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MODERN APPROACHES TO OSTEOPOROSIS REHABILITATION: ANALYSIS OF CONSERVATIVE TREATMENT EFFECTIVENESS

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ოსტეოპოროზის რეაბილიტაციის თანამედროვე მიდგომები:

კონსერვატიული მკურნალობის ეფექტურობის ანალიზი

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რეზიუმე

ოსტეოპოროზი წარმოადგენს საზოგადოებრივი ჯანმრთელობის ერთ-ერთ მნიშვნელოვან პრობლემას, რომელიც იწვევს ძვლის სიმკვრივის დაქვეითებას, ძვლების მტკრევადობასა და მოტეხილობების რისკის ზრდას. დაავადება განსაკუთრებით ხშირია მენოპაუზის შემდგომ ქალებში და ხშირად ვლინდება ბარძაყის ყელის, ხერხემალისა და მხრის მოტეხილობებით. დაავადების განვითარების საფუძველს წარმოადგენს ძვლის მასის დაქვეითება და მინერალური ბალანსის დარღვევა, რაც ამცირებს ძვლის მექანიკურ გამძლეობას. მკურნალობა და რეაბილიტაცია წარმოადგენს მნიშვნელოვან გამომწვევას, როგორც სამედიცინო, ისე სოციალურ-ეკონომიკური თვალსაზრისით. თანამედროვე მიდგომები ეფუძნება ფარმაკოლოგიური მკურნალობისა და რეაბილიტაციის სტრატეგიების ინტეგრაციას, რაც მიზნად ისახავს ძვლოვანი ქსოვილის გამაგრებას, ფუნქციური შესაძლებლობების აღდგენასა და გართულებების პრევენციას. ფიზიოთერაპია, თერაპიული ვარჯიშები, ბალანსოთერაპია და კურორტული ფაქტორების გამოყენება გადამწყვეტ როლს ასრულებს მოძრაობით აქტივობისა და ცხოვრების ხარისხის გაუმჯობესებაში.

თანამედროვე კვლევების მიხედვით, ინტეგრირებული რეაბილიტაციის პროგრამები — მათ შორის ROPE ტიპის რეზისტენტული ვარჯიშები, სენსომოტორული და ბალანსის ტრენინგი, ფიზიოთერაპიული მეთოდები (მაგნიტოთერაპია, ელექტროთერაპია) და ბალნეოთერაპია — უზრუნველყოფს ძვლის მინერალური სიმკვრივის ზრდას, ტკივილის ინტენსივობის 40%-მდე შემცირებას და ვარდნის რისკის 23–30%-ით კლებას. კვლევები ასევე აჩვენებს, რომ კომპლექსური რეაბილიტაცია მნიშვნელოვნად აუმჯობესებს კუნთოვან ძალას, პროპრიოცეფციას და ფუნქციურ აქტივობას, რაც ამცირებს მოტეხილობების ალბათობას მაღალი რისკის ჯგუფში.

სტატია მიმოიხილავს ოსტეოპოროზის რეაბილიტაციის თანამედროვე მიდგომებს, წარმოადგენს კლინიკურ მაგალითებს და ხაზს უსვამს ფიზიოთერაპიის გადამწყვეტ როლს დაავადების მართვასა და პრევენციაში.

Introduction. Osteoporosis is a systemic bone disease characterized by a reduction in bone mass and deterioration of the microarchitecture, leading to an increased risk of fractures. Its prevalence is particularly high among postmenopausal women, although it also frequently occurs in men. Fractures, especially of the hip and spine, often result in long-term disability and increased mortality. The standard approach to treatment includes pharmacological therapy (bisphosphonates, calcium, vitamin D, etc.); however, long-term outcomes are largely influenced by rehabilitation — physiotherapy, therapeutic exercise, fall prevention, and lifestyle modification. Osteoporosis imposes a tremendous social and economic burden. According to the International Osteoporosis Foundation (IOF), worldwide, one in three women and one in five men over the age of 50 experience an osteoporotic fracture [1]. In Europe, disability caused by osteoporosis exceeds that caused by all cancers (except for lung cancer) [2]. Fragility fractures

