

## **HISTOLOGICAL STUDY OF THE FEMURAL HEAD AND NECK MICROSCOPIC ARCHITECTURE IN PERSONS WITH SENILE OSTEOPOROSIS**

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*Summary.* For our study were available fragments of bony tissue from 24 patients (15 females and 9 males) aged between 55–82 which needed hip arthroplasty after they had undergone femoral neck fractures. Biologic pieces have been fixed, then decalcified and processed by wax embedding. We noted that the spongy osseous tissue appeared as rarefied after the remoulding processes; osseous traveas grew unplainly thinner, with their large areolar cavities filled of bony yellow marrow. The osseous cortex presented deformed osteomas with large irregular Havers ducts. The osteocytes appeared rarefied, of small size with a picnotic and hyperchrome nucleus.

*Key words:* osteoporosis, femoral neck, osseous remoulding.

### **INTRODUCTION**

Osteoporosis is a skeleton systemic disease characterized by bony mass reduction and osseous tissue microarchitecture deterioration leading to an increased fragility thus increasing the risk for fractures to appear as a consequence. Epidemiological studies show an increased incidence of that disease of about 80% in females after menopause (Proca, 1988). Adler PC (2000) considers that osteoporosis is present in females after the age of 65 (65–80%) and in males (50–65%). Osteoporosis has evolved asymptotically for a long time; its clinical manifestations might be non-specific and a little blatant, often merged to symptoms of some rheumatismal chronic diseases. That is why, most frequently, osteoporosis is diagnosed when radiographic exams are performed or following some fractures (Mogoantă, 2001).

### **MATERIAL AND METHODS**

The studied material is of human origin and is represented by bony tissue fragments removed from the level of the femoral head and neck belonging to

24 patients (15 females and 9 males) aged between 55–82 years old which needed hip arthroplasty after a femoral neck fracture; they had been hospitalised in the Orthopaedic Clinic of the Emergency Clinic Hospital of Craiova, during the period of 2003–2004.

After the femoral head and neck removing by using some special medical milling machine, bony fragments of 4–5 mm were performed from both the cortical and spongy area of the bone; then they have been fixed in 10% neutral formaldehyde for 14 days at the lab temperature then they have been decalcified with 1% trichloroacetic acid for 45 days.

After an intense washing of 24 hours in running water, the biological material was dehydrated and wax embedded. Sections of 5  $\mu$ m were performed by using a microtome then coloured with Haematoxylin-Eosin and trichromic Goldner-Szeckeli on the basis of green of light.

## RESULTS

Starting from the fact that in the senile osteoporosis the tissue interest is variable, the most affected being the bony trabeculae, which normally are subdued to a mechanic action and more intense remoulding, we chose the femoral head and neck for our study.

Though we suggested a microscopic study we have to reveal that the macroscopic aspect on a section of the femoral head architecture varied from a patient to another considering the age and sex. We therefore noted that in older females the cortical bone was thinner, spongy bone traveas more rare and thinner, and areolas were enlarged, filled with bony yellow marrow; here and there, red bony marrow areas could be seen.

The microscopic study allowed us to establish significant quantitative and qualitative changes at the level of both the spongy and compact bone in the cortex.

Histological aspects of the osteoporotic bones were extremely different from a case to another and even from an area to another in the same bone. One of the main findings was that the osseous tissue had a different tinctoriality from a bony fragment to another, though the bones were identically processed. This microscopic aspect is due to the fact that osteoporotic bone contains variable quantities of mineral salts from one area to another therefore the osseous matrix is unplainly mineralised.

It is known that the dominant spongy bone of the femoral head structure is made up of osseous traveas of different thickness. Some of these traveas called resistance traveas are thicker and they are distributed on traject of the main force lines acting on the femoral head and neck. Linking traveas having a perpendicular or even oblique direction on the former ones connects them.

The two categories of traveas seemed to be differently affected. The most linking traveas appeared to be cut or much rarefied which caused the elastic resistance of the trabecular bone were decreased (Figure 1, Figure 2).

The resistance traveas appeared inhomogeneous thinned, rarefied and sometimes discontinuous limiting large areolar spaces filled with red or yellow osseous marrow.

Some deficitary processes of bony remoulding where the resorption is more intense than its reconstruction cause osseous traveas rarefying.

