ORIGINAL PAPER

The utility of histopathologic examination in appreciation of mandibular osteoporotic status

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Abstract

The study was performed on 14 female patients aged between 54 and 83 years, presented for insertion of mandibular implants and diagnosed with systemic osteoporosis on DXA. Radiological examination showed no striking maxillar bone rarefactions or changes in the mandibular cortex form that allows the diagnosis of osteoporosis at the jaw. To obtain informations on the health status of mandibular bone in these patients, we considered it appropriate to do histopathological investigations on fragments of bone harvested from implant insertion area. To this end, fragments of bone harvested when performing the new alveolus were fixed in Stieve mixture, decalcified with trichloroacetic acid and included in paraffin. Five-micrometer thick sections were stained with Goldner's Trichrome method and examined microscopically. Histopathology revealed changes of different intensity in the organic and vascular components of the mandibular bone, in all patients studied, with differences from case to case. Thus, confirming that patients with systemic osteoporosis diagnosed by DXA at the femoral neck and/or the vertebrae have histological changes in the mandibular bone, but the extent of damage is different. Providing detailed information about organic component and bone vascularization, crucial components in the early stages of osseointegration, histopathology is more useful for assessing mandibular osteoporotic status, compared with methods of investigation that aim only the mineral component, mineralization being the final stage of osseointegration. Highlighting mandibular osteoporotic early lesions by histopathological examination allows a patient-specific therapeutic approach and could be an accurate method of assessment for required osseointegration period, depending on the degree of impairment.

***Keywords*:** systemic osteoporosis, maxillary implants, histopathology, mandibular osteoporosis lesions.

Introduction

Osteoporosis (OP), frequently encountered metabolic disorder is a disease of the entire skeleton. It is characterized by low bone mass and deterioration of bone microarchitecture, resulting in the increase in bone fragility and predisposition to fractures [1]. OP is a public health problem because of the risk of fractures in the vertebrae, forearm and pelvis [2]. The way how OP affects maxillary bones and osseointegration of the implants at this level remains a subject of debate. If some authors do not mention osteoporosis as a contraindication for insertion of implants [3, 4] others mention it, having different opinions: some recommend DPA (*Dual Photon Absortiometry*) in generalized secondary osteoporosis [5], others believe that prolonging the time for osseointegration of the implants is enough [6], while others have found that implants placed after sinus lift in patients with osteoporosis had a lower success rate [7]. Also, integration of biomaterials in patients with osteoporosis is affected [8]. Methods for investigation of osteoporosis include: radiological examination, bone scintigraphy, osteodensitometry, bone markers [9], and bone biopsy [10]. In clinical practice, the method used to estimate BMD (*Bone Mineral Density*) in the spine, forearm and femoral head is DXA, which is more accurate, faster and cheaper than other methods [2]. When bone metabolism is affected, implant integration is more difficult, but that does not mean systemic osteoporosis as an absolute contraindication to implant therapy. The most important thing in these patients is to examine bone quality at the implant site [11].

In practice, the investigation of bone quantity and quality in which to place the implant is made by radiological examination (*Dental Panoramic Radiography* – DPR, *Computer Tomography* – CT). DPR allows approximate assessment of bone height, mesiodistal distance and a rough assessment of bone texture [12]. But it allows diagnosis of OP based on signs of impression, increase bone transparency, but for standard radiographs to highlight signs of OP bone mass lost needs to exceed 30–50% [1]. The diagnosis of OP in the maxillary bone can be made with DPR, based on changing of shape and size of the mandibular cortex [13–15], but the more incipient the maxillary osteoporotic damage is [16] and the more advanced the age [17], the more uncertain the diagnosis using these criteria is.

CT allows predictable, but subjective study of bone structure with information about the thickness of cortical bone, thickness and number of bone trabeculae, allowing inclusion of the bone in one of the four bone

densities appreciated in Hounsfield units [12]. This examination does not provide information on the degree of mineralization of the mandibular bone. It does not provide any information about the organic component of the mandibular bone nor on its vasculature.

In addition, for appropriate osseointegration of the implants it is necessary the bone restoration of the necrotic cortical, caused by bone osteotomy needed to achieve the new alveolus. This recovery will depend on the presence of adequate cells, adequate nutrition of these cells and adequate stimulus to these cells suitable for bone restoration [3].

