BALNEO RESEARCH **Balneo and PRM Research Journal**
English Edition
e ISSN 2734 - 8458 p ISSN 2734 - 844X ROMANIAN ASSOCIATION OF BALNEOLOGY

Research article

Rehabilitation management of postmenopausal osteoporosis associated with degenerative neurological conditions

Roxana Pipernea [1], Gabriela Dumitrescu [1], Florina Ligia Popa [1,2], Mihaela Stanciu [1,2], Mădălina Gabriela Iliescu [3]*, Mara Carsote [4,5], Claudiu Nistor [6,7] *, Adelina Brescan [8], Sergiu Brescan [8], Viorela-Mihaela Ciortea [9], Laszlo Irsay [9], Rodica Ungur [9], Ileana Ciobanu [10]

Citation: Pipernea R., Dumitrescu G., Popa F.L., Stanciu M., Iliescu M.G., Carsote M., Nistor C., Brescan A., Brescan S., Ciortea V.M., Irsay L., Ungur R., Ciobanu L. - Rehabilitation management of postmenopausal osteoporosis associated with degenerative neurological conditions
Balneo and PRM Research Journal **2024**, *15(1): 653*

Academic Editor(s):
Constantin Munteanu

Reviewer Officer:
Viorela Bembea

Production Officer:
Camil Filimon

Received: 16.02.2024
Published: 31.03.2024

Reviewers:
Mihai Băila
Mihai Hoteteu

1 Academic Emergency Hospital of Sibiu, Romania: roxanascheau12@gmail.com (R.P), gabrielaielciu@gmail.com (G.D);
2 "Lucian Blaga" University of Sibiu, Faculty of Medicine, Sibiu, Romania: florina.popa@yahoo.com (F.L.P), mihaela.stanciu@yahoo.com (M.S);
3 Department of Physical Medicine and Rehabilitation, "Ovidius" University of Constanta, Faculty of Medicine, Constanta, Romania: iliescumadalina@gmail.com (M.G.I);
4 Department of Endocrinology, Carol Davila University of Medicine and Pharmacy, Bucharest, Romania: carsote_m@hotmail.com (M.C);
5 Department of Clinical Endocrinology V, C.I. Parhon National Institute of Endocrinology, Bucharest, Romania;
6 Thoracic Surgery Department, Dr. Carol Davila Central Military Emergency University Hospital, Bucharest, Romania;
7 Department 4—Cardio-Thoracic Pathology, Thoracic Surgery II Discipline, Carol Davila University of Medicine and Pharmacy, Bucharest, Romania: ncd58@yahoo.com (C.N);
8 Anregiomed Klinikum Ansbach, Germany: ade_banciu@yahoo.com (A.B), nacserb@gmail.com (S.B);
9 Department of Rehabilitation Medicine, University of Medicine and Pharmacy "Iuliu Hatieganu", Cluj-Napoca, Romania: viorela.ciortea@yahoo.com (V.M.C), irsaylaszlo@gmail.com (L.I), ungurmed@yahoo.com (R.U);
10 Elias Emergency University Hospital, Bucharest, Romania: ileanacuk@yahoo.co.uk (I.C)

* Correspondence: iliescumadalina@gmail.com (M.G.I); ncd58@yahoo.com (C.N)

Abstract: Background: The evolving association of neurological disorders such as Parkinson's disease (PD) and stroke may aggravate postmenopausal osteoporosis. In this situation, inactivity and lack of movement are the main factors that contribute contribute to exacerbate osteoporosis and the occurrence of osteoporotic fractures. Material and Methods: We present the case of a 62-year-old female patient diagnosed with diffuse postmenopausal osteoporosis, Parkinson's disease, and left frontal ischemic lacuna. 6 months before admission to our rehabilitation clinic, she suffered a trauma by falling that resulted in an L3 vertebral fracture and a right forearm fracture. L2-L4 posterior segmental spinal fusion and right forearm osteosynthesis were performed. Postoperatively, a motor deficit was found in the lower limbs. She was diagnosed clinically and following neurophysiological investigations with bilateral external popliteal sciatic nerve paresis. In these circumstances, the patient suffered a new trauma, resulting in an open fracture at the same level of the right forearm which also required surgical treatment. Results and discussion: Following the rehabilitation program, the evolution was favorable with improved functioning and partial restoration of walking. Conclusion: The association of degenerative neurological and bone metabolic diseases in this case led to significant disability, making the rehabilitation process more challenging.

Keywords: degenerative neurological conditions, postmenopausal osteoporosis, osteoporotic fractures, disability, rehabilitation

1. Introduction

Osteoporosis is a chronic metabolic bone disease characterized by reduced bone mass, deterioration of bone tissue microarchitecture, and increased bone fragility.
Postmenopausal osteoporosis results from decreased levels of sex steroids, these hormones having an essential role in bone metabolism. The decrease in estrogen levels causes rapid bone loss. Bone loss is due to increased bone turnover, in which resorption exceeds formation [1].

