ORIGINAL PAPER

A multidisciplinary approach in patients with femoral neck fracture on an osteoporotic basis

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Abstract

Introduction: Osteoporosis is a common affection characterized by a reduction of bone mass that affects mostly women after menopause. It currently leads to fractures, especially of the spine and hip thus enhancing the costs of medical care. There are many factors that contribute to its development, leading to various strategy lines to deal with it. *Aim*: The present study aims at showing how a multidisciplinary, multifactorial approach can be effective in treating and preventing new osteoporotic fractures. *Material and Methods*: The study included 17 patients that had replacement arthroplasty for femoral neck fractures. Bone tissue fragments were obtained from all of them and analyzed by pathology specialists. A dual-energy X-ray absorptiometry exam was also performed on each patient. In the end, the data was collected and processed by rehabilitation experts in order to establish proper therapy. *Results*: The hip fracture incidence was two times more frequent in women than in men, higher in the 71–80-year-old group. By analyzing the bone fragments atrophy could be seen, especially in the femoral neck as well as lamellae and osteon reduction and bone architecture alterations. *Conclusions*: Surgical or pharmacological treatments alone are not sufficient for handling osteoporosis. Strategies such as preventing falls, a proper diet, treating associated conditions and a well-established exercise program need to be considered. Specialists from several areas such as pathology, orthopedics, endocrinology, internal medicine and rehabilitation should work together to design the best approach to deal with osteoporosis.

***Keywords*:** osteoporotic fracture, reduction of bone mass, multidisciplinary approach.

Introduction

Osteoporosis is currently considered a chronic condition characterized by a reduction in bone mass, usually because of aging, leading to a reduction in bone strength and an increase in the risk of fracture. Because women are particularly susceptible to bone loss after the menopause, by far the most common form is postmenopausal osteoporosis [1], the women/men ratio being 3:1–4:1. Current estimates place the lifetime risk of wrist, vertebral or hip fracture at 45% in Caucasian women aged over 50 years [2].

Postmenopausal osteoporosis already has a phenomenal impact on health care budgets, which are expected to double for osteoporosis by the year 2050 [3]. This dramatic increase in cost takes into consideration the fact that older patients are more likely to suffer hip fracture, which is the most disabling and costly osteoporotic fracture [4]. It is associated with an important disability and a death rate of 20–24% in the first year that follows its occurrence [5], implying dependence on family or specialized institutions for help.

The most common form of osteoporosis is the primary or idiopathic one, standing for more than 75% of all cases and representing the involution osteoporosis. Depending on the type of bone (trabecular or cortical), two patterns of bone loss can be seen. The loss of cortical bone starts after the age of 40 years and is linear, registering an annual loss of 0.5–1%, whereas the reduction of trabecular bone begins between 30–35 years and is linear in men and women before menopause (1–4% a year). After menopause, the bone loss process is accelerated, reaching up to 10% a year [6].

Knowing all the possible factors involved in the occurrence and development of osteoporosis is important for choosing the most appropriate treatment and designing a rehabilitation program for each case. Thereby, the study aims to show how a multidisciplinary approach including traumatology, pathology, endocrinology and rehabilitation specialists can be helpful in dealing with osteoporosis.

Material and Methods

The study group consisted of 17 patients that had not been previously diagnosed with osteoporosis and

therefore were not on antiosteoporotic medication. They were all subjected to replacement arthroplasty for femoral neck fractures after falling from their own height and subsequently needed a complex rehabilitation program after the intervention. Performing the arthroplasty enabled the specialists to obtain the biological material needed for the histological study. We included bone tissue fragments from the head and neck of the femur from all 17 patients (11 women and six men). The fragments were sliced down to 5 mm pieces using the oscillatory saw and were immediately set in neutral 10% formalin for three weeks, at room temperature. Once the fixation process was over, the fragments were paraffin embedded, sectioned and stained with Hematoxylin–Eosin or using the Goldner–Szekely technique. In the end, pathologists examined the 5–7 μm slides under the microscope.

Also, once the surgery over, a dual-energy X-ray absorptiometry (DXA) exam was performed on each patient in order to evaluate the bone mineral density (BMD), confirm the diagnosis of osteoporosis and assess the future therapy methods.

All the data was finally collected by the rehabilitation specialists, added to their clinical evaluation and processed in order to establish a proper therapeutic approach. To analyze the data, we used Microsoft Excel and the Statistical Package for Social Sciences (SPSS).