For information on the health of organic and vascular components of the mandibular bone to place implants, we considered it appropriate to make investigations on the histopathology of bone fragments collected from the area where a new alveolus will form.

Material and Methods

This study was conducted on 14 postmenopausal patients aged over 50 years (between 54 and 83-year-old) without hormone substitute, which DEXA showed that osteopenia and osteoporosis, at least one of the sites (L_2–L_4 vertebral, femoral neck, respectively).

Selection of patients was made by DXA T-score resulted from osteoporosis or osteopenia showing at spinal and/or femoral neck. Patients presented total mandibular edentation, all asking implant treatment. DPR were performed to assess osseous offer, bone quality and detect bone changes (erosions presence) in the mandibular cortex.

In order to place the implants, a mucoperiostal incision on the crest was performed, identifying the mandibular arch and after mucoperiostal flap decolation, the hole need for implant was made using a trepan drill at low speed and with increased cooling saline solution close to 0^0C, after which drilling was continued in order to incorporate implant, without cooling with saline solution.

Fragments of bone harvested from the area where new alveolus was created in the studied patients and which not presented aspects of bone rarefaction on panoramic radiographs or changes of mandibular cortex shape were fixed in Stieve mixture for 24 hours, and then the slides were decalcified with 5% trichloroacetic acid solution for five days.

After decalcification, the pieces were washed with alcohol (70^0, 95^0, absolute), clarified with butyl alcohol (*n*-butanol) and included in paraffin.

Five-micrometer thick sections were stained with modified Masson Goldner's Trichrome method and examined under an optical microscope (BX–41 Olympus) to see whether and how exist changes of organic and vascular components of mandibular bones, in patients with systemic osteoporosis diagnosed by DXA at vertebral and femoral level, but without aspects of bone rarefaction on orthopantomography exams.

Results

Radiological examination showed that although patients taken in the study presented osteoporosis/osteopenia on DXA examination, at none is found bone rarefaction on DPR or erosions and changes of the form of mandibular cortex (Figure 1).

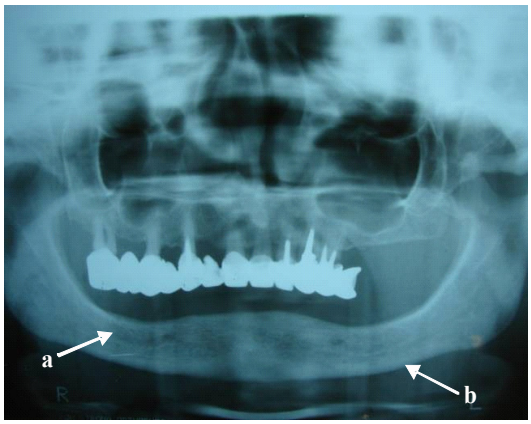

Figure 1 – ***Panoramic radiography of a patient, 60-year-old (DXA -.3.2 vertebral, -1.4 femoral). Edentate arch type 1 is observed, subclass C-I with marked atrophy of mandibular alveolar crest (a), without signs of osteoporosis (b).***

Situation is quite different at histopathological examination of mandibular bone harvested from these patients. For all studied bones, compact component of maxillary bone appears more or less affected, although overall, Haversian systems (osteons) can be assessed as separate entities, in most cases. There are areas in which a small number of osteons present characteristic architecture, i.e. bone lamellae concentrically arranged around the Haversian canal and can be assessed as the number, thickness and arrangement. But also, in case of them, a careful examination shows degenerative changes in one or several of the osteons lamellae. We mention that the number of osteons with discrete changes, incipient, is low, account in majority. In other areas, degenerative processes are more advanced, some osseous lamellae showing bone fragmentation aspects suggested by the apparition of some transverse fissures. Processes of protein degeneration of collagen fibers make that, after a time, contour of osseous lamellae cannot be readily appreciated, because the lamellae initially appear thickened and then present tendency of uniformity (Figure 2).