People with neurological disease have a higher risk of osteopenia, osteoporosis, and fragility fracture compared to age-matched controls. Some studies that show the connection between neurological diseases such as Parkinson's disease, stroke, multiple sclerosis, and osteoporosis [2].

Reduced bone mineral density in neurological disorders is multifactorial. The main factors are nutritional deficits, reduced sun exposure, restriction of daily living activities, vitamin D deficiency, and immobilization. Parkinson's disease has significant risk factors for falls and osteoporotic fractures. The same can be said about stroke or multiple sclerosis. Given that most fractures occur due to falls, preventing falls is essential. Exercise programs that target more components (strength, balance, flexibility, and endurance) reduce the rate of falls in elderly adults. Medication review (withdrawal psychotropics), occupational therapy, and fall prevention education reduce the rate but not the risk of falling [3].

2. Results

The X-ray examination (Figure 1) of the lumbar spine (profile) after the first trauma and after neurosurgical intervention revealed: vertebral static disorders, diffuse demineralization, multiple vertebral compressions, L3 vertebral body fracture, L2-L4 spinal fusion, degenerative changes.

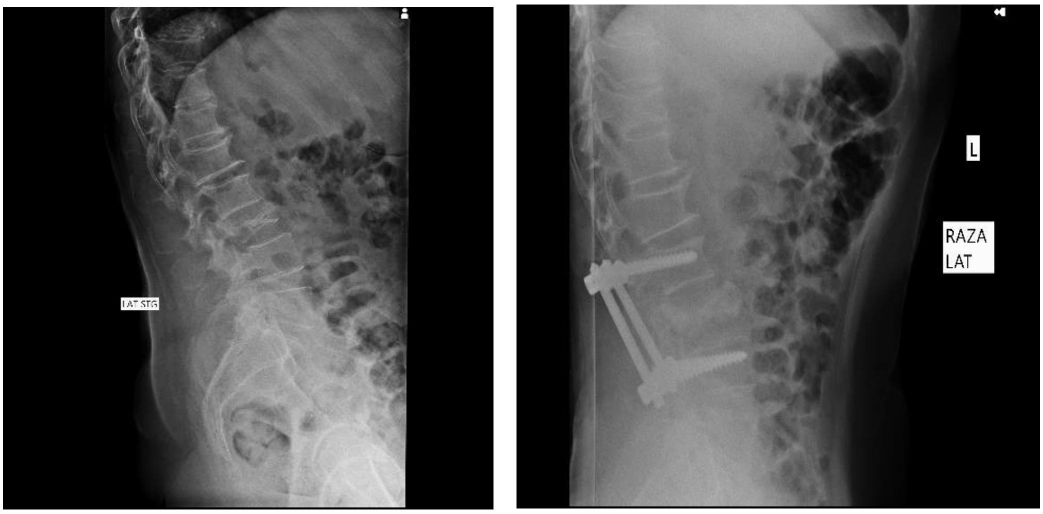


Figure 1. The X-ray examination of the lumbar spine (profile) before and after the neurosurgical intervention: diffuse bone demineralization, sclerotic focus of the vertebral plateaus, lumbar rectitude, multiple vertebral compressions predominantly at the level of the L1, L2 vertebrae, L3 vertebral body fracture, L2-L4 L4 spinal fusion, narrowing of the intervertebral posterior spaces mainly at the level of L1-L2, L4-L5, anterior osteophytes.

The X-ray examination (Figure 2) of the dorsal spine (profile) after the neurosurgical intervention revealed the following findings: vertebral static disorders, diffuse demineralization, multiple vertebral compressions, L3 vertebral body fracture, and degenerative changes.

Figure 2. The X-ray examination of the dorsal spine (profile): diffuse bone demineralization, sclerotic focus of the vertebral plateaus, hyperkyphosis, multiple vertebral compressions predominantly at the level of the T11 vertebrae, narrowing of the intervertebral posterior spaces, anterior osteophytes.

The X-ray examination (Figure 3) of the distal forearm and right hand (anteroposterior) after the first trauma revealed the following findings: diffuse demineralization and multiple fractures. As we know, these fractures were initially treated conservatively orthopedically, but unsuccessfully. Later, osteosynthesis with a titanium plate and 10 screws was performed due to the lack of consolidation. (Figure 3).

Figure 3. The X-ray examination of the distal forearm and right hand (anteroposterior) after the first trauma, before and after surgery: diffuse demineralization, fracture with displacement of the distal epiphysis of right radius, osteosynthesis with a titanium plate and 10 screws; right ulnar styloid, scaphoid bone, lunate bone, the distal phalanx of the V finger of the right hand fractures - under consolidation.