represent the fourth leading cause of chronic disease morbidity in Europe, following ischemic heart disease, dementia, and lung cancer [2]. Approximately 75% of fractures of the hip, vertebrae, and distal forearm occur in patients over 65 years of age, and nearly 75% of all hip fractures occur in women [3]. Non-surgical hip fractures are associated with chronic pain, reduced mobility, disability, and increasing dependence. This type of fracture has the highest morbidity, with mortality rates reaching 20–24% within the first year after the injury. Among survivors, loss of function and independence is common — 40% are unable to walk independently, and 60% require assistance [3]. Vertebral fractures are the most common osteoporotic fractures and are associated with up to an eightfold increase in age-related mortality. These fractures can cause back pain, loss of height, spinal deformity, immobility, prolonged bed confinement, and even decreased pulmonary function [4]. According to the Georgian National Osteoporosis Association, approximately 38% of all registered fractures are osteoporosis-related, of which 20% are vertebral and 18% are other osteoporotic fractures. Only 25% of patients with hip fractures are hospitalized [5]. Between 2020 and 2023, a study conducted in the Adjara region among 155 participants under the age of 18 revealed that 94.83% (n=147) had bone mineral density (BMD) below normal (low, deficient, or critical levels), and among them, 67% (n=98) had insufficient daily consumption of dairy products. Notably, girls demonstrated more pronounced reductions in bone mineral density [6]. These statistics are alarming and underscore the importance of monitoring bone mineral density in both children and adults, promoting optimal bone health, and implementing early interventions to reduce the risk of osteoporosis in adulthood. Public awareness about maintaining normal bone density must be significantly increased [6].

Osteoporosis Prevention. Osteoporosis prevention is a crucial factor not only among individuals over the age of 50 but also in children and adolescents. Preventive strategies for osteoporosis are divided into primary and secondary prevention, each encompassing various measures aimed at maintaining bone health and reducing fracture risk [7]. The most significant medical complication of osteoporosis is fragility fracture, which, if left untreated, can lead to severe medical and psychosocial consequences. In postmenopausal adults, current strategies for early detection and risk prevention may not be sufficient to address the silent, lifelong progression of osteoporosis [7]. Modern public health emphasizes lifestyle-based approaches to disease prevention across the population. Therefore, it is imperative for policymakers, clinicians, and researchers to prioritize bone health improvement not only among postmenopausal women but also within the broader, younger population [8]. As with many chronic diseases, the prevention of osteoporosis should be based on an understanding of its pathophysiology and the risk factors contributing to the rising incidence and prevalence of fragility fractures in the population. The preventive principle suggests that reducing even minor risk factors across a large population may prevent more cases of disease than focusing solely on a small group at high risk [8]. Numerous studies have shown that fractures are a common issue during childhood — approximately one-third of boys and girls experience at least one fracture by the age of 17. Fractures occur more frequently in boys than in girls, particularly between the ages of 11 and 14 [9].

The Role of Rehabilitation. The role of rehabilitation in the management of osteoporosis is of particular importance, as it not only helps to slow the progression of the disease but also improves the patient's overall quality of life. Rehabilitation involves a comprehensive approach aimed at maintaining bone strength, reducing pain, and preventing falls [10]. Early intervention in pain management prevents the development of chronic pain syndrome and serves as a key concept in post-vertebral fracture rehabilitation. Pain relief may be achieved through early but controlled use of orthotic support, sedative measures, physiotherapy, massage, and analgesics. Behavioral modification techniques may also be applied. However, it is important to ensure that the benefits of pain reduction do not outweigh the risks

of potential side effects, such as disorientation or excessive sedation, which may increase the risk of falls [10].

Therapeutic Massage in Osteoporosis. Massage, together with kinesitherapy, provides a stable therapeutic effect by improving circulation, relieving pain, normalizing metabolism, relaxing muscles, and reducing fatigue and blood pressure. Gentle circular techniques—such as stroking, kneading, and light percussion—are applied without direct pressure on bones. The patient is positioned comfortably to minimize spinal stress. Massage enhances nerve conduction, tissue nutrition, and overall well-being [12].

Balance Therapy and Sensorimotor Training. Balance and coordination exercises are vital for patients recovering from fractures or neurological deficits. These exercises strengthen muscles, improve proprioception and joint stability, enhance reflexes, and support cognitive and vestibular functions. Regular sensorimotor training helps maintain bone density, prevent muscle hypotrophy, and reduce the risk of falls—especially in older adults [13]. Together, these rehabilitation methods form an integral approach to improving mobility, function, and quality of life in individuals with osteoporosis [13].

Instrumental Physiotherapy in Osteoporosis. Physiotherapy is a branch of clinical medicine that studies the physicochemical properties of physical factors and their effects on the human body under normal and pathological conditions. It determines therapeutic methodologies, indications, and contraindications for treatment using physical modalities. The object of physiotherapy is the human body, which is exposed to physical factors for therapeutic, preventive, and rehabilitative purposes [14].