Protein degeneration progresses until the osseous lamellae of the osteon cannot be distinguished so that, the osteon can be appreciated only by the presence of Haversian canal and some osteoplasts. In some cases, bone necrosis is observed with progressive destruction of osseous lamellae. Necrotic detritus resulted can be observed at bone surface crowded in areas with osseous lysis and also in Haversian canals together with blood vessels with altered structure (Figure 3), or as compact blocks occupying half, most, or even entirely Haversian canal, blocking it. In longitudinal sections it appears that the necrotic detritus occupies Haversian canal on long distances (Figure 4), which shows clearly that such an osteon is compromised, the changes of this stage being irreversible. The aspects described include a large number of osteons and where neighboring osteons are severely affected, micro-fissures may be identified (Figure 5).

Spongy component of the maxillary bone appears also very affected, the changes from here being drastic and more spectacular. Osseous trabeculae are more or less affected. In some cases, the necrosis includes the osseous lamellae, resulting in pronounced thinning of the trabeculae (Figure 6), or even in their fragmentation.

Blood vessels from the spongy component of the maxillary bone present changes ranging from permeability rabblements to marked structural alterations. In case of relatively large caliber vessels, the wall appears thickened areal, and changes at that level are very pronounced in the intima, pronounced in media and moderate in adventitia. In case of small vessels are present changes ranging from alterations of tunic (Figure 7) until thrombus organization, with obliteration of the lumen and total removal of vessel function (Figure 8).

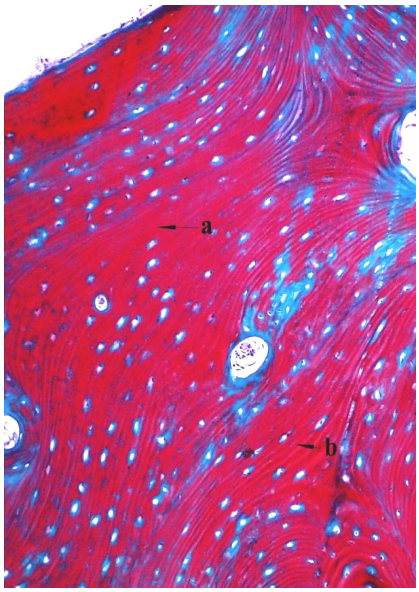

Figure 2 – ***Mandibular cortical: tendency of structural homogenising (a); cancellation of contour of bone lamellae (b) (DXA -2.5 femoral, -1.3 femoral) (Goldner's Trichrome, ob. ×20).***

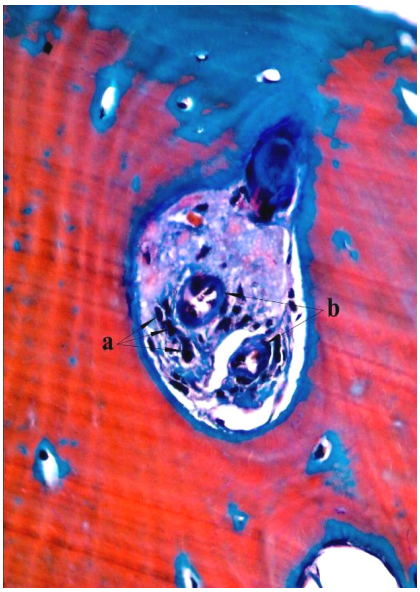

Figure 3 – ***Mandibular cortical– structural homogenising: necrotic detritus in Haversian canal (a) alterations of the vessels from Haversian canal (DXA -3.8 vertebral, -3 femoral) (b) (Goldner's Trichrome, ob. ×40).***

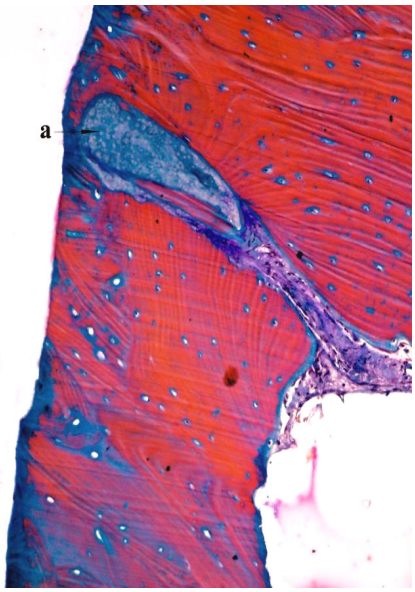

Figure 4 – ***Mandibular cortical: necrotic detritus in the lumen of Haversian canal (a) (DXA -2.5 femoral, -4 vertebral) (Goldner's Trichrome, ob. ×20).***

