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Research article

The impact of the biodex 4 pro system dynamometer in the rehabilitation of ankle sprain in youth football players

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Abstract: (1) Background: The purpose of this study was to identify impact differences in the rehabilitation the second-degree ankle sprain, more specifically the restoration of agonist-antagonist muscle balance, static and dynamic balance, and motor control in junior soccer players will have a different impact on patients who perform the recovery program with the help of Biodex 4 Pro and myofascial therapies compared to those who perform physical therapy using classical methods. (2) Methods: the study included 22 subjects divided into two equal groups in accordance with the agreement to practice modern therapies (MT) and kinesiotherapy (KT): the experimental group that performed the myofascial therapies and exercises with Biodex 4 pro and the control group that performed the KT. The parties' evaluations included: the Biodex 4 Pro for a range of motion assessment and the PodoSmart device for gait assessment. (3) Results: analysis identifies significant improvements for the subjects in the experimental group, respectively for the subjects in the control group, as follows: after completing the therapeutic plan for four weeks, the subjects gained 35.8° of flexion and 36.4° of extension compared to the initial results. In the PodoSmart gait analysis, the experimental group progressed between tests by 14.8% for the foot symmetry parameter, which was 3.8% more than in the control group, whose symmetry progress between tests was 11%. (4) Conclusion: the combined therapeutic plan containing Biodex technology and myofascial therapies is a current effective option in the rehabilitation of athletes.

Keywords: ankle sprain, rehabilitation, Biodex dynamometer, myofascial,

1. Introduction

Ankle sprains are the most common traumas produced at the level of the ankle joint, which occurs as a result of making some wrong movements but also against the background of a complex volume of favorable factors or intrinsic risk factors [1,3]. Analysis

and identification of tissues affected by sports trauma are essential in determining the severity and implication of the rehabilitation protocol. It is also of great importance to be aware of the mechanism of the injury and the risk factors specific to the sport [4,5,6].
Trauma directly affects the anterior fibular-talar and fibula-calcaneal ligaments. In many cases, ankle sprains are associated with midtarsal sprains or other dysfunctions of the soft tissues and joints involved. Due to the anatomical-physiological peculiarities of the deltoid ligament, the risk of injury at this level is low. More specifically, in order to produce trauma to the deltoid ligament, the fibular malleolus must first be fractured [7].
Football is a physically demanding and highly competitive sport with a high injury rate. The foot and ankle joints are particularly at risk of injury [8]. Risk factors for foot and ankle injuries in soccer players are lack of structured warm-up training, neuromuscular deficits, inadequate training, chronic fatigue, previous injuries, foul play, artificial turf, and others [9].

The Biodex 4 pro system is an isokinetic system that allows accurate, both qualitative and quantitative evaluation of the force produced at different speeds, but also of the range of motion. It can be used on the knee, elbow, fist, ankle, and shoulder joints. Physical movements are performed at a constant speed, but depending on the joint lever arm, the force developed varies. An important aspect of the isokinetic dynamometer is that it is possible to measure variables during a movement in real-time [10].

The dynamometer performs the movement at pre-set speed and amplitude parameters. Any movement performed by the subject below the set speed is performed without resistance from the subject. For the effort to become significant, the speed of execution must reach the speed set in the machine program.

The Biodex dynamometer is known for the innovative practical properties it facilitates: identifying, treating, and documenting the physical impairments that cause functional limitations [11,12]. Isokinetic dynamometers represent an up-to-date option in the evaluation of different characteristics of muscle strength, both in the field of research and in clinical practice; Besides the proven effectiveness in patient evaluation, there is no qualitative volume of scientific publications to support the extensive use of these devices as active therapeutic means [13].

The advantages of the Biodex system are: the ability to use 4 working modes: passive, eccentric, isokinetic, and isometric; the passive mode, as well as the active mode, have the ability to self-adapt their resistance, this being a huge advantage; it is a system used both in the assessment and in the recovery program; ergonomics - can be adapted to any patient but also to various pathologies; takes up little space in the recovery room; saving the patient's travel time between devices; the ability to set the parameters in which a move is made; biofeedback provides the patient with real-time data about the movement performed, thus helping to motivate him; objective and qualitative assessment of movement parameters [11].

