderly women.
Statistical analysis
The data obtained were processed using Microsoft Excel programs, averaging (x); standard deviation (α); coefficient of variability (Cv%)
Results and discussion:
In the "1 minute test", the subjects answered under the same conditions referring to the items of the test.

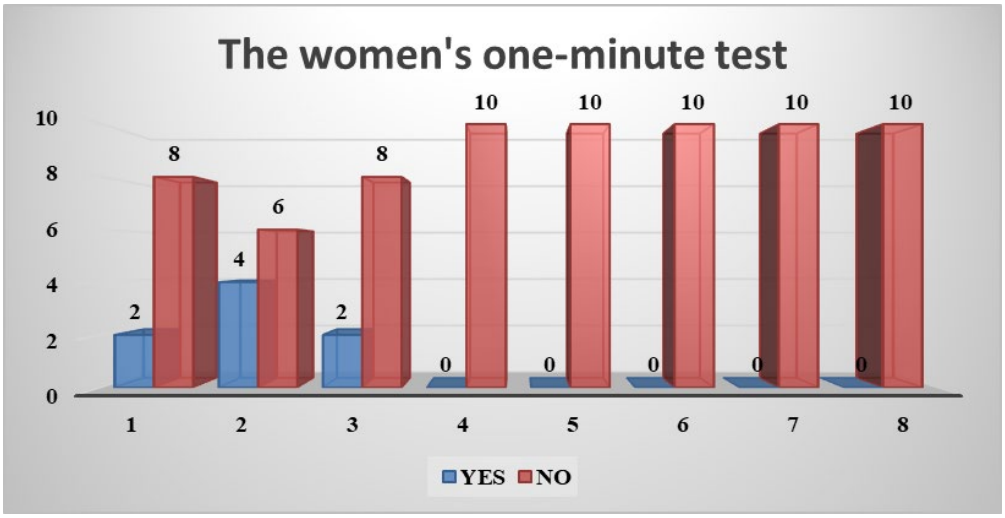

Diagram No. 1 Osteoporosis risk assessment

Referring to the first objective, the frequency of responses was 20% YES and 80% NO regarding the history of family trauma. Regarding the mention of personal antecedents, the frequency score was 40% Yes and 60% No. Another plan investigated was the functional status regarding the onset of menopause before the age of 45, the frequency score was 20% Yes and 80% No. (diagram 1)
Regarding the field of factors favoring the estimation of a fracture in the items regarding cortisone treatments, alcohol consumption, digestive problems, minor traumas, the investigated subjects answered with No 100%.

Table 1 Calculation of BMI statistical indices and estimation of a fracture according to the "FRAX fracture risk calculation tool"
Statistical indicators BMI Hip fracture Major osteoporotic fracture

Statistical indicators	**BMI**	**Hip fracture**	**Major osteoporotic fracture**
x	26.78	2.32	7.00
α	1.87	1.86	2.24
Cv%	6.97	80.03	32.00

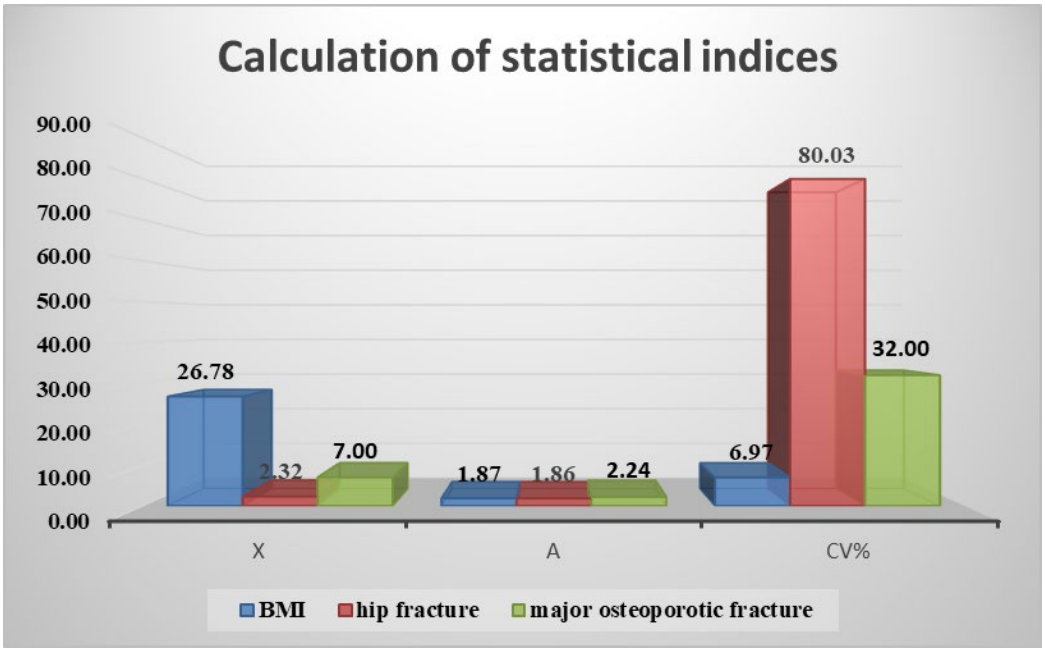

Chart No. 2 BMI and Estimating a Fracture

The BMI test shows a group average of 26.78 uc compared to normal values (between 18.50 and 24.99 - normal weight). (table no.1; diagram 2)
This value indicates an overweight status, which exceeds the maximum allowed values. For hip fracture, the assessment tool shows us an average estimate of 2.32 uc and an estimate of 7.00 uc of major osteoporotic fracture (diagram 3).
The intervention plans calculated by the Frax fracture estimation tool show us the degree of risk of a fracture over a period of 10 years. This approach helped us to establish the elaboration of the program.

Intervention threshold: major fracture
Probability of a 10-year fracture

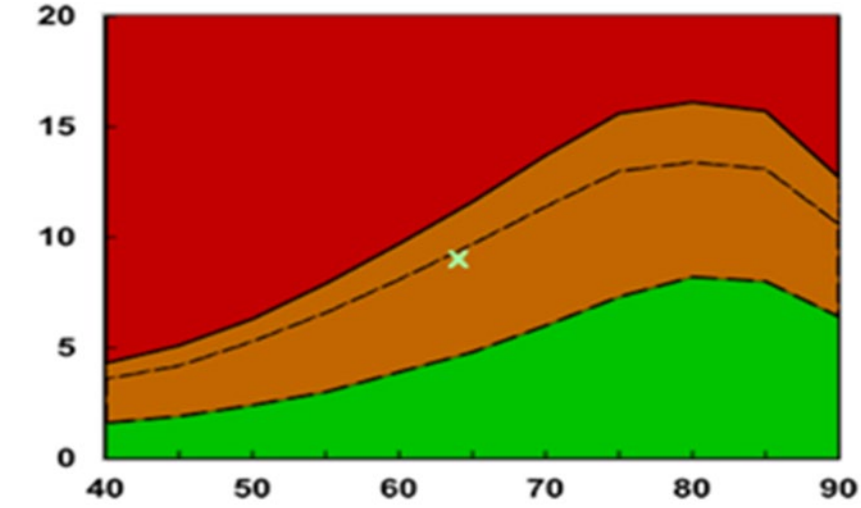

Diagram no. 3 Graphic evaluation model of the Frax Instrument

The intervention plans calculated by the Frax fracture estimation tool show us the degree of risk of a fracture over a period of 10 years. This approach helped us to establish the elaboration of the program.
Following the estimates obtained, a program of means specific to therapeutic swimming was developed to target its objectives (table no. 2).