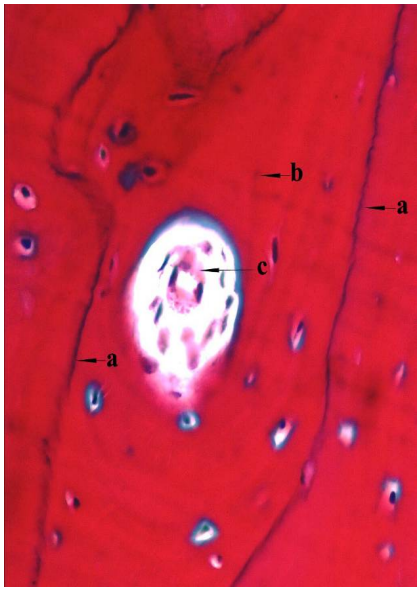

Figure 5 – ***Mandibular cortical: microfissures (a), areal disappearrance of osteoplasts (b), advanced alterations of the vessels from Haversian canal (c) (DXA -2.5 femoral, -4 vertebral) (Goldner's Trichrome, ob. ×40).***

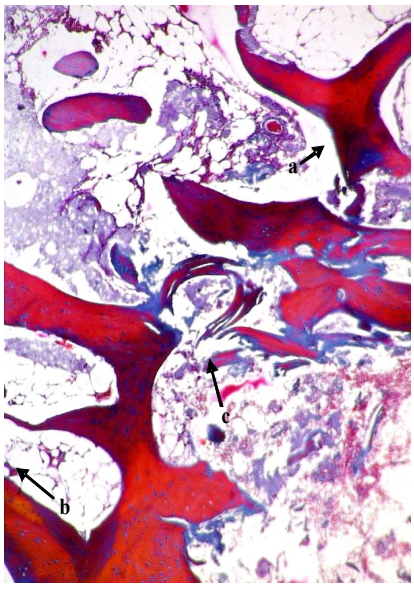

Figure 6 – ***Mandibular spongy: area necrosis (a) thinning of the trabeculae (b) fragmentation of the trabeculae (c) (DXA -1.4 femoral, -3.2 vertebral) (Goldner's Trichrome, ob. ×10).***

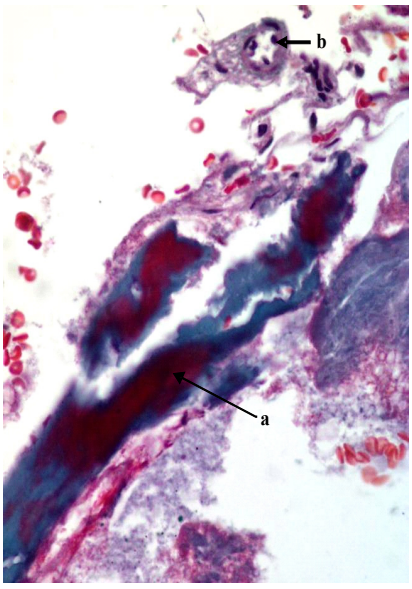

Figure 7 – ***Mandibular spongy: advanced trabecular necrosis (a) alteration of the vessel tunics (b) (DXA -2.7 femoral, -2.4 vertebral) (Goldner's Trichrome, ob. ×20).***

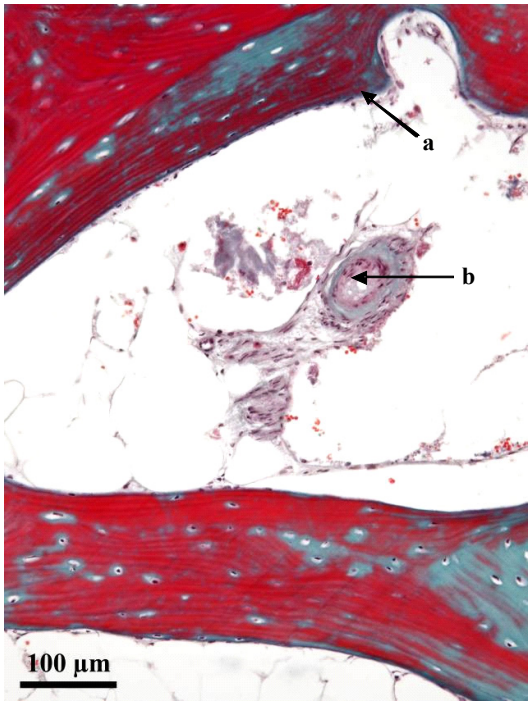

Figure 8 – ***Mandibular spongy: superficial necrosis (a) vascular thrombosis (b) (DXA -2.5 femoral; -21.8 vertebral) (Goldner's Trichrome, ob. ×20).***

