

## PRACE POGLĄDOWE

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# Place of physiotherapy in prevention and treatment of osteoporosis

## Miejsce fizjoterapii w zapobieganiu i leczeniu osteoporozy

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### ABSTRACT

In the recent years osteoporosis has become a substantial health and social-economic problem reaching the level of other civilization diseases. The most significant complication of this osteology illness is the fracture of a thigh bone proximal part, vertebra or forearm. Osteology, a field of study remarkably evolving nowadays, is the science exploring development of bone mass and bone diseases. Osteoporosis is not an inevitable consequence of aging, on the contrary it is a physical disorder that meets all criteria of an illness:

1. Osteoporosis is clearly defined as an illness and its criteria are not only fractures.
2. Science clarified pathophysiological processes of osteoporosis bone mass reduction.
3. Increased peril of fractures can be early diagnosed by measuring bone mass content.
4. There are well known measures for prevention and therapy of osteoporosis.

Physiotherapy and appropriate physical activity have their unique place in prevention and treatment of osteoporosis and osteoporotic fractures. Mechanisms of physical activity in prevention of osteoporosis consequences are as follows: physical activity increases the peak bone mass in young age and it slows down the increased loss of bone mass

### STRESZCZENIE

Osteoporoza w ostatnich latach stała się ważnym problemem zdrowotnym i społeczno-ekonomicznym porównalnym z innymi chorobami cywilizacyjnymi. Jest to choroba należąca do osteologii i najważniejszym powikłaniem jest złamanie proksymalnej części kości udowej, kręgu kręgosłupa lub przedramienia. Osteologia jest nauką, która zajmuje się rozwojem i chorobami kości i dziedziną, która w ostatnich latach bardzo się rozwija. Osteoporoza nie jest nieuchronną konsekwencją starzenia, wręcz odwrotnie – jest to schorzenie spełniające kryteria choroby:

1. Osteoporoza jest jednoznacznie zdefiniowana jako choroba i jej kryteriami już nie są złamania.
2. Udało się dobrze objaśnić mechanizmy patofizjologiczne utraty masy kostnej przy osteoporozie.
3. Zwiększone ryzyko złamań można wcześniej zdiagnozować poprzez pomiar masy kostnej.
4. Są znane skuteczne środki zapobiegania i leczenia osteoporozy.

Fizjoterapia i odpowiednia aktywność fizyczna mają niezastąpioną rolę w prewencji i leczeniu osteoporozy i złamań osteoporotycznych. Mechanizmy aktywności fizycznej w prewencji konsekwencji osteoporozy są następujące: w młodym wieku odpowiednia aktywność fizyczna zwiększa szczytową

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during the menopause and in older age it improves muscle strength, coordination capabilities and stability whereby it can decrease the incidence and severity of falls.

**Key words:** osteoporosis, osteoporotic fractures, physiotherapy.

## Introduction

Severity of consequences of osteoporosis depends on the fracture site. Hip fractures are most dangerous, about 10 to 20% of the affected individuals die within the first year after the accident (more men than women). The risk of death is greatest in the period immediately after the accident, then it gradually decreases. Only a very small proportion of deaths is a direct result of fracture, it is more frequently a basic chronic disease that is a common cause of deaths and fractures. This shows that efforts to prevent fractures have limited potential importance: the basis of therapy must be a comprehensive approach to the affected person [9]. With an increasing age the risk of hip fractures raises also expenditures in health care system for overall treatment [16]. Hip fractures are the most expensive treatment among other osteoporotic fractures like spine, lower extremity, shoulder or wrist [2].

Experience indicates that about half of patients who have suffered a hip fracture lose the ability to move (walk) after the accident and half of women after the fracture need long-term or permanent assistance with their daily activities. This means that in about 7% of women, particularly in older age groups, fractures lead to dependence on external assistance, and in about further 8% of them, fractures are the main reason for being placed to a care facility. The main consequences of vertebral fractures are back pain, kyphosis and decrease in height, but many fractures occur in the absence of pain. Though many fractures are randomly detected by radiology examination, in the long-term they are demonstrated by chronic back pain, connected with functional limitations.