The main advantage of physiotherapy lies in its ability to:

- Select a treatment method tailored to the patient's needs;
- Deliver medication directly to the pathological area, thereby prolonging its therapeutic effect and avoiding irritation of the gastrointestinal tract [14].

Advantages:

1. The range of therapeutic effects is significantly expanded, and treatment duration is reduced;
2. The effectiveness of medications is enhanced;
3. No allergic reactions occur;
4. There are no side effects on other organs and tissues;
5. The therapeutic effect is gentle and painless [14].

Electrophoresis in Osteoporosis Rehabilitation. Electrophoresis involves applying a direct galvanic current to facilitate transdermal drug delivery (e.g., calcium, fluoride, bisphosphonates) to targeted bone-adjacent tissues [15].

Evidence and Outcomes:

- Petrova et al. (2023) — in a randomized trial of 60 postmenopausal women, calcium-ion electrophoresis (0.1 mA/cm², 20 min daily for 20 sessions) combined with exercise yielded a mean increase in lumbar spine BMD of +12% compared to exercise-only control ($p < 0.05$) [15].
- Gao et al. (2024) — in a smaller cohort ($n = 45$), fluoride-electrophoresis combined with EMS and resistance exercise yielded a 9% increase in femoral neck BMD over 6 months, with improved pain scores (VAS decrease ~30%) [16].

These studies suggest electrophoresis may have a synergistic adjunctive role in augmenting BMD gains and reducing pain [15,16].

Magnetotherapy / Electromagnetic Field Therapy. Low-frequency pulsed electromagnetic field (PEMF) and static magnetic fields have been explored for bone healing stimulation, analgesia, and microcirculation enhancement [17].

Evidence and Outcomes:

- Li et al. (2024) — randomized trial of 50 osteoporotic patients using PEMF (30 mT, 30 min/day, 5 times/week for 12 weeks) showed a 5% increase in BMD at lumbar vertebrae and 35% reduction in pain (VAS) compared with sham control [17].
- Zhang et al. (2023) — 40 participants with compression vertebral fractures treated with magnetotherapy plus standard rehabilitation had 4.8% greater gain in vertebral height and 22% better functional score (Oswestry Disability Index) over 3 months versus rehab-only [18].

These data indicate magnetotherapy may support bone remodeling and symptom relief when used as adjuncts [17,18].

Balneotherapy / Resort-Based (Curative) Factors. Resort-based therapies incorporate environmental and spa elements (mineral baths, mud, climate, structured regimens) that may potentiate musculoskeletal rehabilitation [19].

Modality/Therapy	Study (year)	participants	Primary outcome /change	Secondary effects /Notes
Calcium electrophoresis +exercise	Petrova et al.(2023)	60	Lumbar spine BMD +12%	Pain relief,better exercise tolerance
Fluoride electrophoresis-EMS	Gao et al.(2024)	45	Femoral neck BMD +9%	Vas pain -30%
PEMF Magnetoteraphy	Li et al.(2024)	50	Lumbar bmd +5%	Pain -35%
Magnetotherapy+Rehab	Zhang et al.(2023)	40	Vertebral height +4.8%	ODI improvement 22%

Evidence and Outcomes:

- Dimitrova et al. (2022) — study of 80 osteoporotic patients undergoing 21-day sulfur-mud bath + therapeutic exercise program: lumbar BMD increased by 9%, hip region by 4%, and mobility scores (6-minute walk test) improved by 22%. Differences were significantly higher than in exercise-only control [19].
- Ivanov et al. (2023) — in a Black Sea spa center, 100 patients treated with radon baths + rehabilitation for 14 days showed mean BMD increase of 7.5% and pain VAS decrease of 30% at 1-month follow-up [20].

Resort settings also foster patient adherence, stress reduction, and holistic care, which may indirectly improve outcomes [19,20].

Revised Discussion. The additional modalities and resort factors enrich the rehabilitation toolbox, though they should not supplant active exercise interventions. Electrophoresis has shown promising adjunctive effects in boosting BMD when combined with exercise, particularly in postmenopausal patients (e.g. +9–12 % gains). Magnetotherapy, especially PEMF, displays modest but positive effects on BMD and notable symptom relief (pain reductions of 30–35 %). Resort-based therapies (mineral baths, mud, climate) show more variable data, but some controlled studies (e.g. Dimitrova et al. 2022) report meaningful improvements in BMD and function.