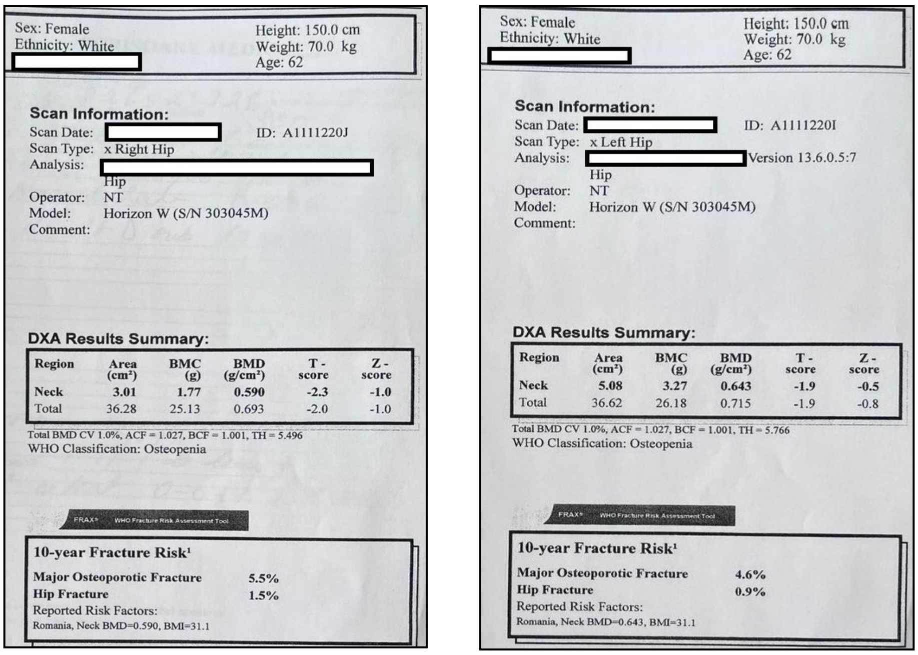
The X-ray examination (Figure 4) of the distal forearm and right hand (anteroposterior) after the second trauma and after surgery revealed diffuse demineralization and multiple fractures fixed with osteosynthesis material.

Figure 4. The X-ray examination of the distal forearm and right hand (anteroposterior) after the second trauma and after surgery revealed: diffuse demineralization, fracture with displacement, and comminution at the distal extremity of both bones of the right forearm - osteosynthesis with 2 titanium plates with 7 screws, respectively with 5 screws, at the level of the radius and ulna.

The nuclear magnetic resonance examination of the cervical-dorsal-lumbar spine performed after the neurosurgical intervention was unsuccessful due to the dyskinetic movements that the patient presents as part of Parkinson's disease.

The computer tomography examination of the skull performed after the trauma reveals the following findings: circumscribed hypodensity in the left frontal white matter with a microangiopathic substrate, wide cortical and cerebellar grooves, and deeper Sylviene valleys.

Examination of the bone density by Dual-energy X-ray absorptiometry (DXA) at the hips shows a T-score of -1.9 on the left side and a T-score of -2.3 on the right side (Figure 6).



Sex: Female
Ethnicity: White
[redacted]
Height: 150.0 cm
Weight: 70.0 kg
Age: 62

Scan Information:
Scan Date: [redacted] ID: A1111220J
Scan Type: x Right Hip
Analysis: [redacted]
Hip
Operator: NT
Model: Horizon W (S/N 303045M)
Comment:

DXA Results Summary:

Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T - score	Z - score
Neck	3.01	1.77	0.590	-2.3	-1.0
Total	36.28	25.13	0.693	-2.0	-1.0

Total BMD CV 1.0%, ACF = 1.027, BCF = 1.001, TH = 5.496
WHO Classification: Osteopenia

FRAX® WHO Fracture Risk Assessment Tool

10-year Fracture Risk[1]
Major Osteoporotic Fracture 5.5%
Hip Fracture 1.5%
Reported Risk Factors:
Romania, Neck BMD=0.590, BMI=31.1

Sex: Female
Ethnicity: White
[redacted]
Height: 150.0 cm
Weight: 70.0 kg
Age: 62

Scan Information:
Scan Date: [redacted] ID: A1111220I
Scan Type: x Left Hip
Analysis: [redacted] Version 13.6.0.5:7
Hip
Operator: NT
Model: Horizon W (S/N 303045M)
Comment:

DXA Results Summary:

Region	Area (cm²)	BMC (g)	BMD (g/cm²)	T - score	Z - score
Neck	5.08	3.27	0.643	-1.9	-0.5
Total	36.62	26.18	0.715	-1.9	-0.8

Total BMD CV 1.0%, ACF = 1.027, BCF = 1.001, TH = 5.766
WHO Classification: Osteopenia

FRAX® WHO Fracture Risk Assessment Tool

10-year Fracture Risk[1]
Major Osteoporotic Fracture 4.6%
Hip Fracture 0.9%
Reported Risk Factors:
Romania, Neck BMD=0.643, BMI=31.1

Figure 6. DXA at the hips shows a T-score of -1.9 on the left side and a T-score of -2.3 on the right side

The electromyographic examination (Figure 7) concluded that its appearance advocates a moderate axonal degeneration of the bilateral peroneal nerve.