Training protocols consisting of proprioceptive exercises and postural control exercises are the most widely used means to recover from and prevent ankle sprain recurrence [14,15]. In interacting with the external environment, accommodation and assimilation, the simplest information link between man and reality is accomplishment through sensations. [2]. At the same time, there is a multitude of current strategies used in the prevention of ankle sprains and their complications that force athletes of all ages to stop competitive activity [16]. A systematized search on the PubMed platforms regarding topical scientific articles (starting with the year 2010) with the keywords ankle sprain, prevention, treatment, and other formulations in the same semantic field included a number of 170 scientific materials. This identified, in a majority approach, the exercises that establish motor control and the agonist-agonist ratio, exercises that include eccentric contraction of the calf muscles, and the effectiveness of training on unstable surfaces (balance board, boss ball, plyometric exercises) in reducing the risk of producing of ankle sprains [17,18]. Rehabilitation after an ankle sprain consists of specific exercises focused on proprioceptive

and strength training. There is evidence that incorporating these exercises is effective in reducing future ankle injuries [1,19]. Neuromuscular and proprioceptive exercises play an important role in restoring balance and postural control. Periodic application of neuromuscular training during the first week of injury leads to higher levels of activity without consequences such as pain or inflammation [1].

Physical training is an important component of sports training that provides the energy fund for performance, determining the optimization of the body's functional and morphological indices [20]. Therefore, early neuromuscular training is certainly effective and is recommended as an important part of the rehabilitation program for athletes with ankle sprains. In the early stages, neuromuscular (sensorimotor) exercises can be started with intrinsic foot movements (toe extension with ankle plantar flexion/toe flexion with ankle dorsiflexion) and exercises performed on a foam surface, Bosu or DynaDisc in the seated position [21,22].

All athletes returning to sports after an ankle sprain should participate in a neuromuscular training program, as should nonathletic patients who have persistent instability perceived during activity or detected on physical examination [23,24,25,26].

The research hypothesis assumes that the rehabilitation of the second-degree ankle sprain, more specifically the restoration of agonist-antagonist muscle balance, static and dynamic balance, and motor control in junior soccer players will have a different impact on patients who perform the recovery program with the help of Biodex 4 Pro and myofascial therapies compared to those who perform physical therapy using classical methods.

2. Results

2.1. Participants

This pilot study included 22 subjects divided in two equal groups accordance with the agreement to practice modern therapies(MT) and kinesiotherapy(KT) programs as follows: the experimental group that performed the myofascial therapies and exercises with Biodex 4 pro and the control group that performed the kinesiotherapy program. Each subject having a confirmed clinical and functional diagnosis of second degree ankle sprain and with 2 affected ligaments as main inclusion criteria. Other inclusion criteria was the age between 17 and 20 years. Exclusion criteria were as follows: age under 17 years and over 20 years, ankle sprain grade 1 and 3, ankle sprain with fractures,and the players who play in the position of goalkeeper.

2.2. Study Design

The pilot study was conducted at the FC Rapid's fotball academy in Bucharest. Research methodology respected the therapeutic and ethical principles specific to the research activity and was structured in the following stages: for MT, an initial test (It) from 1 to 5 July 2021, implementation of the modern program between 6 July to 5 August 2021, intermediate test from 19 to 23 July and a final test (Ft) from 5 to 10 August 2021; for KT, an initial test (It) from 22 to 27 November 2021, implementation of the kinesiotherapy program between 6 december 2021 and 10 January 2022, intermediate test from 20 to 23 december 2021 and a final test (Ft) from 13 to 17 January 2022.

The study was conducted in accordance with the principles set out in the Declaration of Helsinki. Written informed consent was obtained from all participants. The study was approved by the Ethics Commission of the National University of Physical Education and Sport in Bucharest, with no. 33/27.09.2021. All authors contributed equally to this article; all authors have an equal contribution with the first author.