Table no.2 Therapeutic swimming program – model

Working hours - Model			
Objectives: Observation of patients' health status at physiological parameters, especially weight status; Motivation and awareness of patients to exercise in the water; Increasing physical qualities (mobility, strength and endurance of the body);Improving proprioceptive abilities.			
Stage I (2 weeks)	**3 sessions / week**	**time: 35 minutes**	**volume 200-300 m**
goals	• Accommodation with the aquatic environment • Favoring the amplitude of movement at the joint level • Learning the basics of swimming		
Exercise to get used to water and learn the basics T ^{0} water 28.5 ^{0} - 29.5 ^{0}	• static exercises • dynamic exercises Auxiliary swimming pool devices (pool swimming floaties, belt, swimming pool noodles)	• Floating the body (floating on chest, and then floating on back) • walking, running, and jumping • Sliding the body on the water with the help of the physiotherapist	
Stage II (6 weeks)	**3 sessions / week**	**time: 40 minutes**	**volume 300-400 m**
goals	• Maintaining a normal weight status • increase proprioceptive capacity		
Exercises for stability, balance and coordination T ^{0} water 28.5 ^{0} - 29.5 ^{0}	• static exercises • dynamic exercises Auxiliary swimming pool devices (belt, kick boards, pool swimming noodles)	• Sequences of movements performed with the lower limbs • Sequences of exercises performed with the upper limbs • Coordination of the upper limbs with that of the lower limbs • Stretching exercises	
Stage III (8 weeks)	**3 sessions / week**	**time: 60 minutes**	**volume 400-500m**
goals	• Increasing physical capacity • Development of muscle strength		
Exercises for endurance and strength T ^{0} water 28.5 ^{0} - 29.5 ^{0}	• static exercises • dynamic exercises Auxiliary swimming pool devices (swimming fins, water dumbbells)	• Traveling at different distances (25,50,100,150,300 m) in the back stroke style and free style • Sequences of exercises for upper limbs, torso and lower limbs with different water dumbbells)	

The program was based on the one-minute test and the estimates obtained by the Frax fracture estimator.
In order to obtain objective results, the study will continue for a period of 1 year, the intermediate tests will be performed after 4 months from the beginning of the work program and at the same time the program will undergo changes, depending on the results obtained from the evaluations.

The current study included a small number of patients, which does not allow a prediction to be made that can be applied to the general population, requiring the inclusion of a larger number of patients over a longer period of time.

Conclusions:

1. By using the 10-year fracture estimation tool "Frax" a fracture prediction was made in which it is found that any favored factor checked can influence the final result;
2. The correlation between BMI and the risk of hip fractures, as well as major osteoporotic fractures is obvious, and the change in BMI upwards or downwards leads to an increase in the data on the estimate made by Frax;
3. By using the means of therapeutic swimming applied to women, after menopause it is essential to maintain a morphophysiological status that ensures stability in order to prevent fractures.
4. Based on the final result, BMI indicates an overweight status to the people under study, which leads us to apply other assessment tests as well as the introduction of new aquatic exercises.
5. Osteoporosis is considered a public health problem not only in our country (26), but also in Europe, which involves early diagnosis to ensure the implementation of prevention programs and to optimize therapeutic strategies (27-34).

Conflict of Interest

The authors declare that they have no conflict of interest.

Patient Consent

All the patients gave the informed consent for the study. 41 / 17.09.2022

Author contribution

All authors with equal contribution.

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Case presentation

Medical management and rehabilitation in posttraumatic common peroneal nerve palsy

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ABSTRACT: Introduction. The common peroneal nerve and the tibial nerve are the two major components into which the sciatic nerve divides. The severity of common peroneal nerve damage depends on the aetiopathogenic mechanism and the place of injury. The peroneal ram of the sciatic nerve injury is the most common cause of mononeuropathy of the lower limb which can cause a significant disability if is not properly diagnosed and treated. Material and method. We present the case of a 40-year-old patient who suffered a polytrauma by road accident resulting in left trochanteric-diaphyseal femoral comminuted open fracture, lacerated wound on the posterolateral middle third of the left thigh, left sacral wing fracture without displacement, left L1, L2, L3 transverse apophyseal fractures and splenic laceration, treated surgically and orthopedically. The patient was admitted to the Medical Reabilitation Department of Sibiu for left leg motor deficit, mechanical pain and functional deficit of the left hip and ankle, gait disorders. Complex rehabilitation treatment was initiated 3 months after the accident. Results and discussion. Common peroneal nerve palsy was confirmed following neurological consultation the day after admission to Orthopaedics-Traumatology Department of Sibiu where continuous extension-traction was performed in order to relax the fracture and subsequent osteosynthesis surgery of the femur fracture. The presence of a deep and lacerating wound on the posterolateral left thigh caused the nerve injury. The coagulase-negative Staphylococcus aureus overinfection of the wound required secondary suturing and subsequently led to fibrous scar formation, adversely affecting the post-injury repair of the common fibular nerve. Conclusions. In patients with posttraumatic common peroneal nerve palsy, early diagnosis and appropriate treatment, including medical rehabilitation, are essential. Medical rehabilitation should be continued on a sustained basis because nerve regeneration occurs slowly. The prognosis mainly depends on the severity of the initial nerve injury.

Keywords: *common fibular nerve injury, polytrauma, medical rehabilitation*

1. INTRODUCTION

Traumatic injury to the common peroneal nerve can occur by several mechanisms: compression, tearing, crushing, traction/stretching, ischaemia, thermal injury or high velocity

trauma [1]. The injury can occur at any level of the peripheral nerve pathway, but most commonly occurs at the fibular head where it becomes superficial [1,2].
Compresion/entrapment syndrome is common and can affect almost any peripheral nerve, usually occurring in its distal territory [1]. Compression can be acute or chronic, leading to changes in microcirculation within the nerve, altered axonal transport and vascular permeability disorders, contributing to edema and nerve conduction blockages [3]. At the fibular head, the common peroneal nerve presents an area of vulnerability that makes it more prone to injury. The compressive mechanism may be achieved by habitual leg crossing or prolonged squatting, immobilisation of the lower limb in an inappropriate position on a hard surface for a significantly long time (for example during surgery) or in a cast that is too tight or incorrectly positioned [4]. Damage to the common fibular nerve can also occur following various traumatic injuries involving the knee [5].
The most common mechanism of traumatic peripheral nerve injury is transection/dilaceration caused by fractured bone ends or penetrating trauma. In this situation the diagnosis of nerve injury may be delayed due to the association of surrounding tissue injury [1]. Peripheral nerve damage may be aggravated if infection, scar tissue formation, vicious fracture callus or due to the presence of vasculopathy [1].
The common peroneal nerve can also be injured iatrogenically. Continuous transskeletal traction through the tibial tuberosity can lead to injury of this nerve if there is a chronic external instability of the knee [6,7].
The common peroneal nerve has anatomically deficient vascularization. This is provided by only one nutrient artery, unlike the sciatic and posterior tibial nerve in which the vasa nervorum network is represented by 2 to 6 nutrient arteries. Therefore the prognosis is poorer in the case of injury to the common peroneal nerve and necrosis, Wallerian degeneration and fibrous scar formation may occur [8].
Neurodiagnostic tests are useful in assessing the severity, location and prognosis of the nerve lesion [9]. The resulting disability depends on the severity of the lesion and negatively influences the quality of life of these patients if the nerve injury is irreversible [10]. The therapeutic management can be conservative or surgical depending on the severity of the case [11].