The histologic study with strong microscopic lens allowed us to note that these osseous traveas were made up of thinned parallel osseous lamellas. The number of osteocytes in the osseous traveas structure appeared reduced demonstrating that the division and osteoblastic differentiation processes are different in the involution osteoporosis.

Moreover, osteocytes appeared of reduced dimensions with a hiperchrome, picnotic nucleus indicating a preponderance of the osseous cells apoptosis.

Osseous traveas were limited by a thin discontinuous endosteum with flattened cells of small sizes pointing that in osteoporosis the capacity of the spongy bone regeneration is reduced, therefore the risk of s fracture gets increased.

Sometimes, giant multinucleate cells representing osteoclasts were revealed near to the spongy bony tissue trabeculae. The osteoclasts respond of the osseous tissue resorption.

In our study, we could note that sometimes the resorption surfaces of the spongy bone traveas appeared to be smoothy pointing that the osteoclasts were not active; or, they appeared irregular and fenestrate pointed that osteoclast osseous remoulding activity was at the highest development in the moment of the biologic material removing (Figure 4).

At the level of haversian bone type from the structure of the femoral neck cortex we noted the presence of some osteons of different forms and sizes, with enlarged and deformed Havers ducts.

Numerous Havers ducts comprised yellow osseous marrow and rare hematopoietic cells (Figure 3). The osseous lamellas in the osteons structure presented rarefied small size osteocytes, structurally similar to those of the spongy bone traveas.

## DISCUSSIONS

It's known that all along the life bones undergo a continuous remoulding process where both the bony matrix resorption and minerals releasing achieved by osteoclasts is coupled to the sequential forming of bony tissue by osteoblasts activity.

After the age 40 the bony tissue forming is progressively reduced due to osteoblast function decrease while the processes of bone resorption are kept at the same level or they become increased therefore causing a decrease of the bony mass after this age.

In women up to the age of 50–55 bone damage by resorption affects almost exclusively the trabecular bone; after this age osteoclastic resorption becomes more important at the level of the cortical bone thus reaching about 80 years old the total loss of the bony mass in the cortical bone becomes equal to that of the spongy one (Delmas *et al.*, 2001).

Other investigators consider that after menopause an increase of the bony loss up to 10% can be noted (Gherasim, 1995).

As concerning involution osteoporosis, first of all a rapid loss of bony mass occurs, especially at the level of the trabecular bone due to estrogenic deficiency then followed by a slower phase of bony mass damage by secondary hyperparathyroidism (Riggs, 1998).

The mechanism by which the estrogenic deficiency can determine the bone resorption increase in the case of postmenopausal osteoporosis is incompletely known (Delmas, 2001).

New studies show that estrogens act indirectly by means of cytokines and growth factors such as: IL-1 $\alpha$ , tumour necrosis factor (TNF), IL-6, and tumour growth factor- $\beta$  (TGF- $\beta$ ) (Collier, 1998).

They can regulate TGF- $\beta$  production of the bone cell and the decrease of some cytokines secretion might be responsible for the increase of the bone remodelling and for the gap between the osteosynthesis and bone resorption (Jilka *et al.*, 1998).

Pacifici *et al.* (1989) showed that IL-1 produced by the monocytes of the peripheral blood increased after menopause and decreased in the case of substitution hormonal therapy.

Another studies demonstrate that the estrogenic deficiency is the factor causing both the increase of the areas number where remodelling initiates and the resorption expanding over during the first years of the estrogenic deficiency then it goes on more slowly.

It is considered that the decrease of the osteoblasts activity and the secondary hyperparathyroidism are the main factors contributing to the decrease of the bone mass and constituting the involution osteoporosis both in men and women of the third age.

From unknown reasons, hyperparathyroidism causes an increase of the osteoclasts activity affecting the cortical bone more than the spongy one. Intracortical resorption is due to the osteoclasts so-called “speare point” disposition which pierces and enlarges along the Volkmann and Havers ducts. These cortical cutting cones are hyperparathyroidism specific feature (Ronsenberg, 1999).

Into the spongy bone, the osteoclastic tunnel penetrates and dissects all along the bony trabeculum sometimes appearing as a “railway runners” microscopically. In these bony regions with increased cell activity the medullar spaces around the affected spaces are replaced by fibrovascular tissue (Ronsenberg, 1999).

As a consequence of the osteoblasts activity decline, a bony tissue volume reducing occurs which reveals by the enlargement of the medullar cavities containing yellow marrow. Also, later on, reparatory and compensatory remoulding processes at the level of the remaining traveas, plainly thickened by bony matrix deposition can be noted in the senile osteoporosis (Păun, 1999).