Sensory Nerve Conduction Study

Nerve / Sites	Rec. Site	Onset Lat ms	Peak Lat ms	NP Amp µV	PP Amp µV	Segments	Distance cm	Velocity m/s	Comment
R Sural - (Antidromic)									
Calf	Ankle	2.19	2.76	7.8	9.0	Calf - Ankle	14	64	
L Sural - (Antidromic)									
Calf	Ankle	2.50	3.02	7.8	10.1	Calf - Ankle	14	56	

Motor Nerve Conduction Study

Nerve / Sites	Muscle	Latency ms	Amplitude mV	Segments	Dist. cm	Lat Diff ms	Velocity m/s	Comments
R Peroneal - EDB								
Ankle	EDB	3.96	1.6	Ankle - EDB	8			
B. Fib Head	EDB	11.81	0.7	B. Fib Head - Ankle		7.85		
A. Fib Head	EDB	13.08	2.3	A. Fib Head - B. Fib Head		1.27		
R Tibial - AH								
Ankle	AH	4.54	7.7	Ankle - AH	8			
Knee	AH	12.52	5.6	Knee - Ankle	40	7.98	50.1	
L Tibial - AH								
Ankle	AH	4.98	8.8	Ankle - AH	8			
Knee	AH	12.38	6.3	Knee - Ankle	40	7.40	54.1	
L Peroneal - EDB								
Ankle	EDB	5.31	1.6	Ankle - EDB	8			
B. Fib Head	EDB	12.46	1.6	B. Fib Head - Ankle	33	7.15	46.2	
A. Fib Head	EDB	13.96	1.6	A. Fib Head - B. Fib Head	7	1.50	46.7	

Figure 7. The electromyographic examination shows a moderate axonal degeneration of the bilateral peroneal nerve.

3. Discussion

The presented case emphasizes the intricate relationship between postmenopausal osteoporosis and degenerative neurological diseases in a female patient. The association of these pathologies leads to a significant decline in an individual's quality of life and a certain degree of disability.

Our patient is known to have severe osteoporosis, the predisposing circumstances being the hereditary factor, the early onset of the disease, early menopause, the chronic long-term treatment for depression, comorbidities such as Parkinson’s disease, autoimmune thyroid disease, depression and lack of movement due to the associated pathologies.

People with Parkinson’s disease (PD) present a significant difficulty by frequent falls, leading to fractures and other injuries. These patients have an increased risk of fracture, with a four times higher risk of hip fracture as compared with the general population. For some patients with Parkinson's disease, a fracture, along with its resultant immobility, and the potential effects of surgery and hospitalization, can lead to a permanent decline in their condition. Therefore, the measures to prevent falls are essential in PD management. Practically, not every fall can be prevented, so it is important to evaluate the bone mineral density (BMD) according with osteoporosis guidelines and to treat low bone density adequately.

Studies showed that PD patients have lower bone mineral density than age-matched controls. In PD, bones are less dense than in the general population because dopamine receptors are expressed in bone cells and influence bone strength, as demonstrated in studies using cell cultures and animals. Additionally, the decrease in dopamine signaling that occurs in PD may alter bone strength. Other studies revealed that Levodopa therapy in PD may reduce the rate of osteoblasts production. Another mechanism involved in the increased risk of osteoporosis in PD is the presence of Lewy bodies, which can be found in the hypothalamus. The hypothalamus is the area of the brain responsible for secreting hormones that regulate bone density. Another particular condition in patients with PD that may affect bone strength is reduced engagement in weight-bearing activities and spending less time in the sun, leading to potential malnutrition. Both factors can contribute to lower levels of Vitamin D and weight loss [4-6].

Patients with PD are at a higher risk for osteoporosis and have lower BMD in areas such as the hip, lumbar spine, and femoral neck compared to healthy controls, as demonstrated by a meta-analysis [7].

Schneider et al. published the results of a study conducted in women with PD, which included DXA evaluation. The study found that PD patients had a 7.3% lower total hip BMD and an increased risk of hip fracture [8].

Another study published by Daniel et al. found no difference in BMD between male PD subjects with short disease duration (0 to 5 years) compared to those with longer disease duration (5 to 10 years). This suggests that PD progression does not directly correlate with decreasing BMD and emphasizes the importance of early detection of osteoporosis [9].

Osteoporosis increases the risk of fractures, while Parkinson's disease increases the risk of falls [10,11]. Moreover, our patient presents with global dyskinetic movements (interpreted as side effects of long-term Parkinson's disease treatment), representing an additional risk for falling [12], as well as associated motor deficits due to ischemic stroke and bilateral peroneal nerve paresis [13,14].

Depression and antidepressants are both risk factors for osteoporosis. Depression has been shown to be linked with low bone density. Potential mechanisms involved in the pathophysiology include the effects of chronic stress (such as hypercortisolemia, activation of the sympathetic system, decreased levels of estrogen and growth hormone/insulin-like growth factor), as well as the sedentary lifestyle often adopted by these patients [15]. Numerous studies demonstrate that antidepressant medication interferes with bone metabolism, leading to a decrease in bone density, although the pathophysiological mechanisms are not fully elucidated [16-18].