Results

The study included 17 patients with an average age of 66 years, the range being between 55 and 82 years, and the standard deviation of nine years. No antiosteoporotic medication had been administered to the patients before this study.

Table 1 – ***The mean age [years] of studied patients***

	N	Minimum	Maximum	Mean	Standard deviation
Age	17	55	82	66.05	9.046
Valid N (listwise)	17				

We noticed that in women the hip fracture incidence was almost two times (1.83) more frequent than in men and this data is correlated with the one in the existing literature showing that femoral neck fractures due to osteoporosis are more frequent in women.

We found that the femoral neck fractures incidence tends to become higher as age progresses, most fractures being in the 71–80-year-old group. Regarding the genetic factor, more than half of the subjects (64.7%) had family background of osteoporosis. Considering the nutritional and environmental factors, the history of caffeine intake was considered relevant with a percentage of 76.4% having a positive answer. When dividing the group into smokers and non-smokers, we noticed that most of the patients included in this study were a part of the second group. Another important classification was the one based on the existence of previous fractures in the patient's medical history. Only a quarter of the population had suffered such incidents before.

We also established that most fractures took place after falling from very low heights (usually while standing) and the trauma intensity was appreciated as being very small in 76.6% of cases, medium in 17.6% and important in up to 5.8% of cases. The large number of fractures produced by small trauma confirms the reduction of bone resistance in persons affected by osteoporosis.

Gathering all clinical and biological data, we can say that there is a large number of factors involved in the appearance and evolution of osteoporosis, some partly unknown.

Starting from the fact that cellular injuries and tissue changes vary from one part of the bone system to another and that these changes are more severe in the neck and head of the femur, we analyzed fragments of bone tissue from all 17 patients.

The macroscopic aspect of the femoral neck and head architecture varied from one patient to another. Therefore, in older patients, the cortical bone was a lot thinner and the trabecular bone rods were more attenuated and thinner compared to those of younger patients. In some patients, the bone tissue digression started in the central part of the bone and extended towards the margins, such as the eccentric bone atrophy. In other cases, the remaining bone rods suffered a process of compensatory thickening, creating the aspect of hypertrophic bone atrophy. Atrophic changes in osteoporosis were seen in the femoral neck slices, even more intensely than in the corresponding femoral head. At this level, eccentric atrophy seems to prevail. Thus, we noticed that while the femoral head rods suffered only thinning and compensatory thickening, in the femoral neck rods important ruptures could be seen, to such extent that bone mass was completely lost. The bone resorption was uneven leading to a more complex imagine with smaller and larger areolas and bigger connecting spaces (Figure 1).

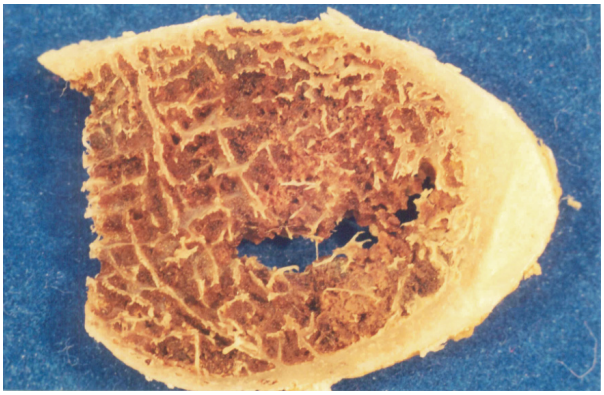

Figure 1 – ***A 77-year-old female patient with osteoporotic femoral neck fracture (a 2 mm slice from femoral neck). Broken interconnecting rods and thinned resistance ones can be seen.***

The microscopic study enabled us to highlight the changes in quantity and quality appeared in the trabecular and compact bones from the femoral neck and head. A first thing to be noticed was that the bone showed a different coloration from one bone fragment to another, even though they were identically processed. This microscopic aspect was attributed to the fact that the osteoporotic bone contains quantities of minerals that vary from one part to another, probably because the bone matrix is unevenly decalcified (Figure 2).