Objectives

The aim of our article is to highlight the role and importance of early and sustained rehabilitation in a patient with posttraumatic common peroneal nerve palsy.

Material and method

We present a case of a 40-year-old patient who was admitted to our Rehabilitation Department with left leg motor deficit, mechanical pain and functional deficit of the left hip and ankle, gait disorder. The patient had suffered 3 months ago a polytrauma due to a road accident resulting in left trochanteric-diaphyseal femoral open comminuted fracture, lacerated wound on the posterolateral middle third of the left thigh with involvement of the fascia lata and herniation of the posterior musculature, left sacral wing fracture without displacement, left L1, L2, L3 transverse apophyseal fractures, splenic laceration and haemoperitoneum. Splenectomy and left thigh wound revival were performed. For the trochanter-diaphyseal femoral fracture continuous transskeletal traction through the tibial tuberosity was performed, and then osteosynthesis of the proximal third of the left femur. A motor deficit was found in the left foot since admission to the surgical department. Neurological and neurosurgical consultations were requested and an electromyography was recommended. The evolution of the thigh wound was unfavourable due to a superinfection with coagulazo-negative Staphylococcus aureus and it was necessary to institute appropriate antibiotic therapy, local surgical cleansing and secondary suturing of the wound.


Fig 1. The aspect of deep wound on the posterolateral middle third of the left thigh - clinical appearance on admission to the surgical service.
Fig 2. Postoperative scar on the posterolateral middle third of the left thigh - clinical appearance after 3 months.

Clinical examination revealed: lack of muscle substance and multiple supple postoperative scars on the posterolateral middle third of the left thigh; moderate left gambo-podal edema; left gluteal muscle hypotrophy (positive Trendelenburg sign); pain on left hip mobilization and decreased mobility for flexion = 110°, external rotation and abduction = 30° and internal rotation = 15°; inability to perform left foot eversion and left foot/toe dorsiflexion; evaluation of the muscle strength using the Medical Research Council scale (MRC) highlighted motor deficit in following left lower limb muscles: gluteus medius (value +3/5 MRC), iliopsoas (value 4/5 MRC); hamstrings (value +3/5); anterolateral compartment of the leg (value +1/5 MRC); superficial hypoesthesia on the lateral part of the left leg and dorsal part of the left foot; without pathological changes on examination of deep tendon reflexes; walking difficulties, steppage gait with left foot drop, supported by two Canadian crutches.

Functional evaluation reveals: the visual analog scale (VAS) for pain intensity index = 8, the activities of daily living scale (ADL) index = 8 (quasi-independent), instrumental activities of daily living scale (IADL) index = 6/8 (aided), Functional Ambulation Categories scale (FAC) index = 3 (needs supervision), quality of life scale (Short Form 36 Health Surve - SF 36) score = 64%. According to these results we found a slight to moderate deficit in selfcare and locomotion.

The following images show the results of pre- and postoperative paraclinical investigations. (Fig 3, Fig 4).

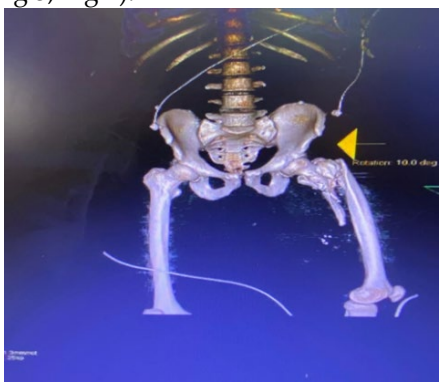
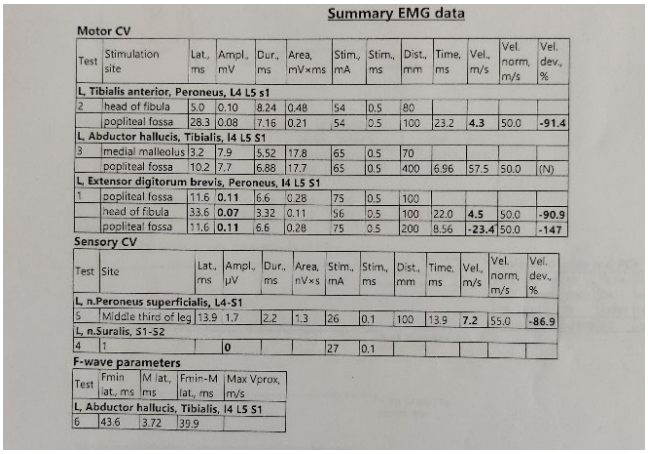



Fig 3. Computer tomography of the pelvis with 3D reconstruction - preoperative view.
Fig 4. Radiological examination of the left hip - comminuted fracture of the proximal left femur, osteosynthesis with Gamma centromedullary rod fixed distally.

The electrodiagnostic study revealed severe axonal degeneration of the left common peroneal nerve and sural nerve. The control electromyography performed five months after the accident highlighted the same aspect (Fig 5).



Summary EMG data

Motor CV

Test	Stimulation site	Lat., ms	Ampl., mV	Dur., ms	Area, mV×ms	Stim., mA	Stim., ms	Dist., mm	Time, ms	Vel., m/s	Vel. norm, m/s	Vel. dev., %
L, Tibialis anterior, Peroneus, L4 L5 s1												
2	head of fibula	5.0	0.10	8.24	0.48	54	0.5	80				
	popliteal fossa	28.3	0.08	7.16	0.21	54	0.5	100	23.2	**4.3**	50.0	**-91.4**
L, Abductor hallucis, Tibialis, I4 L5 S1												
3	medial malleolus	3.2	7.9	5.52	17.8	65	0.5	70				
	popliteal fossa	10.2	7.7	6.88	17.7	65	0.5	400	6.96	57.5	50.0	(N)
L, Extensor digitorum brevis, Peroneus, I4 L5 S1												
1	popliteal fossa	11.6	**0.11**	6.6	0.28	75	0.5	100				
	head of fibula	33.6	**0.07**	3.32	0.11	56	0.5	100	22.0	**4.5**	50.0	**-90.9**
	popliteal fossa	11.6	**0.11**	6.6	0.28	75	0.5	200	8.56	**-23.4**	50.0	**-147**

Sensory CV

Test	Site	Lat., ms	Ampl., µV	Dur., ms	Area, nV×s	Stim., mA	Stim., ms	Dist., mm	Time, ms	Vel., m/s	Vel. norm, m/s	Vel. dev., %
L, n.Peroneus superficialis, L4-S1												
5	Middle thirs of leg	13.9	1.7	2.2	1.3	26	0.1	100	13.9	**7.2**	55.0	**-86.9**
L, n.Suralis, S1-S2												
4	1		**0**			27	0.1					

F-wave parameters

Test	Fmin lat., ms	M lat., ms	Fmin-M lat., ms	Max Vprox, m/s
L, Abductor hallucis, Tibialis, I4 L5 S1				
6	43.6	3.72	39.9	

Fig. 5. Electromyographic examination of the left lower limb 5 months after the trauma.

A Magnetic Resonance Imaging (MRI) of the left thigh was performed 6 months after the trauma, but the result was irrelevant. It was not possible to assess the level of nerve injury due to the existence of numerous artefacts determined by presence of osteosynthesis material.