Statistics indicate that the most common site for osteoporotic fractures is the vertebral column [19]. As studies suggest, in the majority of affected patients, acute osteoporotic vertebral body fractures lead to a painful, long-lasting disabling condition that deteriorates the quality of life. Myelopathy, although not a common finding in vertebral osteoporotic fractures, can occur, further aggravating the disability [20]. In our patient, myelopathy might be incriminated, as clinical examination suggests, although there is no objective evidence, as the MRI exam could not be performed.

The strongest predictor for fragility fractures is a previous fragility fracture. Studies report that at 10 years after a vertebral fracture, secondary fractures had occurred in 25.7% of patients [21,22]. In the presented case, the patient suffered multiple fractures after three distinct episodes of falling throughout several months, 2/3 times resulting in vertebral fractures, among others.

Autoimmune thyroid disease (AIT), a chronic autoimmune inflammation, is considered in recent years as a contributing factor to the alteration of bone quality. Data published over the past decade have demonstrated strong evidence of the link between systemic inflammation and bone quality. Alteration of osteoclastic activity in new bone formation could result from chronic inflammatory autoimmune disorders, leading to decreased bone mineral density [23-26].

Our case demonstrates that severe osteoporosis can be explained not only by thyroid autoimmune inflammation but also by Parkinson's disease.

Positive TPOAbs, confirming autoimmune inflammation of thyroid tissue, represent a potential marker of increased fracture risk in patients with autoimmune thyroiditis. In sub-clinical hypothyroidism, TSH is a good predictor of future fragility fractures, more precisely than TPOAb. It is helpful to check BMD by DXA in postmenopausal women with TIA to assess the increased risk of fragility fractures [26, 27].

These conditions, which deteriorate quality of life, might worsen pre-existing depression, potentially exacerbating osteoporosis further.

In this case, the association between osteoporosis (in a patient with positive hereditary antecedents for osteoporosis, early menopause) and neurological conditions such as Parkinson's disease (on long-term treatment with antiparkinsonian drugs) and stroke lead to an increased risk of falling. It is important to highlight the depressive disorder in prolonged treatment with antidepressant medication.

The increased risk of falling led to vertebral and forearm fractures occurring in this case. The vertebral fracture resulted in radicular damage and a distal motor deficit in the lower limbs that accentuated the existing disability and increased the risk of falling.

One of the rehabilitation goals is represented by falling risk prevention, for example, by training the balance with the help of robotic equipment. Improving the symptomatology of neurological diseases can be achieved through multiple rehabilitation methods.

An innovative approach concerns repetitive transcranial magnetic stimulation (rTMS) in patients with Parkinson's disease and in patients after stroke, which could have been beneficial in this case. Repetitive transcranial magnetic stimulation is a non-invasive neuromodulation technique that has been closely examined as a possible treatment for Parkinson's disease. Ying-hui Chou et al. showed in a 2015 study that rTMS improves motor symptoms in Parkinson's disease [28]. Another study shows that a 25 Hz rTMS can lead to cumulative and long-lasting effects on motor performance in these patients [29].

Numerous studies highlight the positive effects of rTMS in stroke patients. A prospective study revealed that rTMS has a positive impact on motor recovery, especially for those with subcortical stroke. It showed that low-frequency rTMS in the unaffected hemisphere may be more beneficial than high-frequency rTMS over the affected hemisphere. It is also well known that low-frequency stimulation has an inhibitory effect, while high frequencies induce an increase in cortical excitability [30].

Studies show that repetitive peripheral magnetic stimulation over spinal roots, nerves, or muscles, is a new painless and non-invasive approach that can contribute to motor restoration. This method is based on the theory that, under rPMS, neural networks involved in motor control would be adjusted by high recruitment of proprioceptive afferents, with little activation of cutaneous receptors [31].

The prevalence of osteoporosis, and neurodegenerative diseases is increasing in the general population and the consequences of this association will negatively impact the evolution as well as the rehabilitation process [32,33].

A better understanding of the pathophysiology and the intricate mechanisms that lead to complex disability, as in our patient's case, is essential for preventing such cases in the future through early intervention and a multidisciplinary approach.

4. Materials and Methods

We report the case of a caucasian female, aged 62 years, admitted to the Medical Rehabilitation department of the Academic Emergency Hospital of Sibiu for gait and balance disorders, global dyskinetic movements, postural rest tremor, mechanical pain, and functional deficit in the dorsolumbar spine and right hand.

From the hereditary history, we mention the mother diagnosed with osteoporosis, and from the patient’s personal history, we mention menopause onset at 45 years old.

The patient is known with: severe diffuse osteoporosis since the age of 40 under bisphosphonate treatment for 20 years, currently under treatment with parathormone derivative (Teriparatide), mild Vitamin D3 deficiency, non-toxic multinodular goiter, chronic autoimmune thyroiditis, Parkinson's disease under specific treatment (since 56 years old), left frontal ischemic lacuna and cerebral atrophy (accidentally diagnosed), ischemic heart disease, essential hypertension, organic affective disorder, and mild cognitive disorder.