Due to that fact, there can also be noted thickened support traveas alongside the very osteoporotic thinned ones, thus achieving a hyperthrophic bone atrophy aspect. Another age factor contributing to the bone mass decrease is the diminishing of the intestinal calcium absorption which grows more and more important after the age of 70, in both sexes partly due to a relative deficiency of vitamins and possibly to a more decreased tissular response to the active metabolites of the calcium.

### CONCLUSIONS

Osteoporosis is a multifactorial disease causing skeleton fragility by a quantitative anomaly represented by the bone mass decrease and a qualitative anomaly, as well, represented by its microarchitecture deterioration. It is produced by a lack of balance appearing between the processes of osteogenesis and osteolysis.

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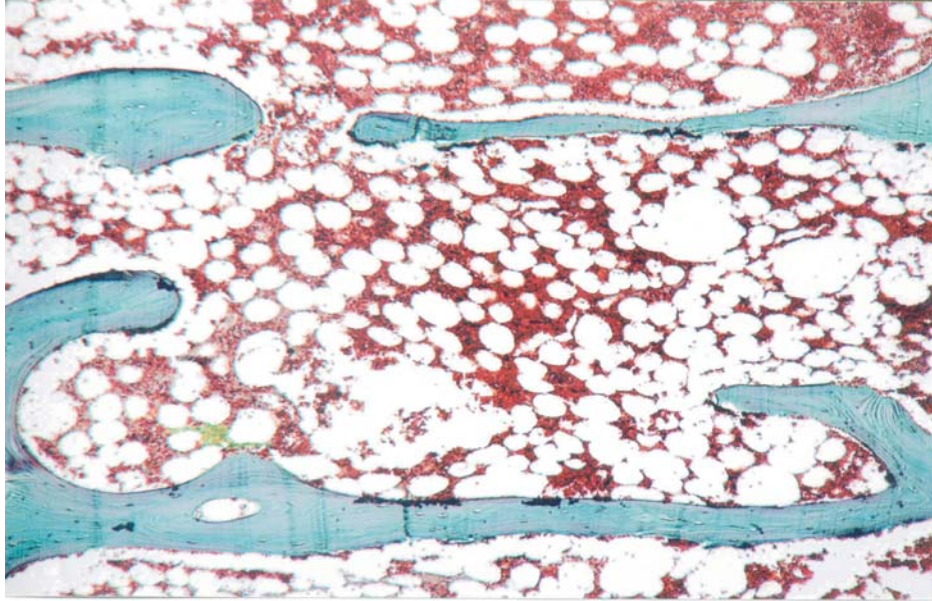


Figure 1 – Microscopic image of the spongy bone at the level of the femoral head in a male of 77; the reducing of the resistance trabeculae and the link trabeculae amputation can be noted (Trichromic Goldner-Szeckeli stain,  $\times 400$ )

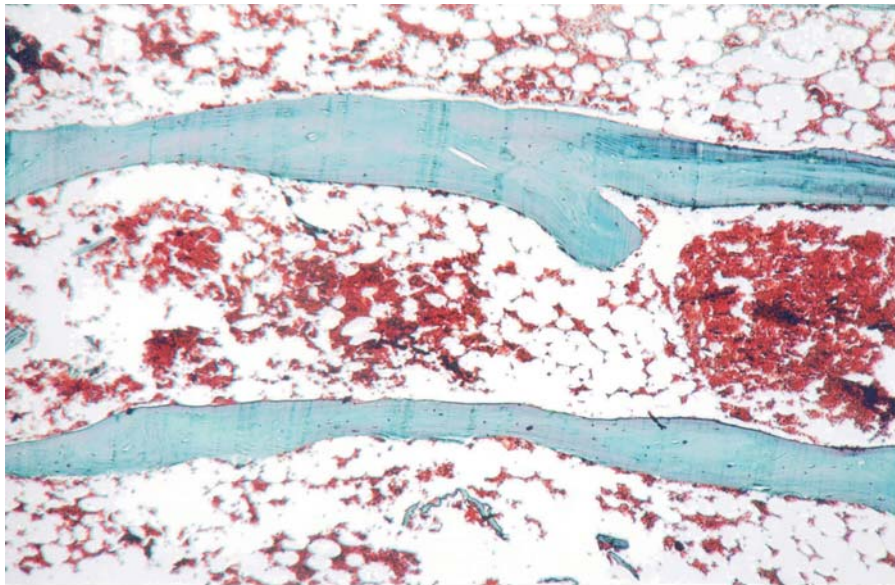


Figure 2 – Identical image to the previous one in a woman of 75; resistance trabeculae thinning and destroying can be noted (Trichromic Goldner-Szeckeli stain,  $\times 400$ )