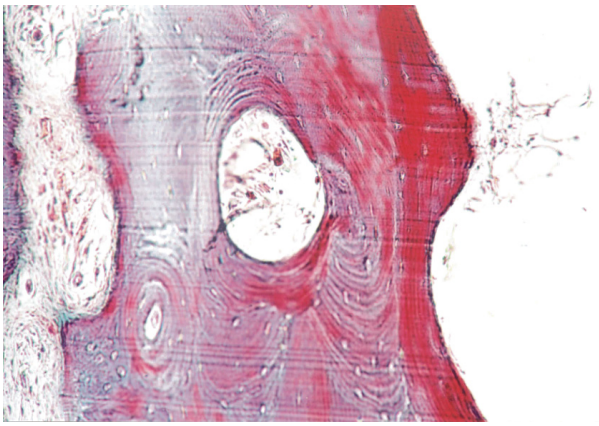

Figure 2 – ***Different staining in bone rods can be seen (Hematoxylin–Eosin stain, ×100).***

Thinned leftovers with sharp ends from the trabecular bone rods could be seen (Figure 3).

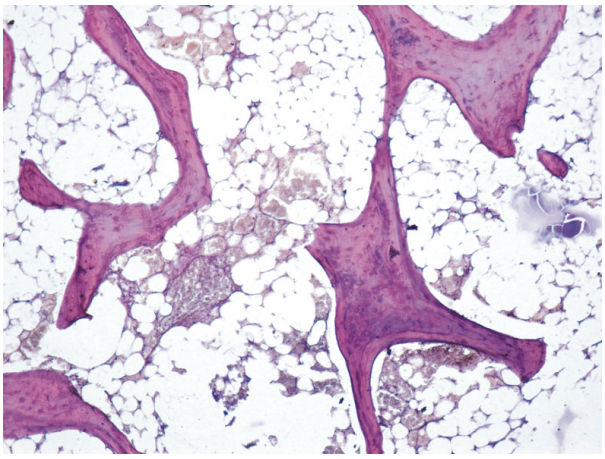

Figure 3 – ***Bone disruption can be seen, with few thin, parted bone rods (Hematoxylin–Eosin stain, ×100).***

On many of the analyzed fragments we observed that the resorption surfaces of the trabecular bone rods appeared smooth, demonstrating the fact that osteoclasts were not active. We also noticed large osteoplasts that did not contain any osteocytes. Others were irregular and "Z" shaped (Figure 4) leading to the conclusion that osteoclasts' bone remodeling activity was in full process at the time of the fragment prelevation.

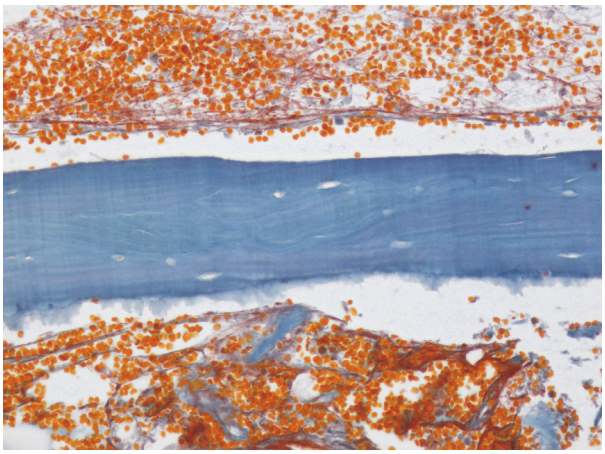

Figure 4 – ***Trabecular bone with fewer, empty osteoplasts (Trichromic Goldner-Szekely stain, ×100).***

In advanced osteoporosis, we discovered that in compact bone tissue, the lamellae in the structure of an osteon were few and sometimes they were so poorly organized that viewing the osteons was not possible.

On some of the analyzed fragments osteons were rarely seen, most of the cortical bone consisting of broken bone lamellae coming from the inter-Haversian system and lacking bone vessels.

Discussion

We found that studying the macroscopic and microscopic structure of the osteoporotic bone is very helpful in choosing the proper therapy, both pharmacological and physical. Involving specialist from several domains enabled a faster and more adequate approach of osteoporosis.

The multidisciplinary approach has been studied by other authors as well, in order to identify and correct the factors that contribute to osteoporosis and thus, enhance treatment effect aimed at reducing the risk of subsequent fractures [7]. A large number of factors are responsible for the induction of osteoporosis, the most important being age and sex (particularly after menopause). Some of them may interfere either as helping factors (in primitive osteoporosis) or as prevailing factors (in the secondary form). Among these types of factors we can mention: hormonal (early menopause, late puberty, Cushing's disease, hyperthyroidism), genetic (family osteoporosis, *osteogenesis imperfecta*), ethnic, anthropometric (low height, asthenia), nutritional (insufficient calcium intake, low vitamin D level, malabsorption), environmental (smoking or alcohol excess, low-sun exposure, previous fracture), iatrogenic (glucocorticoid treatment, thyroid hormones, heparin), lack of exercise (sedentary life, prolonged immobilizations) [8].