The specific therapeutic program for Pilot Group of subjects (n=11) featured the Biodex 4 Pro System Dynamometer as a main therapeutic method, being combined with specific therapeutic exercises and myofascial techniques. This protocol was followed for a period of 4 weeks, with a frequency of 3-4 sessions per week. In the acute and subacute phase,

game ready was used for 10 minutes, kinesiotaping, flossing for 2-3 minutes once every 2 sessions to reduce pain and improve edema. Dry needling and Instrument Assisted Soft Tissue Mobilization (IASTM) were applied for proprioceptive stimulation, decontracture and fascia recovery, especeally on long and short peroneus muscle.

Biodex technology allowed early initiation of the treatment plan for subjects in Pilot Group. Initially, movement was passively performed to restore range of motion (ROM), and the passive protocol began with 10g/s without exceeding 45g/s. After developing the ability to perform pain-free ankle movements in all planes (flexion/extension and inversion/eversion), passive-active movements were implemented. If the subjects were able to perform the passive-active movements without pain until the end of the movement, the isometric movements were introduced in different angles starting from 0 degrees and progressing towards the direction in which the injury occurred. After demonstrating the ability to load the segment in isometric mode without discomfort or barriers, we mainly performed eccentric movements where the patient opposed the passive movement of the Biodex device.

Figure 1. Biodex

The last program of the active isokinetic protocol where the patient had to express force in different speed regimes starting at 180 g/s and progressing to 60 g/s. Thus, the biodex technology represented a main means of rehabilitation for subjects in Pilot Group , being combined with therapeutic physical exercise and myofascial techniques.

In the chronic phase, the Biodex was used in isokinetic mode with an execution speed of 90-120^0/s with the aim of increasing joint mobility and muscle strength, the session lasted 20 minutes.

In this phase, football-specific exercises were also used with the aim of neuroproprioceptive recovery. For the return to sports activity, football-specific exercises were used with the aim of re-educating the motor skills, such as specific exercises to increase the explosive force and reaction speed during the game or training.

The subjects in Control Group (n=11) had a structured treatment plan over the same period of time, but without the use of the Biodex dynamometer as an active part of the exercises, but only as an evaluation method. Thus, they had a protocol in accordance with the doctor's recommendations for each stage of rehabilitation that focused on electrotherapy session, therapeutic physical exercises, passive and passive-active mobilizations and active exercises.

2.3. Assessment

The analysis of the functionality of the affected limb was systematically evaluated by comparison with the unaffected lower limb. The main methods included both Biodex technology (range of motion, izokinetic strength) and assessment of foot biomechanics and step cadence (using Podosmart technology). The systematic analysis of the results was facilitated by the performance of 3 specific measurements. The main evaluations (initial - before the start of the treatment plan and final - at the end of the 4-week plan) analyzed the functionality in comparison with the unaffected limb. In order to give more veracity and an accumulation of relevant details regarding the rehabilitation process, the results of the intermediate evaluation (after 2 weeks of treatment, halfway through the intervention protocol) were also analyzed. The general terms (initial, intermediate, final) described the three evaluations only to facilitate the interpretation of the results in the text. Their relevance is a particularity through which specific clinical details can be observed that analyze both the short-term effect and the long-term beneficial effects of the therapeutic intervention.

In order to determine the range of motion, we performed the evaluation with the help of Biodex System 4 Pro in passive mode, the particularities of each parameter being a point of observation and a criterion for the analysis of therapeutic efficiency:

- Initial evaluation performed at a reduced speed of 200/s;
- Final evaluation performed at a speed of 900/s;
- Isokinetic evaluation performed at a speed of 1200/s.

Figure 2. Evaluation through Biodex

The initial assessment is specific to the acute phase, the movement parameters were set so that the mobilization could be achieved without the presence of pain. In the case of final assessments, testing was done actively and actively against resistance.

In order to evaluate the subjects, the Biodex device was used in the research. With its help, several parameters could be monitored during the movements in the ankle joint. The main parameters targeted in the evaluation were: range of motion and muscle strength [12].