6 months before admission to our rehabilitation clinic, the patient suffered a fall trauma from the same level, resulting in a fracture with displacement of the distal epiphysis of the right radius, right ulnar styloid, scaphoid bone, lunate bone, and distal phalanx of the fifth finger of the right hand, for which surgical intervention was performed with osteosynthesis. The fall also resulted in a vertebral fracture at the L3 level, initially neglected, and later neurosurgically treated with L3 laminectomy and L2-L4 spinal fusion.

Postoperatively, a motor deficit was found in the lower limbs, and she was diagnosed clinically and following neurophysiological investigations with bilateral external popliteal sciatic nerve paresis. On this background, the patient suffers a new trauma resulting in an open fracture at the same level of the right forearm, which was also treated surgically by replacement of the osteosynthesis material (2 titanium plates with 7 screws, respectively with 5 screws, at the level of the radius and ulna).

At the time of admission to our clinic, the patient was conscious and cooperative, with intact comprehension, a heart rate of 90 beats per minute, and blood pressure of 130/80 mmHg. An increased ventricular rate toward the upper limit of normality was diagnosed as iatrogenic tachycardia in the context of antiparkinsonian medication, following a cardiological consultation.

Clinical examination revealed a patient with hypomimic facies, bradylalia, bradykinesia, global dyskinetic movements, postural tremor, bilateral positive Negro-Noica sign, increased deep tendon reflexes globally, and a positive Babinski test on the right side, with the left side showing an inconsistent positive result.

It was observed: moderate lumbar spinal syndrome, with a typical postoperative scar at the lumbar level measuring about 10 centimeters, mild dextroconvex thoracolumbar scoliosis, a Schober test value of 10/11 centimeters, bilateral negative Lasegue test; thoracic hyperkyphosis; right forearm with multiple postoperative scars of normal appearance, right radiocarpal deformity with slight radial deviation and decreased mobility for dorsal and palmar flexion (a value of 30 degrees) and for lateral flexion; decreased muscle strength at antero-external calf muscle (value +3/5 on the MRC scale in the left lower limb and 4/5 on the MRC scale on the right side); transfers and rolls were possible, sitting at the edge of the bed was possible, orthostasis was possible with support, walking was difficult, requiring support with a wheeled walking frame.

During hospitalization, the patient underwent her chronic treatment, consisting of antiparkinsonian drugs, antidepressant drugs, and anti-osteoporotic drugs such as Teriparatide 20mcg/80ml injectable solution (1 ampoule/day, bone strengtheners). Additionally, symptomatic medication was administered, and the patient followed an individualized rehabilitation program. The evolution was slightly favorable.

The rehabilitation objectives were: improving disability, preventing falls, relieving pain, improving paravertebral, gluteal, and abdominal muscle tone and strength, walking and balance training. The patient underwent analgesic physical therapy and specific kinetic exercises, including balance training exercises.

The following recommendations were made for discharge: a diet rich in vitamins and minerals, continuation of specific kinetic exercises, and continuation of chronic treatment.

5. Conclusions

Medical rehabilitation is indeed essential for patients with osteoporosis associated with degenerative neurological conditions, such as Parkinson's disease and stroke. It plays an important role in improving lifestyle and preventing disease complications. However, the association of these pathologies results in severe disability, making the rehabilitation process more challenging. The integration of advanced technologies into the rehabilitation program can enhance the chances of improving functioning for these patients.

Supplementary Materials: Not applicable

Author Contributions: Conceptualization, R.P., G.D., F.L.P., M.S., M.G.I., M.C., A.B., L.I., C.N., and I.C.; methodology, R.P., G.D., M.S., F.L.P., M.G.I., M.C., I.C., A.B., S.B., V.M.C., R.U., L.I., and C.N.; software, M.S., F.L.P., S.B., A.B., V.M.C., and I.C.; validation, R.P., M.S., F.L.P., L.I., R.U., A.B., and I.C.; formal analysis, R.P., M.G.I., V.M.C., R.U., L.I., M.S., F.L.P., and I.C.; investigation, R.P., G.D., M.S., F.L.P., and I.C.; resources, R.P., G.D., M.S., F.L.P., and I.C.; data curation, R.P., M.S., F.L.P., and I.C.; writing—original draft preparation, R.P, M.S., G.D., F.L.P., and I.C.; writing—review and editing, R.P, F.L.P., M.G.I., and M.S.; visualization, M.C., M.S., F.L.P., and C.N.; supervision, R.P., M.S., F.L.P., M.G.I., and C.N.; project administration, F.L.P., and M.S.; funding acquisition, F.L.P., and M.S. All authors have read and agreed to the published version of the manuscript. *All authors had equal contribution in this paper.*

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki. The data were collected retrospectively.