Though direct limiting consequences of forearm fractures are less acute, compared with femoral neck fractures, they may significantly impair a patient's quality of life (restriction in dressing, meal preparation and other routine activities of personal hygiene, etc.). Many patients complain of a variety of functional deterioration even for longer than 6 months after their injury.

## Prevention

It is a complex therapy, especially prevention that is extremely important in osteoporosis. In addition to diet therapy and pharmaco-prevention, adequate physical activities that are frequently underestimated by patients are one of the deciding factors. Regular physical activities may be considered as a means protecting the skeletal integrity and they also act as an important factor in preventing fractures [7]. There are several mechanisms by

masę kostną (peak bone mass), w okresie menopauzy zwalnia zwiększoną utratę masy kostnej i w starszym wieku poprawia siłę mięśni, koordynacyjne zdolności i stabilność, dzięki czemu może zmniejszyć częstość występowania i powagę upadków.

**Słowa kluczowe:** osteoporoza, złamania osteoporotyczne, fizjoterapia

which exercise may reduce the incidence of osteoporotic fractures. At a young age appropriate physical activity may raise the so-called peak bone mass and thus reduce the risk of fractures later in life. Exercise training early in menopause reduces the increased bone loss, caused by estrogen deficiency. Physical activity of the elderly slows down the bone loss and reduces the incidence and the severity of falls. From the economic point of view the fact should also be pointed out that physiotherapy is less expensive than pharmacotherapy. It is better to make bone decalcification prevention than its successive costly treatment. In osteoporosis prevention regular exercise, recommended 3–4 times a week with duration of about 30–40 minutes [12], is a key precondition. Prevention has not yet acquired a privileged position in our country. No doubts are cast on it by anybody, however, a thorough implementation of prevention programs has rarely been brought to an end. In terms of osteoporosis patients' health status, their quality of life, economic aspect and, finally, of the necessary social care, which amounts to millions, the priority of osteoporosis prevention is more economical than therapy itself [6].

There are several theories of an explanation of how physical activity affects the bone. Each of them is trying to find a link how mechanical signals during exercise (skeletal deformation structures) are turned into biochemical and bioelectric signals. The following theories are known: [13, 15]

- The rise of the deformation potentials as a result of piezoelectric phenomena. Muscle contraction leads to a deformation of crystals of hydroxyapatite that gives rise to a positive potential on the tense side and a negative potential on the compression side, whereby osteoblasts are stimulated and osteoid is formed.
- The effect of prostaglandins. Due to membrane deformation in osteocytes, DNA and RNA synthesis is increased through prostaglandin E<sub>2</sub> and cyclic adenosine monophosphate, which results in the proliferation of osteoblasts and osteocytes.
- Changes in the flow of ions through preformed bone channels when bone is deformed by the bone movement. It is assumed that negatively charged surfaces attract calcium ions.
- Increased blood supply to the bone. A positive correlation between the blood flow in bones and the force of endosteal apposition has been demonstrated.
- Theory of the rise and reparations of small plates microfractures of Haversian channels. When bone is loaded by movement, microscopic damage to

the blades occurs. Defective areas are degraded by osteoclasts and secondary osteons are built by osteoblasts in the vacant place. If this process is long enough there, renewal processes, especially of cortical bone, may arise. The effects of exercise on bone are complex, in principle, there are three mechanisms:

- activation of osteoblasts,
- fixation of Ca<sup>+</sup> ions to the negatively charged surfaces
- increased supply of material for ossification.

In principle prevention is divided into three phases:

Primary prevention - refers to the period of bone growth, i.e. the period of childhood and early adulthood. Its aim is to obtain the maximum amount of bone. The primary means is a sufficient weight-bearing load of bones (walking or stand in an upright position) and proper nutrition (especially adequate calcium intake).