Results

The objectives of the medical rehabilitation treatment in this case are: atrophy prevention of the left leg denervated muscles, preventing the installation of vicious attitudes and positions, pain relief in the left hip, restoration of joint mobility (hip and left ankle), amelioration of vasculotrophic disorders, restoration of the motor and sensory deficit in the affected lower limb, gait reeducation, socio-familial and professional reintegration.

The patient received neurotrophic drug treatment in our department. The rehabilitation program was performed twice a day for 15 days and consisted of: electrical stimulation with exponential pulses on denervated muscles, kinetotherapy and massage. In addition, pulsed short wave therapy (Diapulse) was instituted for its pain-relieving effects, acceleration of trochanteric fracture healing, facilitation of nerve regeneration, reduction of tissue edema and prevention of keloid scar formation. Fixed ankle-foot orthosis was also recommended to improve gait. It should be noted that rehabilitation treatment was initiated 3 months after the motor deficit installation.

The evolution was favourable with improvement in pain, joint mobility and muscle strength in the left lower limb, except the left foot where only a slight improvement of the motor deficit was observed.

Discussion

In the case presented, the road accident caused a lumbar, abdomino-pelvic and left thigh polytrauma imaging confirmed by cervico-thoraco-abdomino-pelvic computed tomography (CT). The lesional level of the common peroneal nerve was determined based on neurodiagnostic study.

L5 algoparetic radicular involvement by lumbar spine compression was excluded based on imaging investigations and clinically by lack of ankle inversion muscle involvement.

For anatomical reasons, fractures of the L1, L2, L3 left transverse apophyses and fracture of the left sacral wing without displacement cannot be the cause of plexopathy with sciatic nerve injury.

At the same time, based on the abdominal-pelvic CT examination, compression of the lumbar roots L4, L5 in the lower portion or of the sciatic nerve by a post-traumatic hematoma in the iliopsoas or gluteus medius muscle was excluded.

Piriformis syndrome occurs due to compression of the sciatic nerve at the level of the piriformis muscle and mainly affects the peroneal part of the nerve. In very rare cases the major components of the sciatic nerve leave the sacral plexus separately. In this situation the common peroneal nerve crosses the piriformis muscle at the level of the greater sciatic

notch, and the tibial nerve passes inferior to the piriformis muscle. The involvement of only the common peroneal nerve with secondary paralysis can be explained if we consider the compression of only this component in the piriformis muscle. Piriformis syndrome can manifest clinically as muscle weakness of the hamstrings. In our case, muscle strength of the hamstrings was decreased in the context of muscle and tegumentary changes secondary to the posterolateral laceration in the middle third of the left thigh.
The left open trochanteric-diaphyseal fracture could have caused the sciatic nerve trunk injury, but does not explain paralysis of the peroneal nerve alone in this case.
The place where the sciatic nerve divides into its major components (tibial nerve and common peroneal nerve) is highly variable. Most commonly the division occurs at the junction of the middle third and lower third of the thigh near the apex of the popliteal fossa, but it can occur at any level above this point and less commonly below this point. The laceration at the posterolateral middle third of the left thigh may be the cause of common peroneal nerve palsy if the sciatic nerve division is at this level. For clarification MRI examination of the left thigh was performed, but the result was inconclusive.
Iatrogenic causes of common peroneal nerve injury by compression due to direct manipulation during orthopaedic surgery or due to intraoperative positions in abdominal surgery (prolonged compression during lateral rotation of the hip and lower limb with knee flexion) have been excluded [11]. In our case the electromyographic result showed that the nerve lesion occurred above the fibular head, and the motor deficit was noted since admission to the surgical department.
Continuous transskeletal traction through the tibial tuberosity [6,7] applied in femur fractures may result in injury to the common fibular nerve [12,13]. Two cases of transient common peroneal nerve palsy are cited in the literature as a complication of this technique, but both patients had incompetence of the lateral collateral ligament of the knee as a contributing factor [14]. Lateral collateral ligament incompetence causes secondary widening of the lateral compartment of the knee and its varus deformity, with consequent injury to the common peroneal nerve after initiation of transskeletal traction. In our case the motor deficit was observed before this procedure was performed.
The ability to regenerate of a peripheral nerve injured by trauma depends on a number of intrinsec factors (age, tissue nutrition manner, time since nerve injury, type and level of injury) and extrinsec factors (drug or surgical treatment, including postoperative management) [1,9]. Hypoanaesthesia may improve within two years of nerve repair. Recent studies have shown that the injured common fibular nerve regenerates much less compared to that of the tibial nerve [8].
Due to the significant motor deficit in the left leg, functional electrical stimulation would be useful in our patient. There are studies that have demonstrated the efficacy of this method, being associated with increased gait speed and improved gait symmetry [15].
In our patient's case, the severity of the common peroneal nerve injury requires consideration of neuroraphy or nerve transposition. Clinical studies conducted so far do not have scientific evidence on the effectiveness of neuroraphy [16,17].
Gastrocnemius tendon transfer and postoperative medical rehabilitation can be used to correct the "foot drop" and regain the ability to walk without an assistive device. The results of clinical trials have demonstrated the effectiveness of the method [18].
Severe lower limb impairment and pain may be associated with depressive disorders and lower patient motivation to comply with medical rehabilitation treatment [19]. Pain is an insufficiently understood symptom and difficult to tackle and is frequently not totally relieved resulting in low quality of life [20]. In physical medicine and rehabilitation motivation and ambition are very important [21]. It is therefore essential that clear, achievable goals should be set in the rehabilitation programme to improve outcomes [22,23].

Conclusions

The particularity of the case presented is given by the injury of the common peroneal nerve at the level of the left thigh, without involvement of the posterior tibial nerve, in a patient who suffered a polytrauma by road accident resulting in multiple fractures of the spine and lower limb and a deep thigh wound on the path of the sciatic nerve. The patient requires sustained medical rehabilitation treatment. Prognosis is poor due to severe peripheral nerve injury and late initiation of rehabilitation program. However, left common peroneal nerve neuroraphy or nerve transposition remains under discussion.

Patient Consent

In this article was included an informed consent that was obtained from the patient.

Authors' contributions

All authors have equal contribution in this publication.

Conflicts of interest: The authors declare that they have no conflict of interest.

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Research article

Rehabilitation of post-COVID patients with chronic fatigue and cognitive disorders syndromes

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ABSTRACT: Introduction. Almost all patients, who have experienced acute manifestations of COVID-19, regardless of the severity of the acute phase of the disease, are only at the beginning of a long way to recovery. According to experts, SARS-CoV-2 infection should affect almost 80% of the world's population, so all these patients to a greater or lesser extent will need a rehabilitation of certain manifestations of postcovid syndrome.
Purpose: to study the effectiveness of rehabilitation program and the dynamics of cognitive impairment and manifestations of chronic fatigue syndrome in patients after coronavirus disease.
Methods: The study design included 60 patients after SARS-Cov-2 infection. Among the examined patients there were 26 (43,3%) women and 34 (56,7%) men. An average age of the patients was 43,9±1,08 years. Patients were referred to the Department of Physical Rehabilitation after coronavirus disease with chronic fatigue and cognitive disorders syndromes. Accordingly, all patients, who participated in the study, were divided into two groups: group I - 28 patients with a general condition of moderate severity at the hospital stage and 32 patients - group II, with severe course of the disease and oxygen demand at the hospital stage. Depending on the duration of rehabilitation, two observation periods were used - on the 7th and 14th day of rehabilitation program.
Results: It has been proven, that patients, who didn't need oxygen, were complaining about anosmia, cephalgia, cognitive impairment, increased anxiety and fatigue. Dysgeusia, dyssomnia, and depression were more common in patients, requiring oxygen therapy at the hospital stage. Rehabilitation program eliminated cognitive dysfunction, depression, cephalgia, drowsiness and dyssomnia on the 7th day in patients, who did not require oxygen therapy (p>0,05), and in patients, who needed oxygen therapy - on the 14th day of the rehabilitation program (p>0,05). However, 2 (6,3%) and 3 (9,4%) patients, who needed oxygen therapy, even after 14 days of rehabilitation had manifestations of minor recurrent headache and drowsiness.
Conclusion: Thus, patients after coronavirus disease, who needed oxygen therapy at the hospital stage, need long-term rehabilitation program.