Bone fragility increases as age advances because of the appearance of abnormalities in bone remodeling [9]. The negative balance between the relatively greater volume of bone resorbed by osteoclasts than that subsequently deposited by osteoblasts in the basic multicellular unit combined with a high rate of bone remodeling produce trabecular thinning, loss of trabeculae, cortical porosity and cortical thinning [10]. These are consequences of a decrease in osteoblast number and activity and an increase in osteoclast activity determined by a secondary hyperparathyroidism, especially in old persons. Another factor involved is the decrease of the intestinal calcium absorption due to the relative vitamin deficit and lower tissue response to their metabolites.

Nearly 80% of patients have fall-related risk factors for fractures, as published in other studies [11]. Although it has not been shown until now that fall prevention strategies themselves can prevent fractures, they reduce the risk of other fall-derived complications [12]. Exercise interventions have been proved effective in lowering the risk and rate of falls in older people living in the community [13]. A multifactorial intervention program to reduce postoperative falls and injuries after femoral neck fractures has been successfully applied [14].

Of all the modifiable risk factors for fragility fractures, regular physical activity is unique because it can strengthen both bones and muscles, improve balance

and gait, and subsequently prevent falling [15]. Exercise (high-impact loading exercise) appears to positively influence bone mass and geometry in postmenopausal women and preferentially influence cortical rather than trabecular components of the bone. Exercise programs aiming at fall and fracture reduction for patients with osteoporosis should at least include balance and muscle strengthening exercises. Strengthening exercises should be performed at least two to three times a week. For the improvement of BMD, aerobic activities and strength training could be recommended. At least part of these exercises should be weight-bearing [16].

Besides the need for exercise and fall prevention, pharmacological therapy is very important in treating and preventing subsequent fractures. Beyond the need for sufficient calcium and vitamin D, the past decade has seen an emerge of new data supporting a growing industry of therapeutics for osteoporosis [17]. Pharmacological interventions useful in the prevention and treatment of osteoporosis affect bone remodeling by either inhibiting bone resorption or enhancing bone formation. Most commonly used are bisphosphonates and strontium ranelate. While bisphosphonates, synthetic analogues of bone pyrophosphate adhere to hydroxyapatite and inhibit osteoclasts, strontium ranelate is a new dual action bone agent that has anti-resorptive and anabolic effects. Viewing the microscopic structure of the bone enabled specialists to see which process suffered more damage and which is the most appropriate way to treat it.

Despite an increasing number of well-designed studies providing evidence for pharmacotherapy in reducing primary or secondary fracture risk, many high-risk patients are not treated [18], and for patients who initiate therapy, adherence to therapy is commonly below 50% at one to two years [19]. Even for good adherence to treatment, studies show that the number of patients needed to be treated in order to prevent one hip fracture is 91 for bisphosphonates and 48 for strontium ranelate [1].This emphasizes the need for a better collaboration between specialists and a more effective approach to osteoporotic fractures treatment.

Only limited data is available about collaborations between surgeons and internists in taking care of osteoporosis in patients presenting fractures. Some initiatives were very successful [20], but, in most instances, the collaboration has failed [21]. This study states that, besides these two categories, the contribution of pathology specialists adds to a better understanding and treatment of patients with a clinical fracture.

Conclusions

In the past decade, we have witnessed a veritable revolution in osteoporosis diagnosis and therapeutics. Much of the success achieved has been motivated by an enhanced understanding of basic bone biology recognizing the severe consequences of fractures in terms of morbidity and short-term re-fracture and mortality risk. The clinical implication is that patients older than 50 years presenting with a fracture need immediate attention to reduce the risk of a subsequent fracture. This is a situation in which it is important to initiate a treatment that has been shown to reduce fracture risk within the short term.

Knowing the factors that contribute to osteoporotic fractures and how they modify the bone structure is a first step towards a better care in this matter. In order to achieve that, a proper collaboration between all specialists involved in treating patients with osteoporosis is required. The traumatologist, endocrinologist, pathologist, internist and rehabilitation expert should work together to prevent further unwanted events. Surgical intervention, analyzing the bone structure, the factors or previous conditions that lead to the current state and designing an appropriate rehabilitation and pharmacological program, may be as important in reducing the risk for new fractures.

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