The Podosmart system provides an accurate measurement of the patient's gait profile under real-life conditions in just minutes. It includes a pair of smart tags with a Bluetooth transmitter and a web interface to view the results [27]. Analysis of the recorded results

was performed with the help of a specialized software that denotes the biomechanical efficiency of the athletes.

2.4. Statistical Analysis

For the analysis and interpretation of the obtained results, the SPSS 24 system was used with a p - value of < 0.05 as reference for statistical significance. More than this, there was used a relevant volume of statistical tests as follows: U—Mann–Whitney U test, Z—Z test, Friedman $\chi 2$ test and parameters: r—effect size, mean (X), mean difference between tests (ΔXFt-It), median (M). The Mann-Whitney U test was used to check the statistical significance of the final results for the two groups of subjects (especially with intra-group interpretation). The Friedman test was used to test the significance of the differences between the three measurements (initial, intermediate, final).

3. Results

This section includes the most relevant results that analyzed the functional parameters of the subjects within the initial, intermediate and final evaluation.

The preliminary analysis of the data highlighted the fact that, in the case of the results recorded in the tests for the assessment of range of motion – (flexion and extension) for the assessment of leg symmetry and the cadence of steps (Podosmart system) and for the assessment of muscle strength - flexion and extension (isokinetic test, performed actively, with resistance) both in the case of the Pilot Group - which included the participants who followed programs with Biodex as an active rehabilitation method, and in the case of the Control Group - trained of the participants who followed classic rehabilitation program, no extreme values (marginal or excessive) were found.

A desired performance objective regarding the quality of physical therapy must be confirmed by the practical and statistical interpretation of the research results. The main indicators of the descriptive statistics for the results of the Pilot Group (intervention by Biodex) in the 3 evaluation tests, performed both in the case of the healthy ankle (uninjured) and in the case of the affected ankle (injured) are presented below.

Table 1. Statistical analysis of the results – range of motion (measured in degrees)

Group	Ankle	Movement	Initial evaluation (baseline)		Intermediate evaluation (after two weeks)		Final evaluation		ΔM Ft-It
			X	M	X	M	X	M	
Pilot Group	Uninjured	Flexion	64.9	64	65.1	64.1	65.3	64.2	0.2
		Extension	64.9	64	66	65.4	65.8	65.4	1.4
	Injured	Flexion	24.6	24.7	47.5	48.1	65.3	64.1	39.4
		Extension	26.1	26.2	47.9	49	65.9	65.3	39.1
Control Group	Uninjured	Flexion	65.1	64.5	65.3	64.8	65.3	64.8	0.3
		Extension	65.1	64.6	65.3	64.9	65.3	64.9	0.3
	Injured	Flexion	24.5	24.3	39.9	40	60.8	60.1	35.8
		Extension	25.1	24.6	40.4	40.2	61.6	61	36.4

**It – initial test, Ft – final test, X – arithmetic mean, M – median,* ΔM Ft-It – *median difference between final and initial tests*

Table 1 shows the results obtained by the both groups in the evaluation for ankle range of motion. At the initial testing (baseline), statistically significant differences ($p < 0.05$) were found for both groups between the results obtained in the case of the uninjured ankle

and those obtained in the case of the injured ankle in terms of range of motion for flexion and extension.

The effect size is r = 1.18, which means that the effect of the group variable (uninjured ankle and injured ankle results) is a very strong one, in terms of range of motion, for flexion and extension.

According to the median difference between final and initial values, the Pilot Group progressed with 39.4 degrees for flexion movement and with 39.1 for extension. The final evaluation (after four weeks of rehabilitation program) identifies significant improvements for the subjects in Pilot Group, respectively for the subjects in Control Group (who benefited from a different therapeutic plan), as follows: after completing the therapeutic plan for four weeks, the subjects gained 35.8 degrees of flexion and 36.4 degrees of extension compared to the initial results. This statistical interpretation gives extremely interesting perspectives between the two groups of subjects.