Keywords: *postcovid syndrome, anxiety, depression, drowsiness, rehabilitation*

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1. INTRODUCTION

The pandemic, caused by COVID-19, has changed not only the lifestyle of each of us, but also the stereotype of our thinking. Stepping confidently for more than a year, SARS-Cov-2 infection has absorbed the world's medicine with its scale and created new conditions for the development of virology, immunology and medicine in general.
The COVID-19 pandemic, caused by the new coronavirus SARS-CoV-2, or 2019-nCoV, is an infectious disease, first detected in humans in Wuhan, Central China, in December 2019. The disease began as an outbreak, that developed in a pandemic. SARS-CoV-2 coronavirus, the circulation of which in the human population was unknown until December

2019, has become a cause of the disease (1). Due to data of Johns Hopkins University of Medicine Coronavirus Resource Center on February 22, 2022 there were registered 427 005 566 total cases of this disease; the largest epicenters of the disease remain USA, with 78 583 084 cases, India with 42 851 929 cases, and Brazil with 28 258 458 cases (2). The SARS-Cov-2 epidemic monitoring system records new cases of disease, mortality and recovery from SARS-Cov-2 infection on a daily basis. According to the statistical data of Public Health Center of Ministry of Health of Ukraine 4 758 773 cases of this disease were diagnosed in Ukraine, which is approximately 10 % of the total population, with 104932 deaths and 3 985 601 people recovered (on February 22, 2022) (3).

On the early stages of pandemic development the efforts of world medicine were aimed at the treatment of acute life-threatening consequences of COVID 19. But more and more often people after SARS-Cov-2 infection seek medical help with certain symptoms of postcovid syndrome and need immediate rehabilitation (4).

SARS-Cov2 virus can cause pathological changes in the central and peripheral nervous system due to both direct infection of neurons and indirectly, through immune and inflammatory mechanisms.

Disorders of smell and taste in COVID-19 occur due to infection of epithelial cells in mucous membranes. Angiotensin-converting enzyme 2 (ACE2) is present in significant amounts on the sensory cells of the nasopharynx and oral cavity. By binding to ACE2, the SARS-Cov2 virus can inhibit sensory cell function by penetrating the cribriform plate and infecting olfactory bulb neurons. Similarly, the retrograde spread of the virus from receptor cells on the tongue to neurons of the solitary nucleus of the medulla oblongata may explain the loss of sense of taste in individuals with SARS-Cov2 infection (5). However, data from some studies have shown, that taste dysfunction is more common in patients with COVID-19, than olfactory disturbances, and that 10,2-22,5 % of COVID-19 cases are accompanied by loss of taste perception without olfactory disturbance (6,7).

There is a high probability, that cytokine storm, large and small strokes, damage to the blood-encephalic barrier, high level of inflammation in the brain substance, cause long-term neurocognitive disorders (8). Neurons contain a large number of ACE-2, so SARS-Cov2 is able to penetrate them and disrupt important intracellular processes, such as energy production in mitochondria and conformation of SARS-Cov2 proteins (9). Impaired conformation and aggregation of proteins in patients, who survived and recovered from acute infection, could theoretically lead to brain degeneration in the following decades (10). Health systems around the world in the coming years may be loaded by the influx of people with depression, post-traumatic stress disorder, anxiety, insomnia (11), psychosis, cognitive impairment (1).

According to the WHO, the time from onset to clinical recovery in mild cases of coronavirus disease is about 2 weeks, while in severe or critical cases – 3-6 weeks (12).

Currently there is no clear agreed definition of postcoronavirus syndrome. The clinical guidelines of the National Institutes of Health and the Improvement of Health Care of Great Britain (NICE) "Treatment of long-term consequences of COVID-19" (NG188) use the following clinical definitions for primary disease and long-term coronavirus disease 2019, depending on when they occurred and during which time they persist: acute coronavirus disease 2019-signs and symptoms of the disease persist for up to 4 weeks; long-term coronavirus disease 2019 with symptoms – signs and manifestations persist for 4-12 weeks; post-COVID-syndrome – signs and manifestations develop during or after coronavirus disease 2019, persist for more than 12 weeks and are not explained by alternative diagnoses (4).

Taking into account the obvious need for the guidance on the rehabilitation of those, who have undergone COVID-19, a team of experts from the rehabilitation center of Ministry of Defense in Stanford Hall (United Kingdom) developed a document – The "Stanford Hall" Consensus (13), which contains the following general recommendations after

COVID: the rehabilitation treatment plan should be individualized, according to the patient's needs, taking into account the concomitant diseases; for patients with COVID-19 rehabilitation should be aimed at relieving symptoms (shortness of breath), improving the psychological state (14), physical shape and quality of life; patients should be periodically examined during rehabilitation; patients should receive information about their condition and recovery strategies after COVID-19 (15, 16).

Purpose: to study the effectiveness of rehabilitation program and the dynamics of cognitive impairment and manifestations of chronic fatigue syndrome in patients after coronavirus disease.

Methods. The study involved 60 patients who had SARS-Cov-2 infection approximately 12 weeks ago which was confirmed by polymerase chain reaction of nasopharyngeal swab and enzyme-linked immunosorbent method. Among the examined patients there were 26 (43,3%) women and 34 (56,7%) men. An average age of patients was 43,9 ± 1,08 years. Patients were referred to the physical rehabilitation department of Central City Clinical Hospital of Ivano-Frankivsk City Council under the direction of a family doctor or physician, in the presence of symptoms of postcovid syndrome. Symptoms of neurological-cognitive nature and chronic fatigue syndrome were frequent complaints of such patients. By retrospective analysis of medical records of inpatients and case history, it was found, that all patients were hospitalized in specialized departments. However, 32 (53,3%) patients in the inpatient stage of treatment required oxygen therapy and had a severe course of disease, which corresponded to class 3, according to the systemic classification of patients of the American Association of Anesthesiologists (ASA), and 28 (46,7%) patients with moderate condition, class 2 according to ASA, did not require oxygen therapy.

All patients, who participated in the study and were included in the rehabilitation program, were divided according to the severity of the condition and the need for oxygen therapy in the inpatient phase of treatment into two groups: group I – 28 patients with condition of moderate severity and 32 patients – II group with severe course of disease. Depending on the frequency of rehabilitation measures, two observation periods were used with evaluation of chronic fatigue syndrome and cognitive impairment: after the use of 7- and 14-week rehabilitation programs. As a control group served 12 healthy persons, 7 women (58.3%) and 5 men (41.7%) of 44,2 ± 0,98 years old. The evaluation criteria were a reduction in the manifestations of chronic fatigue syndrome, or complete leveling of certain symptoms. The clinical trial was conducted in accordance with the principles and norms of the Helsinki Declaration of the World Medical Association "Ethical principles of medical research with human participation as the object of study", participants were giving a written informed consent to participate in the study. The trial was approved by the bioethics committee of the Ivano-Frankivsk national medical university.