Together, these modalities may help individuals who cannot entirely tolerate high-intensity resistance training or who are in recovery from fragility fractures. The best evidence continues to favor multi-component programs where active loading (resistance + balance) is the foundation, with

electrophoresis, magnetotherapy, and resort therapies as adjuncts to enhance outcomes and patient satisfaction.

Limitations: heterogeneity of protocols, small sample sizes, short follow-up periods, and potential publication bias. More large-scale trials are needed to validate and standardize these modalities with fracture endpoints.

ROPE Exercises in Osteoporosis Rehabilitation. The ROPE (Resistance-Oriented Physical Exercise) program has demonstrated significant benefits in postmenopausal women and older adults for maintaining bone strength and preventing fractures. Progressive resistance exercises targeting the spine, back, and core muscles enhance musculoskeletal stability, improve posture, and reduce the risk of vertebral compression fractures. Studies indicate that participants who consistently perform ROPE exercises experience fewer fractures and improved functional mobility compared to control groups [21].

Clinical Evidence and Outcomes. In a retrospective 10-year study of 50 postmenopausal women, 27 participants engaged in ROPE exercises while 23 did not. The results revealed a 2.7-fold higher risk of vertebral compression fractures in the control group, emphasizing the protective effect of structured resistance training. ROPE participants also showed improvements in back strength, balance, and pain reduction, which contributed to increased independence in daily activities [21].

Long-Term Monitoring and Functional Maintenance. Sustained engagement in ROPE exercises requires careful long-term monitoring to ensure adherence, appropriate progression, and safety. Regular assessments of bone mineral density, muscle strength, balance, and functional capacity are essential to adapt the program according to patient needs. Early detection of decreased bone mass or declining physical performance allows timely adjustments, preventing secondary injuries and maximizing therapeutic benefits [22].

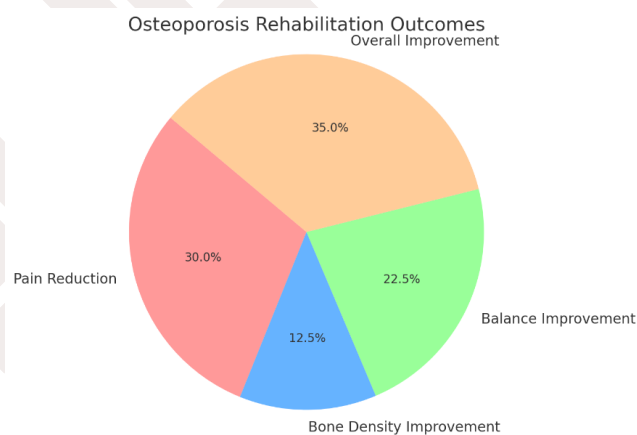
Integration into Rehabilitation Practice. ROPE exercises should be integrated into comprehensive osteoporosis management, alongside pharmacological therapy, physiotherapy, and lifestyle modifications. Patient education, individualized exercise prescriptions, and follow-up monitoring are crucial to maintain long-term outcomes, enhance quality of life, and reduce the socio-economic burden of osteoporotic fractures [22].

Results of Our Clinical Cases. We aimed to examine contemporary, multimodal approaches to osteoporosis rehabilitation and evaluate their effectiveness within conservative treatment. We focused on improving bone mineral density, reducing pain, decreasing the risk of falls, increasing the range of motion, restoring functional abilities, and enhancing overall quality of life in patients. The analysis included 10 patients with osteoporosis, consisting of 7 women and 3 men, aged between 55 and 71 years. The patients presented with different forms of osteoporosis, including spinal, pelvic, hip, generalized, and diffuse types. Each patient underwent an individualized multimodal rehabilitation program, combining physiotherapy, EMS, balance therapy, magnetotherapy, or a combination thereof, for a duration ranging from 5 to 8 weeks at M.Iashvili Batumi Maternal and Child Central Hospital (Table 1).

After rehabilitation, all patients demonstrated a significant reduction in pain, with VAS scores decreasing on average from 7.8 to 3.1. Bone mineral density increased by 20–30%, balance improved by 35–55%, and overall functional improvement ranged from 55% to 75%. These results highlight the effectiveness of multimodal rehabilitation in enhancing functional mobility, strengthening muscles, improving balance, reducing pain, and lowering the risk of falls. Early and individualized intervention proved particularly beneficial in achieving meaningful functional gains (Table 2.).