According to the final testing for Pilot Group, there are no statistically significant differences (U = 59.5, A no = 11, Z = 59.5, $p > 0.05$) between the results obtained in the case of the uninjured ankle (M = 64.2) and those obtained in the case of the injured ankle (M = 64.1) in as for range of motion for flexion. Likewise, not even in the case of the range of motion assessment - through the extension test, there are no significant differences (U = 59.5, A no = 11, Z = 59.5; $p > 0.05$) between the results obtained in the case of the uninjured ankle (M = 65.4) and those obtained in the case of the injured ankle (M = 65.3) at the final testing (Table 1). The interpretation through the Mann-Whitney U test demonstrates the fact that following the treatment plan through Biodex technology, physical exercises and myofascial techniques, the subjects showed a complete rehabilitation of ankle's range of motion.

The same test also demonstrates the fact that things did not present a similar efficiency for Control Group of subjects, where the difference between the injured and the uninjured ankle still expresses the presence of a functional deficit, significant from a statistical point of view with $p < 0.05$ and r = 0.80, a value that highlights a strong effect size. This conclusion applies for both measurements, in flexion U = 17.5, B no = 11, Z = 2.79, $p < 0.05$ and extension U = 19.5, B no = 11, Z = 2.65, $p < 0.05$. Completing the therapeutic plan in a favorable time and preventing the risk of re-injury is and will certainly be considered the main objective in the recovery of athletes. The presence of the functional deficit, as in the case of subjects from Control Group, may require the extension of the treatment stage and implicitly a longer break from sports activity.

Within the Table 2 are presented the main indicators of the descriptive statistics for both groups (including the distribution according to the injured/uninjured ankle), in the case of the strength evaluation test at the final testing. This test can be considered the most relevant in the analysis of functionality and the identification of potential functional deficits. The Biodex dynamometer is a proven means for testing muscle strength for several muscle categories.

Table 2. Statistical analysis of the final isokinetic strength evaluation using Biodex

Group	Ankle	Movement	Final evaluation	
			X	M
Pilot Group	Uninjured	Flexion	250.3	249.1
		Extension	61.14	61.2
	Injured	Flexion	253.5	251.3
		Extension	61.74	61.4
Control Group	Uninjured	Flexion	238.2	245.5
		Extension	60.57	60.3
	Injured	Flexion	214.3	211
		Extension	46.9	51.2

**Ft – final test, X – arithmetic mean, M – median*

Also by means of the Mann-Whitney (U) statistical test, the existence of significant differences was investigated for the assessment of muscle strength (flexion and extension; isokinetic test performed actively with resistance) between the results obtained with the uninjured ankle and those recorded for injured ankle for both groups. There were no statistically significant differences (U = 53, A no = 11, Z = - 0.459, $p > 0.05$) between the results of Pilot Group subjects obtained in the case of the uninjured ankle (M = 249.1) and those obtained in the case of the injured ankle (M = 251.3) in terms of strength level muscles in the flexion test. The very good evolution of the subjects in Pilot Group is also suggested by the analysis of the extensor muscles of the ankle, where there are also no significant differences between the uninjured (M = 249.1) and injured ankle (M = 251.3), U = 45, A no = 11, Z = -0.984, $p > 0.05$.

To analyze the efficiency of the two intervention plans, the same test was used to compare the average results of Control Group (intra-group statistical interpretation using Mann-Whitney Test), depending on the character of the lower limb (uninjured/injured). According to the results displayed in Table 2, there is a difference in the average final results expressed for both muscle categories. For the flexor muscles of the ankle, the final testing of the uninjured ankle and the injured ankle expresses a difference of 35.5 units, the value being confirmed also from a statistical point of view, U = 5, B no = 11, Z = 3.611, $p < 0.05$ with a strong effect size r = 1.08 on the final results. Also, after testing the muscle strength on the extension movement, there can be identified differences between the uninjured (M = 60.3) and injured ankle (M = 51.2). The interpretation of the Mann-Whitney test confirms the statistical significance U = 0, B no = 11, Z = 3.939, $p < 0.05$ and r = 1.18, a value that highlights a very strong effect size.