Informed Consent Statement: Written informed consent has been obtained from the patient to anonymouly use her medical records.

Data Availability Statement: Not applicable

Acknowledgments: Not applicable

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

References

1. Pouresmaeili F, Kamali Dehghan B, Kamarehei M, Yong Meng G. A comprehensive overview on osteoporosis and its risk factors. Therapeutics and Clinical Risk Management 2018, 14, 2029–2049. doi:10.2147/tcrm.s138000 10.2147/tcrm.s138000.
2. Oleson CV. Osteoporosis in neurological disorders: Parkinson's disease, stroke, and multiple sclerosis. Marcus and Feldman's Osteoporosis 2021, 1033-1059.
3. Dobson R, Yarnall A, Noyce AJ, Giovannoni G. Bone health in chronic neurological diseases: a focus on multiple sclerosis and parkinsonian syndromes. Practical Neurology 2013, 13(2), 70–79. doi:10.1136/practneurol-2012-000435.
4. Van den Bos F, Speelman AD, van Nimwegen M, van der Schouw YT, Backx FJ, Bloem BR, Munneke M, Verhaar HJ. Bone mineral density and vitamin D status in Parkinson's disease patients. J Neurol. 2013, 260(3):754-60. doi: 10.1007/s00415-012-6697-x. Epub 2012 Oct 9. PMID: 23052606.
5. Ozturk EA, Gundogdu I, Tonuk B, Umay E, Kocer BG, Cakci A. Bone mineral density and serum vitamin D status in Parkinson's disease: Are the stage and clinical features of the disease important? Neurol India 2020, 68(2):394-400. doi: 10.4103/0028-3886.283755. PMID: 32415013.
6. Parihar J, Goyal V. Early Loss of Bone Mineral Density in Parkinson's Disease Patients. Neurol India. 2021 Mar-Apr;69(2):520-521. doi: 10.4103/0028-3886.314582. PMID: 33904496.
7. Zhao Y, Shen L, Ji H-F. Osteoporosis risk and bone mineral density levels in patients with Parkinson's disease: a meta-analysis. Bone 2013, 52 498–505. 10.1016/j.bone.2012.09.013.
8. Schneider JL, Fink HA, Ewing SK, Ensrud KE, Cummings SR for the Study of osteoporotic fractures (SOF) research group. The association of Parkinson's disease with bone mineral density and fracture in older women. Osteoporos. Int. 2008,19, 1093–1097. 10.1007/s00198-008-0583-5.
9. Daniel SK., Lansang MC., Okun MS. Bone mineral density (BMD) in male patients with Parkinson's disease. Int. J. Neurosci. 2012, 122, 523–527. 10.3109/00207454.2012.685530.
10. Pelicioni PHS, Menant JC, Latt MD, Lord SR. Falls in Parkinson's Disease Subtypes: Risk Factors, Locations and Circumstances. International journal of environmental research and public health, 2019, 16(12), 2216. https://doi.org/10.3390/ijerph16122216
11. Kanis JA, Norton N, Harvey NC, Jacobson T, Johansson H, Lorentzon M, McCloskey EV, Willers C, Borgström F. SCOPE 2021: a new scorecard for osteoporosis in Europe. Archives of osteoporosis 2021, 16(1), 82. https://doi.org/10.1007/s11657-020-00871-9
12. Marsden CD, Parkes JD, Quinn NP. "Fluctuations of disability in Parkinson's disease – clinical aspects." Movement disorders neuroly 1981, 96-122, https://doi.org/10.1016/B978-0-407-02295-9.50012-6
13. Cho K, Yu J, Rhee H. Risk factors related to falling in stroke patients: a cross-sectional study. Journal of physical therapy science 2015, 27(6), 1751–1753. https://doi.org/10.1589/jpts.27.1751
14. FL Popa, C. Diaconu, A. Canciu, VM. Ciortea, MG. Iliescu, M. Stanciu. Medical management and rehabilitation in posttraumatic common peroneal nerve palsy. Balneo and PRM Research Journal. 2022, 13(1):496. Print ISSN: 2734-844X Online ISSN: 2734-8458. DOI 10.12680/balneo.2022.496.
15. Cizza G, Primma S, Csako G. Depression as a risk factor for osteoporosis. Trends Endocrinol Metab 2009, 20(8), 367–373. https://doi.org/10.1016/j.tem.2009.05.003
16. Fernandes BS, Hodge JM, Pasco JA, Berk M, Williams LJ. Effects of depression and serotonergic antidepressants on bone: mechanisms and implications for the treatment of depression. Drugs & aging 2016, 33, 21-25.