Secondary prevention – refers to the period of maturity, and especially in women, to the menopause. Its aim is to slow down the degradation of bone and thereby to reduce the bone loss. It also includes means of physical activity and nutrition, however, in women the hormone replacement therapy should be added, too. Some studies confirmed that leisure time physical activity in adulthood is associated with higher BMD and reduced risk of osteoporosis later in life [11].

Tertiary prevention - refers to people with pre-existing fractures, especially to those advanced in age. Its aim is to prevent or defer the occurrence of further fractures. In addition to physical activities and nutrition, it includes adequate treatment of associated diseases and adjustment or removal of architectural pitfalls (door sills, appliances cords, the shifting carpets, wet and slippery floors and stairs). The main focus of the spine school should be directed from the field of tertiary prevention to the field of secondary and mostly primary prevention. Prevention of osteoporosis, and especially osteoporotic fractures, is possible, effective and less expensive than the treatment proper [10].

### Rehabilitation in the prevention and treatment of osteoporosis

Rehabilitative care is irreplaceable in the prevention and treatment of osteoporotic fractures. The mechanisms by which physical activities may reduce the incidence of osteoporotic fractures include [1]:

- Appropriate physical activity at an early age may increase the so called peak bone mass and reduce the risk of fractures in old age;
- Exercise early in menopause may reduce the increased bone loss caused by estrogen deficiency;
- Physical activity in old age may slow down bone loss, improve muscle strength, mobility, stability, posture, coordination of movement and thus reduce the incidence and severity of falls [14].

Every movement causes the skeletal modelling and remodelling response and thus it's very important to the organism. A prerequisite for optimal function of the bones is submaximal, not the maximal intensity of load. The movement of bone directly affects the bone changes, both their course and the time of occurrence of pathological changes. The optimal choice of physical activities and observance of the principle of harmonic stimulation of the body as a whole and in its individual systems is a prerequisite for a positive physiological effect. The effect of exercise on bone is complex, there are basically three mechanisms:

- activation of osteoblasts,
- fixation of Ca<sup>2+</sup> ions to the negatively charged surfaces
- increased supply of material for ossification.

### Physiotherapy

The aim of kinesiology is simultaneously to operate in several areas:

- Loading bones by movement, which leads to increased bone formation through stimulation of bone cells so that intensified outer layers of bone get stronger and bone strengthens through reconstruction of bone beams in the direction of the major tensions and pressures,
- Increased muscle tension release – post-isometric and anti-gravity relaxation, soft techniques;
- Enhancement of entire muscles so that bones may be loaded by bigger force and a band of more robust muscles around the spine is created, which helps to spring back the interlocking of vertebra with intervertebral disc, thereby significantly reducing both spine pain but also prevents ejecting the intervertebral discs from its position;
- Overall improvement in mobility, improvement of the patient's ability to cope with normal daily activities and minimization of the risk of suffering fractures;
- Improvement of the overall muscle interplay by stabilization, balance and coordination exercises, and thus preventing falls and fractures;
- Restoration of correct motor stereotypes (breathing, sitting, standing, bending, lying, getting up, correct lifting and carrying loads, etc.)
- Reduction or elimination of pain.

Appropriate loading drill is therefore very important. Patients with osteoporosis are burdened not only with functional but also structural deformations in the spine that cannot stand a bending load, which intensifies pain repetitively. Patients with osteoporosis should seek axial loading of the spine. It is important to learn the recommended protecting spine position, accept it and apply it in all physical activities, remember wrong loading is a path to pain [4].

General principles of treatment in patients with osteoporosis:

- Endurance, not hurry;
- Pull, not swing;
- Sub-maximal load;
- Total duration of physical activity – 30 to 60 minutes, maximum 180 minutes,
- Mixed static-dynamic load;
- Regular walking following an exercise program;
- Sport and physical activities;
- The minimum represents targeted movement load 3 times a week (altogether 3–4 hours weekly) with alternation of its nature;
- Take care of a long-term use of assistive devices (corset braces).