The statistical analysis of the final isokinetic strength evaluation using Biodex confirms the fact that the subjects in Pilot Control Groupenefited from a much more effective therapeutic plan than the subjects in Control Group.

Table 3. Statistical analysis of PodoSmart test results

Test	Group	Initial evaluation (baseline)		Intermediate evaluation (after two weeks)		Final evaluation (after four weeks)		ΔX Ft-It
		X	M	X	M	X	M	
Foot symmetry (%)	Pilot	83.3	84	92	92	98.1	98	14.8
	Control	81.2	81	88.6	88	92.2	93	11
Cadence (number of steps per minute)	Pilot	75.7	76	88	88	106	107	30.3
	Control	75.2	75	86.1	86	89.6	90	14.4

**It – initial test, Ft – final test, X – arithmetic mean, M – median, ΔX Ft-It – mean difference between tests*

In the PodoSmart gait analysis, the Pilot Group progressed between tests (after implementing the modern and combined therapy program) by 14.8% for the foot symmetry parameter, which was 3.8% more than in the Control Group, whose symmetry progress between tests was 11%. Cadence analysis described that the average progress for the Pilot Group was higher by 16.4 steps per minute compared to the Control Group (Table 3). These biomechanical features are of major importance in analyzing and testing the functionality of the affected limb.

The results obtained after the Friedman test demonstrate the excellent evolution in terms of the functionality of the lower limbs, both in the case of foot symmetry and in the measurement of cadence, especially for Pilot Group, $\chi^2 = 22$; $p < 0.05$. The treatment goal settings were in agreement with the prognostic health profiles in the athletes' recovery.

The identification of statistical and practical milestones that demonstrate the evolution of the subjects facilitates the understanding of the research problem, helps to test the purpose and demonstrates the usefulness of the therapeutic intervention.

This much more favorable evolution within Pilot Group is also proven by the mean difference in average results between the initial and final testing in terms of step cadence. The mean difference expresses a progress of a double efficiency in favor of Pilot Group, with an increase of 30.3 steps/minute compared to the initial testing.

3. Discussion

Athlete rehabilitation can be considered a challenge for every physiotherapist. Establishing the most suitable objectives, choosing the most effective methods of intervention, their dosage are topical missions in the recovery of performance athletes. The idea of using this new element in the therapeutic field based on visual feedback is less common in physical therapy rooms, but very important for the active involvement of the patient in the recovery process. For the patient, this feedback can be considered a guide for performing the exercises correctly, with constant involvement, a fact that creates a favorable environment for progress.

Following a meta-analysis carried out in 2016, it was concluded that football presents the highest risk of ankle sprains, with an incidence of 7 per 1000 individuals. The absence of proprioceptive exercises in training can increase the number of injuries. Between 60 and 90% of all injuries that occur in young football players, were classified as traumatic, and approximately 10 to 40% were sprained ankles [5].

Although the majority of studies set a common perspective, there is evidence to suggest that early mobilization for daily activities (functional mobilization) is superior to prolonged rest in reducing pain and recovery time after an ankle sprain.

Evidence also shows that focused range of motion exercises started in the first week, in addition to functional mobilization, provide even greater return-to-sport benefits [26]. In another study, the development of skills and motor components can also be achieved through the use of audiovisual media [28]. These was one of the main premises that indicated the use of the biodex dynamometer as an active method of treatment starting from the acute phase of the functional rehabilitation of sports patients.

One of the most important features of Biodex technology is the ability to display real-time visual feedback of the exercises performed. At the same time, depending on the requirements of the treatment plan and its specific phase, the therapist can choose a complex range of passive, isometric or isokinetic exercises. These particularities allow the initiation of the acute phase of treatment from the first days, an extremely valuable element that described the specific treatment plan for subjects in Pilot Group. The early initiation of treatment under safe conditions allows the development of multiple advantages over the mobilization of the affected lower limb and the activation of the muscles that encompasses the ankle joint.