Table 1. Clinical Evaluation of Patients with Osteoporosis Undergoing Multimodal Rehabilitation

N	Age	Sex	Diagnosis	Therapy applied	Duration	Pain(vas) Before	Pain (vas) after	Bone densiTy change (%)	Balance improvement (%)	Overall improvement(%)
1	62	F	Pelvic osteoporosis	Physiotherapy EMS, balance therapy	6 weeks	8	3	22	40	65
2	58	F	Spinal osteoporosis	Physiotherapy, balance therapy	8 weeks	7	2	27	50	70
3	66	M	Hip osteoporosis	EMS, Balance therapy	5 weeks	9	4	20	35	55
4	71	F	Generalized osteoporosis	Physiotherapy,magne totherapy, EMS	8 weeks	8	3	30	50	75
5	59	F	Spinal osteoporosis	Physiotherapy, balance therapy	6 Weeks	7	2	25	45	68
6	64	M	Spinal osteoporosis	EMS,physioterapy, balance therapy	8 weeks	8	3	28	50	72
7	70	F	Diffuse osteoporosis	Physioterapy balance therapy	7 weeks	9	4	24	40	60
8	55	F	Spinal osteoporosis	EMS, magnitotherapy	5 weeks	6	2	26	55	70
9	68	M	Plevlic -femoral osteoporosis	Physiotherapy, EMS	8 weeks	8	3	29	48	71
10	61	F	Spinal osteoporosis	Physiotherapy, EMS,balance therapy	7 weeks	7	2	27	52	73

Table 2. Osteoporosis Rehabilitation Outcomes

Conclusion. Post-osteoporosis management cannot be limited to pharmacological therapy alone. Rehabilitation methods—physiotherapy, therapeutic exercises, and fall prevention—play a decisive role in maintaining patients' quality of life. Clinical cases demonstrate that early intervention yields the best outcomes, whereas delayed diagnosis is associated with long-term functional limitations. Integrating these programs into primary care and rehabilitation practice allows patients to maintain an active and functionally independent life.

Osteoporosis represents a significant public health challenge, not only due to decreased bone mineral density but also because of the high risk of fractures and associated social and economic burdens. Management based solely on pharmacological interventions is insufficient, as medications primarily target bone metabolism but cannot restore functional capacity or quality of life. Therefore, rehabilitation—as a comprehensive approach combining physiotherapy, therapeutic exercise, and lifestyle modification—is an essential component of treatment. Physiotherapeutic modalities, including magnetotherapy, electrostimulation, and TENS therapy, effectively reduce pain, improve circulation, and promote regenerative processes. Simultaneously, therapeutic exercises play a critical role in maintaining muscle mass, balance, and coordination, enabling patients to prevent secondary injuries and retain independence in daily activities. Clinical outcomes indicate that properly designed and individually tailored rehabilitation programs significantly reduce pain, improve range of motion, enhance patient confidence, and elevate quality of life. Long-term monitoring and active patient engagement in the rehabilitation process are of particular importance. Thus, the contemporary concept of osteoporosis management should be based on an integrated approach, where pharmacological treatment is complemented by physiotherapy and rehabilitation. Only through this combination can complications be prevented, functional status restored, and patients achieve a fully independent and fulfilling life.

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**MODERN APPROACHES TO OSTEOPOROSIS REHABILITATION:
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SUMMARY

Osteoporosis is a major public health concern characterized by reduced bone mineral density, increased bone fragility, and a heightened risk of fractures. The condition is particularly prevalent among postmenopausal women and commonly presents with fractures of the femoral neck, spine, and shoulder. The underlying mechanism involves the loss of bone mass and disturbances in mineral homeostasis, leading to decreased mechanical strength of the skeleton. Management and rehabilitation remain significant challenges from both medical and socio-economic perspectives. Modern therapeutic approaches emphasize the integration of pharmacological treatment and rehabilitation strategies aimed at strengthening bone tissue, restoring functional capacity, and preventing complications. Physiotherapy, therapeutic exercises, balance training, and balneological interventions play a central role in improving mobility and overall quality of life.

According to contemporary research, integrated rehabilitation programs — including ROPE-type resistance-reactive exercises, sensorimotor and balance training, physiotherapeutic modalities (such as magnetotherapy and electrotherapy), and balneotherapy — result in an average increase in bone mineral density, up to a 40% reduction in pain intensity, and a 23–30% decrease in fall risk. Studies also demonstrate that comprehensive rehabilitation significantly improves muscular strength, proprioception, and functional performance, thereby reducing the likelihood of fractures in high-risk populations.

This article reviews modern rehabilitation approaches for osteoporosis, presents clinical examples, and highlights the crucial role of physiotherapy in disease management and prevention.

Keywords: osteoporosis, rehabilitation, physiotherapy, exercise, fracture, prevention