### Pain in osteoporosis

The cause of pain in the acute stage is usually caused by bleeding under the periosteum with microfractures, by stretching of ligaments and intervertebral joint subluxation. Chronic pain arises in the periosteum by its blood staining or when the shape of the vertebra is changed. To change the position of a locomotive segment, ligaments, muscles and outer casings of the intervertebral joint are stretched painfully, and the latter at a subluxation position may be deformed in arthrotic manner, whereby the bone tissue pain is similar to Sudeck's syndrome. Also radicular symptomatology may occur and the pain of internal organs may join. Psyche has a significant share in the matter. The chronic pain is remarkably dull, it usually is monotonous and is escalated through movement and load (e.g. climbing stairs, longer standing or sitting).

In patients pain provokes the feelings of anxiety, fear and depression. The adverse psychological situation may bring about reverse painful stimuli. Pain can interfere in the patient's social sphere, it may affect even his existence [5].

Due to long-term improper loading and overloading of the back muscles, osteoporotic chronic pain is mostly muscular, it arises as a result of long-term pathological curvature of the spine, brought about by vertebrae deformation. Increased tension of the overloaded back muscles results in their contracture and ischémisation, producing a painful syndrome. Improper long-term loading of muscles in the wrong location causes muscle imbalance.

Muscle imbalance is an uneven loading of bone (joint) by stretching at the attachment of muscles. Contracted muscles (agonists) act on the bone by a stronger stretch than their antagonists, that are functionally weakened, stretched and attenuated.

Muscular imbalance contributes to the formation of enthesopathies and participates in the deformation changes of osteoporotic vertebrae. Physiotherapy reduces tension in the relevant muscles, relaxes spasms, reduces and eliminates pain, compensates muscle imbalance.

Osteoporotic pain can be influenced by pharmacological and non-pharmacological treatment methods.

### Non-pharmacological pain treatment in osteoporosis

Correct diet:

- Adjustment of diet - optimal Ca intake by age and sex;
- Care for regular bowel movement.

### Kinesiotherapy

Means of physical therapy:

- Electrotherapy (DDP, TENS, IP, Bioptron);
- Mechanotherapy - fascial mobilization techniques;
- Hydrotherapy;
- Magnetotherapy;
- Phototherapy.

Most patients with osteoporosis suffer from chronic spine and entire back pain. Therefore they mistakenly believe that their disease needs to avoid any movement. It should be explained to the patient that he or she must begin physiotherapy even in spite of pain [5].

### Rehabilitation procedures for osteoporotic fractures

The aim of training exercises is to act simultaneously in several areas:

- Attempt to relax muscle stiffness by certain positions and exercises and thus to relieve the sick of the greatest pain;
- Loading of bone through movement so that currents arising from exposed bone crystals boost the bone cells to produce larger bone mass
  - so that the outer layer of bone and trabecular bone are made stronger, and, in addition to that, the bone strengthens through its rebuilding in the direction of biggest compressions and stretches
- Overall strengthening of muscles
  - so that the bones are loaded with more force and the effect of exercise is greatest,
  - so that a belt of muscles around the spine is stronger, which would help „to spring back“ the interlocking of the vertebra with the intervertebral disc, thereby significantly reducing the spine pain in standing and in walking.

### Basic principles of physical therapy

Exercise is compiled with the aim

- to meet the condition of least deformation and stress of vertebrae, depending on the basic types of stress (stretch, compression, slide, rotation), and combinations thereof,
- to cope with muscle imbalance so that the rest potential in the agonists and antagonists remains the same.

### The aim of the long-term regular physiotherapy is [18]:

- to prevent further bone loss in combination with drug therapy so that bone mineral mass is increased,
- to reduce or eliminate pain and thus to decrease the cost of the medical treatment.

### Rehabilitation Procedures

Incorrectly chosen methodology of physiotherapy and movement patterns in daily life in patients with osteoporosis may lead to formation of microfractures and to progression of vertebrae deformations as a result of their improper loading.