Our research highlighted, following statistical calculations, the fact that in the case of the final testing, there are no significant differences ($p > 0.05$) between the results obtained in the case of the uninjured and injured ankle for Pilot Group. This fact is noted both for the flexion and extension test, which proves that the rehabilitation programs that involved modern methods were effective, and the objectives were completely achieved. The statistical interpretation demonstrates the fact that the intervention by modern methods, in the analysis of another relevant functional parameter, muscle strength, was an effective one, so that the strength level of the affected ankle is relatively similar to the strength level of the healthy ankle.

Following the descriptive interpretation, conclusions were highlighted that show existing differences between the healthy and the affected ankle according to Mann Whitney (effect size - intensity differences ankles) and Friedman for subjects in Control Group.

The use of biodex technology as an active method of ankle sprain rehabilitation has presented a multitude of advantages. Awareness of biomechanically correct movement, constant assistance through visual feedback and monitoring of the most relevant functional parameters are some properties of biodex technology on the efficiency of the treatment plan.

The research methodology highlighted the dual role of Biodex technology within the therapeutic plan: therapeutic and evaluation method. The ability to monitor the most significant functional parameters provides valuable information to observe the quality and efficiency of the established rehabilitation protocol. In the situation where there are a number of indicators that do not show significant improvements, the physiotherapist can adapt the program making it more effective for the subjects. This set of properties signifies the extremely useful role of Biodex technology in adapting the rehabilitation process to the particularities of the subjects and the goals of each treatment phase.

The implementation of exercises through Biodex technology assisted and improved the subjects' motor ability and functionality.

The analysis and interpretation of the results also confirms the usefulness of the test methods: Biodex and Podosmart. The effectiveness of a type of therapeutic intervention is confirmed by the degree of functionality, the level of symptoms and the elimination of any imbalance related to range of motion, strength and stability compared to the uninjured lower limb.

These differences suggest that the therapeutic plan carried out during the four weeks had a very favorable evolution for Pilot Group of subjects. The rehabilitation of athletes is a mission that requires the choice of the most effective therapeutic means to optimize the treatment and shorten the period of unavailability.

Strengths. The study aimed at designing and implementing two programs-based interventions, more specifically, a kinesiotherapy programme and a modern therapy programme for the clinical-functional of patients with ankle sprain, in order to identify the impact of these programmes on the improvement of ROM, foot symetry and cadence of gait. For this purpose, we persuaded 11 patients to attend the modern therapy programme by accepting dry needling treatment, IASTM and Biodex 4 exercises programe to perform two categories of tests for the assessment of their gait and ROM.

5. Conclusions

The main objective, in addition to the complete rehabilitation of the athlete and the return to the sports form before the injury, is also to limit the risks of recurrence. Rapid resumption of training without complete healing after an ankle sprain will cause joint instability to occur which will decrease athletic performance and increase the risk of recurrence.

Exercise programs guided by computerized devices have a higher yield due to the control over the movement, the approach as part of a combined treatment increasing the therapeutic efficiency of young athletes. Moreover, the therapeutic strategy can also be implemented in the rehabilitation of other sports injuries from the level of the lower limbs, of course in accordance with the particularities of the subjects.

The research methodology helps to conclude that routinely collected data can help improve the quality of physiotherapy (through a combined treatment) by benchmarking, personalizing and individualizing treatment in line with recovery principles.

There is certainly a significant volume of combined treatments recommended for ankle sprains, but the results of current research confirm the effectiveness of the therapeutic intervention by means of the Biodex dynamometer. Other categories of muscle injuries can be analyzed later to test the effectiveness of the therapeutic intervention, as well as in the case of different groups of subjects. Without a doubt, the combined therapeutic plan containing Biodex technology and myofascial therapies is a current effective option in the rehabilitation of the athletes..

Limitations: involvement of a relatively small number of patients; involvement of only male patients because our attempts to persuade female patients were unsuccessful; romanian football academies do not have access to Biodex system because it is very expensive; lack of analysis and other proprioceptive and motor parameters.

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