The rehabilitation program included the following measures. The first week of the rehabilitation program included massage of the neck area, galvanization with the application of the 1st electrode of the shawl collar type on the neck area, and the 2nd on the lumbar area, connecting to the anode and cathode of the device. The first procedure was performed at the amperage of 6 mA, lasting 6 minutes. Then, after two procedures, the amperage was increased by 2 mA and the duration by 2 min, 5 procedures per course of treatment, every other day. Galvanization was carried out using the device galvanizer “Potok-1”. We also used low-frequency magnetic therapy of 25-30 MT for up to 20 min, 5 procedures per course, every other day (“DIMAP” device). On the second week of rehabilitation the massage procedures of the neck area proceed, amplipulse in the projections of the cervical sympathetic ganglia, paravertebral and interscapular area with an average frequency of modulation (30-50 Hz), 5 procedures per course, every other day (“Amplipulse-5” device); darsonval of the scalp region of the head, capacity of 4-6 divisions, lasting 10 minutes, 5 procedures per course, every other day (“ISKRA-1” device)

were prescribed. Throughout the rehabilitation program, electrosleep procedure was used, according to the ocular-occipital technique, using a pulsed current of rectangular shape with a frequency of 15-20 Hz, a pulse duration of 0,2-2 ms, a current of up to 10 mA, the duration of the procedure was 40-60 min, 5 procedures per course, every 3rd day (device "Electroson-4T").

For the evaluation of clinical effectiveness of the rehabilitation program, testing of patients before rehabilitation and on the 7th and 14th days of rehabilitation was used. To evaluate cognitive functions, a modified online Stroop Test was used (17); to determine the signs of depression – depression scale of Beck (Beck Depression Inventory) (18), to determine anxiety – Spielberger-Khanin test (STAI) (19); to detect the severity of headache – a modified facial pain scale, The Faces Pain Scale-Revised (FPS-R) (20); to determine the signs of dyssomnia and drowsiness – sleepiness scale of Epworth (Epworth Sleepiness Scale) (21, 22) and the Pittsburgh Sleep Quality Questionnaire (PSQI) (23, 24, 25).

Statistical analysis was performed depending on the distribution of the statistical sample using Student's parametric criteria and Fisher's exact criterion. To represent the obtained data, we used the method of descriptive statistics (mean, standard deviation, minimum and maximum value, scope, number of valid cases for quantitative changes); number, fraction and distribution for qualitative parameters. The results were considered significant at $p < 0,05$.

Results and discussion. Patients sought rehabilitation care with the following manifestations of postcovid syndrome. Anosmia persisted in 6 (10,0%) patients, dysgeusia - in 18 patients (30.0%), cephalgia - in 58 (96,7%), impaired concentration of attention and memory were observed (mild cognitive impairment) - in 59 people (93,7%) , dyssomnia - in 48 (80,0%), increased anxiety - in 59 (98,3%), depression - in 46 (76,7%), drowsiness - 57 (95,0%), rapid fatigue was observed in all patients (100,0%).

Analyzing the manifestations of postcovid syndrome, in patients of both study groups (table 1), according to the distribution of Fisher's exact criterion, it is seen, that symptoms, such as anosmia, cephalgia, impaired concentration and memory, increased anxiety, rapid fatigue, were observed for a long time in patients of both groups to the same extent, dysgeusia (ageusia), dyssomnia, drowsiness, depression - more often observed in patients of group II.

In order to detect cognitive impairment, a modified online Stroop test was used in the examined patients. Based on testing, it was found, that patients, who did not require oxygen therapy during inpatient treatment of SARS-Cov-2 infection, answered questions for an average of 6,18±0,39 s, which was 1,3 times faster, than in patients, who required oxygen therapy during inpatient treatment – 7,78±072 s (table 2). In addition, patients of group I needed 46,8% more of the average time to respond to the test, and patients of group II – 84,8% more, compared to the group of healthy individuals ($p < 0,001$).

However, after the application of the rehabilitation program on the 7th day in patients of group I, the average response time was 4,54±0,16 s, which almost did not differ from the same indicator in healthy individuals ($p > 0,05$) and the average time of passing the test decreased by 36,1%, in comparison to the indicator before rehabilitation ($p < 0,001$). In patients of group II on the 7th day of rehabilitation, the dynamics was not significant, so the average response time was 6,16±0,36 s and decreased by 26,3% ($p < 0,05$), which was significantly higher than in healthy individuals ($p < 0,001$).

On the 14th day of rehabilitation program the average response time in patients of group I did not decrease significantly compared to the previous observation period and was 4,11±0,08 s ($p < 0,05$), but decreased by 50,4% compared to the same indicator before treatment. Accordingly, patients of group I in the second stage of observation required the same time for response, as healthy individuals ($p > 0,05$). In patients of group II, after a 14-day course of rehabilitation measures, the average response time decreased to

4,15±0,08 s, which was 88,3% less, than before rehabilitation and 48,4% compared to the previous observation period (7 day), p <0,001. Patients of II group at the end of the rehabilitation program spent the same average time for responding to the test (4,15±0,08 s) as healthy individuals (p>0,05). The total test time in patients of group I was 1,2 times shorter compared to patients of group II. Patients of group I were spending 14,5% more time on the test compared to healthy individuals, and group II patients – by 25,3% (p<0,001). On the 7th day of rehabilitation program the total test time decreased to 45,75±0,55 s in patients of group I, which was 13,02% less, than before treatment (p<0,01) and was almost the same as in healthy individuals (p>0,05). In patients of group II the total test time decreased to 51,47±1,91 s compared to the beginning of rehabilitation (p<0,05), and by 14,08% compared to healthy people (p<0,001). Continuation of rehabilitation program helped to reduce the total test time to 44,25±0,25 s in patients of group I, which did not differ significantly from the previous observation period by 3,4% (p<0,05) and healthy individuals (p>005). However, significant dynamics of this indicator was observed in patients of group II on the 14th day of rehabilitation program, which was manifested by a decrease in the total test time to 45,03±0,55 s, which was 31,5% lower compared to the beginning of rehabilitation (p<0,001) and by 14,3% in comparison with the previous period of rehabilitation program (p<0,01). In patients of group II on the 14th day of treatment the total test time was almost the same as in healthy individuals (p> 0,05).

The dynamics was similar with the following test parameters - the total number of correct answers and the percentage of correct answers. Thus, in patients of group I, these two indicators were 1,2 times higher than in patients of group II. Group I patients were answering 36,9% less questions before rehabilitation, and the percentage of their answers was 36,5% lower in relation to healthy individuals, compared to group II patients - by 47,6% and 44,6% (p<0,001). On the 7th day of rehabilitation program, the number of correct answers in patients of group I increased to 9,29±0,21, and the percentage - to 92,5±2,12, which was 32,7% and 30,0% more, than before rehabilitation (p<0,001), and practically did not differ from healthy individuals (p>0,05). In patients of group II after 7 days of the rehabilitation program, the number of correct answers increased to 6,69±0,53, and the percentage - to 69,38±5,25, which was 22,4% and 21,6% more, than before rehabilitation (p<0,05), but differed significantly from healthy individuals (p<0,001). On the 14th day of rehabilitation in patients of group I the number of correct answers increased to 9,71±0,17, and the percentage - to 97,14±1,74, which was 35,6% and 34,64% higher, than before rehabilitation (p<0,001) and by 4,3% and 4,64% compared to the previous period (p<0,05). In group II patients, this difference was 45,7% and 41,07%, respectively, in comparison with rehabilitation (p<0,001) and 29,9% and 26,07% compared to the previous observation period (p<0,001).