Therefore, we consider it important to define a unified methodology of physiotherapy as an integral part of a comprehensive antiosteoporotic care.

### Stages of exercise for patients with bone decalcification

Zero stage - the period of acute complications: the patient is in hospital or at home as a result of vertebral, hip or other bones fractures, possibly with root irritation.

First stage - a period of great pain: the patient is not confined to bed, because of pain he or she moves with difficulty. Spinous processes of the vertebrae are sensitive to percussion or depression, muscle stiffness occurs along the spine.

Second stage – a period of mild or occasional pain: pain occurs only after long static load (standing, sitting) or certain movements or loads without obvious major muscle hardening.

Third stage – the so-called period of stabilized osteoporosis with radiographic and clinical signs of bone loss, but without too much pain and muscle stiffness. The sick is in good condition. After completing all stages of exercise the patient is allowed to make another movement: walking, swimming, easy hiking.

#### Zero stage

Fractures of the spine – rest on a hard bed, the supine position with the knees slightly supported. Suitable breathing exercises to develop and maintain the patient's mobility are recommended. Hip fractures – position on the back, a healthy limb bent at the knee, foot resting on the mat. Exercises to improve respiration, to activate the abdominal musculature, to maintain mobility of the spine, as well as the concentration of isometric muscles of the leg are recommended [8].

#### First stage

Active breathing gymnastics, vascular gymnastics, actively assisted exercise with the affected extremity,

isometric contraction, active exercise with unaffected muscles.

#### Second stage

Repetition of exercises from the first stage and addition of active exercise with back, abdominal, gluteal muscles and upper and low extremities muscles.

Repetition of exercises from stage 1 and 2 should apply particularly exercises for increasing stability, removing ataxia, improving muscle strength and respiration [8]. Use of a fall prevention device for walking (mallet) should be considered to increase security, reduce fear, especially when walking on an uneven surface. Eye care is also important.

### Recommendations for Practice

Exercise is important for the prevention of osteoporosis and the reduction of fracture risk because it improves muscle mass and strength, besides improving balance [17]. Consequently with improvement of above mentioned parameters quality of patient's life enhances [3]. The importance of physiotherapy to maintain bone and muscle mass, and thus the prevention of fractures is unquestionable. The pain which is often concomitant with osteoporotic changes in the skeleton increases disproportionately the strain of ligaments and muscles. A prerequisite of a successful treatment is pain alleviation, proper posture management and, if necessary, exploitation of the support devices for the spine apparatus and targeted physical therapy. Also trunk extensors strengthening and creating a sufficiently solid muscle corset play the dominant role. We must not forget the paraspinal muscle relaxation training either. The treatment program should be accompanied by training of deep, especially chest breathing. All exercises are performed slowly, new pain should not arise. Exercise program must be individualized according to the severity of osteoporosis and in compliance with physical and mental ability of the patient. The largest increase in muscle strength can be achieved relatively quickly with exercise and maximum load. Especially in elderly patients who bear with difficulties the maximum intensity exercise, it is advisable to reduce the training load and to increase the number of repetitions or frequency of exercise to achieve the same result in strengthening muscles. A precondition for increasing bone mineral density is a reasonable implementation of a long-term and regular physical activity, because after completion of long exercise bone density decreases fairly rapidly to baseline.

### Conclusion

It should be pointed out in the context of the presented information that:

- Osteoporosis may be prevented timely and in effective manner,

- Osteoporosis and its risks may be diagnosed early,
  - Osteoporosis may be treated early and effectively, thus preventing fractures,
  - a small increase in bone mass treatment ensures significantly greater reduction in fracture risk (especially in the elderly), that is, it is never too late to treat osteoporosis,
  - the cost of targeted and well founded therapies may not be higher than the cost of treating fractures,
  - suffering, death and costly operations associated with fractures are often unnecessary.
- Osteoporosis may be treated early and effectively using physiotherapy, thus preventing fractures.

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