17. Diem SJ, Blackwell TL, Stone KL, Cauley JA, Hillier TA, Haney EM, Ensrud KE for the Study of Osteoporotic Fractures Research Group. Use of antidepressant medications and risk of fracture in older women. Calcified tissue international 2011, 88, 476-484.
18. Mercurio M, de Filippis R, Spina G, De Fazio P, Segura-Garcia C, Galasso O, Gasparini G. The use of antidepressants is linked to bone loss: A systematic review and metanalysis. Orthop Rev (Pavia) 2022, 14(6):38564. doi: 10.52965/001c.38564. PMID: 36267210; PMCID: PMC9568413.
19. Carlson BC, Robinson WA, Wanderman NR, Sebastian AS, Nassr A, Freedman BA, Anderson PA. A Review and Clinical Perspective of the Impact of Osteoporosis on the Spine. Geriatric orthopaedic surgery & rehabilitation 2019, 10, 2151459319861591. https://doi.org/10.1177/2151459319861591
20. Suzuki N, Ogikubo O, Hansson T. The prognosis for pain, disability, activities of daily living and quality of life after an acute osteoporotic vertebral body fracture: its relation to fracture level, type of fracture and grade of fracture deformation. European spine journal: official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society, 2009, 18(1), 77–88. https://doi.org/10.1007/s00586-008-0847-y
21. Carlson BC, Robinson WA, Wanderman NR, et al. A Review and Clinical Perspective of the Impact of Osteoporosis on the Spine. Geriatric Orthopaedic Surgery & Rehabilitation 2019;10. doi:10.1177/2151459319861591
22. Hodsman AB, Leslie WD, Tsang JF, Gamble GD. 10-Year Probability of Recurrent Fractures Following Wrist and Other Osteoporotic Fractures in a Large Clinical Cohort: An Analysis From the Manitoba Bone Density Program. Arch Intern Med. 2008;168(20):2261–2267. doi:10.1001/archinte.168.20.2261
23. Stanciu M, Bera LG, Popescu M, Grosu F, Popa FL. Hashimoto's thyroiditis associated with thyroid adenoma with Hürthle cells - case report. Romanian Journal of Morphology and Embryology = Revue Roumaine de Morphologie et Embryologie. 2017, 58(1):241-248. PMID: 28523326.
24. Popa FL, Iliescu MG, Stanciu M, Georgeanu V. Rehabilitation in a case of severe osteoporosis with prevalent fractures in a patient known with multiple sclerosis and prolonged glucocorticoid therapy. Balneo and PRM Research Journal 2021, Vol12, Nr 3, pp 284-288.
25. Lambrinoudaki I, Armeni E, Pliatsika P, et al. Thyroid function and autoimmunity are associated with the risk of vertebral fractures in postmenopausal women. J Bone Miner Metab 2016. doi:10.1007/s00774-016-0752-0.
26. Polovina SP, Miljic D, Zivojinovic S, Milic N, Micic D, Brkic VP. The impact of thyroid autoimmunity (TPOAb) on bone density and fracture risk in postmenopausal women. Hormones (Athens) 2017, 16(1):54-61. doi: 10.14310/horm.2002.1719. PMID: 28500828.
27. Stanciu M, Zaharie IS, Bera LG, Cioca G. Correlations between the presence of Hürthle cells and cytomorphological features of fine-needle aspiration biopsy in thyroid nodules. Acta Endocrinol (Buchar) 2016, 12(4):485-490. doi: 10.4183/aeb.2016.485. PMID: 31149137.
28. Chou YH, Hickey PT, Sundman M, Song AW, Chen NK. Effects of repetitive transcranial magnetic stimulation on motor symptoms in Parkinson disease: a systematic review and meta-analysis. JAMA neurology 2015, 72(4), 432-440.
29. Khedr EM, Rothwell JC, Shawky OA, Ahmed MA, Hamdy A. Effect of daily repetitive transcranial magnetic stimulation on motor performance in Parkinson's disease. Movement disorders: official journal of the Movement Disorder Society 2006, 21(12), 2201-2205.
30. Hsu WY, Cheng CH, Liao KK, Lee IH, Lin YY. Effects of repetitive transcranial magnetic stimulation on motor functions in patients with stroke: a meta-analysis. Stroke 2012, 43(7), 1849-1857.
31. Beaulieu LD, Schneider, C. Effects of repetitive peripheral magnetic stimulation on normal or impaired motor control. A review. Neurophysiologie Clinique/Clinical Neurophysiology 2013, 43(4), 251-260.
32. Nasui, B.A.; Talaba, P.; Nasui, G.A.; Sirbu, D.M.; Borda, I.M.; Pop, A.L.; Ciortea, V.M.; Irsay, L.; Purcar-Popescu, A.I.; Cinteza, D.; et al. The Influence of Diet and Physical Activity on Oxidative Stress in Romanian Females with Osteoarthritis. Nutrients 2022, 14, 4159. https://doi.org/10.3390/nu14194159.
33. Ciortea, V.M.; Motoasca, I.; Borda, I.M.; Ungur, R.A.; Bondor, C.I.; Iliescu, M.G.; Ciubean, A.D.; Lazar, I.; Bendea, E.; Irsay, L. Effects of High-Intensity Electromagnetic Stimulation on Reducing Upper Limb Spasticity in Post-Stroke Patients. Appl. Sci. 2022, 12, 2125. https://doi.org/10.3390/app12042125.