In both groups at the end of the rehabilitation program, the total number of correct answers and the percentage of correct answers were the same as in healthy individuals (p>0,05).

The following scales were used and analyzed to evaluate chronic fatigue syndrome. According to the Beck depression scale, 15 (53,6%) patients of group I were diagnosed with mild depression, and 5 (17,9%) - with moderate depression. However, in patients of group II, the distribution on the Beck depression scale was as follows: mild depression was diagnosed in 4 (12,5%) patients, moderate - in 18 (56,3%), severe - in 4 (12,5%) patients. Evaluating the data of the Beck depression scale, it is seen, that patients of group I, taking the questionnaire, scored 1,5 times less points, than patients of group II (table 3).

Prior to rehabilitation program, patients of group I scored 42,3% more points than healthy individuals, and patients of group II - by 62,2%, respectively (p<0,001). On the 7th day of rehabilitation, the number of points in patients of group I in the survey decreased

from 19,96±0,93 points to 12,32±0,91 points, which was 38,3% less, than before the rehabilitation program (p<0,001), and coincided with the data of the survey of healthy individuals – 11,51±0,49 points (p>0,05). Group II patients also had a positive dynamics of reduction of signs of depression - from 30,41±2,53 points to 20,88±3,11 points, which was 31,3% less, than at the beginning of rehabilitation (p<0,001) and 44,8 % more in comparison with healthy individuals (p<0,01). The last observation period, 14 days, showed, that in patients of group I the manifestations of depression were significantly reduced to 11,29±89 points, by 76,8% compared with the beginning of rehabilitation (p<0,001) and by 9,1% relative to the 7th day of rehabilitation (p>0,05), and in patients of group II - by 97,2% relative to the beginning of rehabilitation (p<0,001) and by 38,8% relative to the 7th day of rehabilitation program (p<0,05). At the last stage of observation, patients in both groups underwent a questionnaire, which was evaluated in the same number of points as in healthy individuals (p>0,05).

The distribution according to the situational anxiety test was as follows: 23 (82,1%) and 24 (75,0%) patients of I and II groups showed moderate anxiety, and 4 (14,3%) and 8 (25,0%) had high anxiety. Mathematical analysis of the level of situational anxiety showed, that in patients of group I the rate of anxiety was higher in comparison with healthy individuals by 38,4%, and in patients of group II - by 41,5% (p<0,001). Situational anxiety had a significant tendency to decrease from 41,89±0,94 points to 29,11±1,56 points on the 7th day in patients of group I (p<0,001), and the survey data almost did not differ from healthy individuals (p>0,05). In patients of group II, after 7 days of rehabilitation program the signs of situational anxiety were not significantly reduced, which was reflected in the decrease of the survey data from 44,09±1,34 points to 36,03±2,06 points and by 22,4% (p<0,01) in relation to treatment and by 28,4% in relation to healthy individuals (p<0,001). On the 14th day of rehabilitation, the rate of situational anxiety was significantly reduced in patients of group I to 26,11±0,91 points and by 60,4% as before rehabilitation (p<0,001) and by 10,3% relative to the 7th day of rehabilitation (p>0,05), and in patients of the second group - by 54,4% (p<0,001) relative to the indicator before rehabilitation and by 22,9% compared to the previous period of the rehabilitation program (p<0,01). According to the Spielberger-Khanin questionnaire, patients in both groups had almost the same number of points after a 14-week rehabilitation program as healthy individuals (p> 0,05).

The study of the modified facial pain scale showed, that 20 (71,4%) and 20 (62,5%) patients of groups I and II were diagnosed with mild headache, 7 (25,0%) and 6 (18,8%) patients of both groups - moderate cephalgia, and 5 (15,6%) patients of group II, complained of severe headache. Statistical analysis of the modified facial pain scale The Faces Pain Scale-Revised (FPS-R) showed, that patients, who required inpatient oxygen therapy during treatment of SARS-Cov-2 infection, were 1,3 times more likely to complain of headache. Prior to rehabilitation, patients of group I during the test on the pain scale scored 2,96±0,28 points, and after the rehabilitation - 1,11±0,11, which was 62,5% less, than before treatment (p<0,001), and patients of the II group from 3,84±0,46 points to 2,75±0,33 points, which was 28,4% less, than the indicator before rehabilitation (p>0,05). After 14 days of rehabilitation program, patients of group I did not complain of headache, but 2 patients of group II complained of minor recurrent headache, which on the pain scale corresponded to 0,97±0,03 points, which was 74,7% lower, as before treatment and 64,7% lower in comparison with the 7th day of rehabilitation (p<0,001).

Evaluation of such a complaint as drowsiness, according to the Epworth drowsiness scale, showed, that 25 (89,3%) patients in group I had moderate drowsiness, and 1 (3,6%) - severe drowsiness. Moderate drowsiness was observed in 26 (81,3%) patients of the group II, and 5 (15,6%) - complained of severe drowsiness. Testing on the Epworth Sleepiness Scale and a summary assessment of sleep quality according to the Pittsburgh questionnaire showed, that patients in group I scored 43,3% and 68,3% more in comparison

with group of healthy people before rehabilitation, and patients in group II – 47,7% and 72,8% ($p<0,001$) more scores. In patients of group I, on the 7th and 14th day, the dynamics of drowsiness and sleep quality according to the respective questionnaires was the same, as when using the scales described above, thus the number of points was progressively decreasing ($p<0,001$) and was approaching the norm ($p>0,05$) after 7 days of rehabilitation program. In patients of group II on the 7th day of rehabilitation the manifestations of drowsiness in the questionnaire decreased to 7,09±0,26 points and by 21,7% in comparison with the indicator before rehabilitation (8,63±0,67 points), $p<0,05$ and was 36,4% different from the same indicator of healthy people ($p<0,001$). On the 14th day of rehabilitation in patients of group II, the manifestations of drowsiness decreased by 41,0% in comparison with the beginning of rehabilitation ($p<0,001$) and by 15,8% relative to the 7th day of rehabilitation ($p<0,05$). However, in patients of group II, the manifestations of drowsiness were not completely leveled and were observed on the 14th day of rehabilitation in 3 study participants ($p<0,05$). The total quality of sleep according to the Pittsburgh questionnaire in patients of group II on the 7th day of rehabilitation decreased by 31,4% ($p<0,001$), but still exceeded the value of healthy individuals by 2,5 times ($p<0,001$), but on the 14th day of rehabilitation program, the indicator decreased by 3,4 times relative to the beginning of rehabilitation and practically did not differ from the indicator of healthy individuals ($p>0,05$).