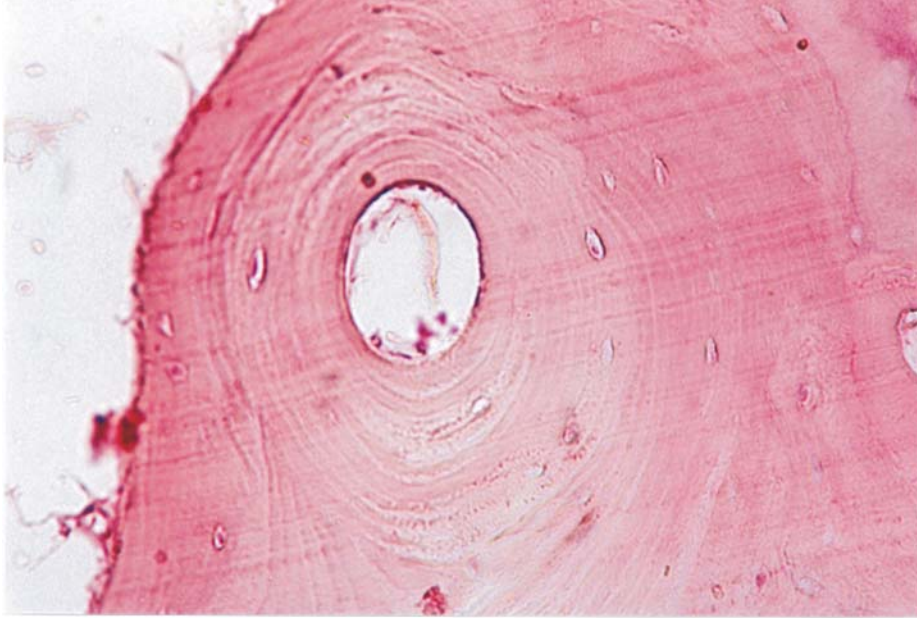


Figure 3 – Osteon of the femoral neck cortex; the enlargement of the Havers' duct (HE stain,  $\times 200$ )

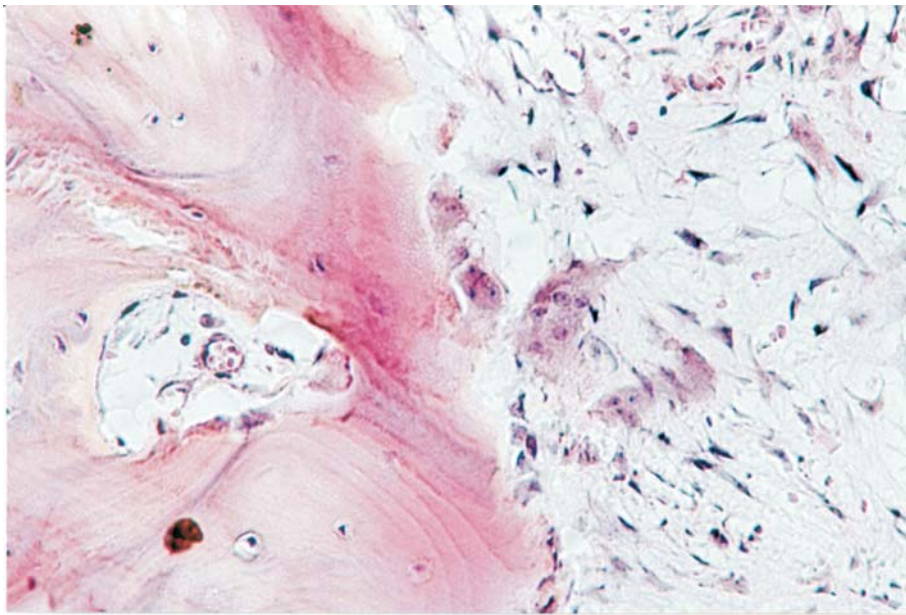


Figure 4 – Osteoclasts in activity: the femoral neck of a woman of 58 years (HE stain,  $\times 200$ )