Conclusions

Thus, SARS-Cov-2 infection, in addition to high mortality, significantly reduces the quality of life of patients with this disease. According to the study, the manifestations of postcovid syndrome after 12 weeks of acute illness depended on the severity of the general condition of the patient in the hospital stage of medical care and the need for oxygen therapy. Thus, in patients, who did not need oxygen in the inpatient stage, anosmia, cephalgia, cognitive impairment, increased anxiety and fatigue were frequent manifestations of the postcovid syndrome in the future. Patients, who required oxygen therapy in the hospital, in addition to the above manifestations of postcovid syndrome, were more likely to experience taste disturbances and loss of taste, sleep disturbances, increased drowsiness and severe depression.

The rehabilitation program (26-28), which was used for all patients to the same extent, has led to the leveling of cognitive dysfunctions on the 7th day in people, who did not require oxygen therapy at the hospital stage. However, patients, who required oxygen therapy at the hospital stage, noted an improvement in memory and attention, based on the performance of the modified online Stroop Test, only on the 14th day of the rehabilitation program.

Positive dynamics in relation to depression due to BDI scale, anxiety according to the STAI test, cephalgia according to FPS-R parameters, drowsiness and sleep disturbances (ESS and PSQI) were observed in patients, who did not require oxygen therapy at the hospital stage, before the 7th day of use of the rehabilitation program. In patients, who required oxygen therapy during inpatient treatment in the acute period, the manifestations of depression and anxiety were disappearing after 14 days of rehabilitation program, and manifestations of minor recurrent headache and drowsiness were observed in 2 (6,3%) and 3 (9,4%) patients after another 14 days of rehabilitation.

Thus, this study proves, that patients, who needed oxygen therapy at hospital stage of treatment, and severe course of disease require longer rehabilitation measures for the manifestations of postcovid syndrome of chronic fatigue and cognitive disorders nature, than patients, who did not require oxygen at inhospital stage of treatment of acute SARS-Cov-2 infection.

Table 1. Characteristics of postcovid syndrome symptoms (in absolute numbers and %)

Symptoms	General number of patients (n=60), 100%	Group I (n=28),%	Group II (n=32),%	Fisher's exact criterion, p
Anosmia	9 (15.0)	3 (10.7)	5 (15.6)	=0.43
Dysgeusia (ageusia)	18 (30.0)	5 (17.9)	13 (40.6)	=0.49
Cephalgia	58 (96.7)	27 (96.4)	31 (96.9)	=0.72
Impaired concentration of attention and memory	59 (98.3)	27 (96.4)	32(100.0)	=0.02
Dyssomnia	48 (80.0)	21 (75.0)	27 (84.4)	=0.28
Increased anxiety	59 (98.3)	27 (96.4)	32 (100.0)	=0.47
Depressed condition	46 (76.7)	20 (71.4)	26 (81.3)	=0.7
Drowsiness	57 (95.0)	26 (92.9)	31 (96.9)	=0.71
Rapid fatigue	60 (100.0)	28 (100.0)	32(100.0)	=0.99

Table 2. Dynamics in the process of using the rehabilitation measures, modified online Stroop Test, for the determination of cognitive functions of patients after SARS-Cov-2, M±m

Indicators	Healthy	Before rehabilitation		7th day		14th day	
		Group I (n=28)	Group II (n=32)	Group I (n=28)	Group II (n=32)	Group I (n=28)	Group II (n=32)
	1	2	3	4	5	6	7
Average response time, sec	4,21±0,13	6,18±0,39 p1-2<0,001	7,78±0,72 p1-3<0,001	4,54±0,16 p2-4<0,001 p1-4>0,05	6,16±0,36 p3-5<0,05 p1-5<0,001	4,11±0,08 p4-6<0,05 p1-6>0,05	4,15±0,08 p7-3<0,001 p7-5<0,001 p1-7>0,05
Total test time, sec	44,22±0,13	51,71±1,86 p1-2<0,001	59,22±2,91 p1-3<0,001	45,75±0,55 p2-4<0,01 p1-4>0,05	51,47±1,91 p3-5<0,05 p1-5<0,001	44,25±0,25 p4-6<0,05 p1-6>0,05	45,03±0,55 p7-3<0,001 p7-5<0,01 p1-7>0,05
Total number of correct answers	9,9±0,09	6,25±0,61 p1-2<0,001	5,19±0,52 p1-3<0,001	9,29±0,21 p2-4<0,001 p1-4>0,05	6,69±0,53 p3-5<0,05 p1-5<0,001	9,71±0,17 p4-6<0,05 p1-6>0,05	9,55±0,19 p7-3<0,001 p7-5<0,001 p1-7>0,05
% of correct answers	99,0±0,95	62,5±6,13 p1-2<0,001	54,38±5,28 p1-3<0,001	92,5±2,12 p2-4<0,001 p1-4>0,05	69,38±5,25 p3-5<0,05 p1-5<0,001	97,14±1,74 p4-6<0,05 p1-6>0,05	95,45±1,92 p7-3<0,001 p7-5<0,001 p1-7>0,05

Notes: n- number of patients; p - reliability of the indicator.

Table 3. Dynamics of antenovegetative syndrome in the process of using the rehabilitation measures in patients after SARS-Cov-2 infection, M±m

Psychological tests	Healthy	Before rehabilitation		7th day		14th day	
		Group I (n=28)	Group II (n=32)	Group I (n=28)	Group II (n=32)	Group I (n=28)	Group II (n=32)
	1	2	3	4	5	6	7
Beck Depression Inventory, scores	11,51±0,49	19,96±0,93 p1-2<0,001	30,41±2,53 p1-3<0,001	12,32±0,91 p2-4<0,001 p1-4>0,05	20,88±3,11 p3-5<0,05 p1-5<0,01	11,29±,89 p2-6<0,001 p4-6>0,05 p1-6>0,05	12,78±2,06 p3-7<0,001 p5-7<0,05 p1-7>0,05
Determine of anxiety (Spielberger-Hanin test), STAI, scores	25,81±1,09	41,89±0,94 p1-2<0,001	44,09±1,34 p1-3<0,001	29,11±1,56 p2-4<0,001 p1-4>0,05	36,03±2,06 p3-5<0,01 p1-5<0,001	26,11±0,91 p2-6<0,001 p6-4>0,05 p1-6>0,05	29,31±1,33 p3-7<0,001 p5-7<0,01 p1-7>0,05
Modified facial pain scale The Faces Pain Scale-Revised (FPS-R) , scores	-	2,96±0,28	3,84±0,46	1,11±0,11 p2-4<0,001	2,75±0,33 p3-5>0,05	-	0,97±0,03 p3-7<0,001 p5-7<0,001
Epworth Sleepiness Scale, scores	4,51±0,29	7,96±0,52 p1-2<0,001	8,63±0,67 p1-3<0,001	5,07±0,24 p2-4<0,001 p1-4>0,05	7,09±0,26 p3-5<0,05 p1-5<0,001	4,89±0,25 p2-6<0,001 p4-6>0,05 p1-6>0,05	6,12±0,29 p3-7<0,001 p5-7<0,05 p1-7<0,05
Pittsburgh Sleep Quality Questionnaire (PSQI), scores	2,71±0,34	8,54±0,53 p1-2<0,001	9,97±,87 p1-3<0,001	3,04±0,22 p2-4<0,001 p1-4>0,05	6,84±0,31 p3-5<0,001 p1-5<0,001	2,86±0,21 p2-6<0,001 p4-6>0,05 p1-6>0,05	3,06±0,32 p3-7<0,001 p5-7<0,001 p1-7>0,05

Notes: n- number of patients; p - reliability of the indicator.

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