Discussion

Changes pointed out after histopathological examinations of the blood vessels, cortical and spongy of mandibula, indicate that patients with osteoporosis detected by DXA at the femoral neck and/or the vertebrae level, present osteoporosis also at the level of mandibular bone, even if this thing not always can be assessed on panoramic radiographs. Apparently normal appearance of the mandibular bone on radiographs in patients with osteoporosis diagnosed by DXA at vertebral and hip level in the study, suggests that bone degenerative processes evolve differently, at least as decoiling speed. Correlation between bone mineral density in different parts of the body, such as the femoral neck, vertebrae, forearm, detected by DXA, is not precise enough to assess that these changes affects also the maxillary bones [18–20], while other authors have different opinions [21, 22]. Degree of damage of the organic component of the mandibular bone is very different from one patient to another and even from the same patient, from one area to another. Comparative analysis of the results of histological examinations of bone samples, show that, most often, affection of the bone is even greater as the skeletal DXA has increased T score values. This means, that there is a relationship between bone damage at skeletal level and mandibular damage, although the degree of bone damage is often different. That these changes may not always be appreciated by radiologic examination, constitutes a major disadvantage in accurately assess of the chances of success for implants osseointegration and especially in determining the period necessary for osseointegration.

DPR is very useful in diagnosing of injuries of teeth and maxillary bones, but allows the diagnosis of osteopororosis only within certain limits, both at maxillary level and at the skeletal level, based on erosion of the mandibular cortex and its width, method being even more imprecise as the cortex is less eroded [16]. Evaluation of bone metabolism should be an important concern to all patients who require implant treatments or techniques of bone augmentation [23]. Bone-implant contact distinguished at bone histomorphometry of compromised implants (due to mechanical causes, etc.), and removed with a trepan drill is about the same in patients with OP (dignosed after their insertion) compared with patients without OP (diagnosed anamnestic). So, OP itself cannot be considered as an absolute contraindication, but a relative one in case of oral rehabilitation with dental implants [24, 25]. Affection of small vessels from Haversian canals, widely influence the decoiling of bone metabolism, necrotic processes being often the consequence of a poor vascularization. Synthesis of new bone lamellae depends widely by a proper decoiling of bone metabolism, an efficient vascularization being vital for these processes. Any deficiencies in this direction affect bone synthesis, with extension of the period required by implants osseointegration. To shorten the period required by implants osseointegration in patients with bone disorders, some authors recommend the use of some stimulant preparations containing growth factors, especially that, the osteogenic activity is lower after 50 years [26]. One of the most modern methods is use of the PRGF (*Plasma Rich in Growth Factors*) [12].

Growth factors are present in both platelets and the bone, acting as signaling proteins [27]. After activating the PRGF, growth factors are released by platelets and have a very important role in revascularization and bone formation by inducing osteogenesis and proliferative effect of endothelial and osteoprogenitor cells. In the same purpose, it proposes drilling without cooling at speeds between 20–80 rotations per minute [28], because intense cooling with saline or pyrogen-free water wash "signaling proteins" with active role in bone regeneration [29]. Mineralization of newly formed bone is the last step and ensures consolidation of the area around the implant. Given that radiography may not always offer complete informations about the health of mandibular bone in patients with osteoporosis, histopathologic examination of bone harvested from implant insertion area can provide useful information, even in some patients presenting incipient lesions. In addition, fragments of bone is removed to create a new alveolus anyhow, and histopathology is not very difficult or complicated, good results could be obtained, with the techniques described by more than a century ago (Hematoxylin–Eosin, 1875) which were slightly modified [30]. Good used, histopatologic technique cannot be replaced in routine diagnosis, even by electron microscopy. This aspect is supported by Cook HC (1993), which states that although can not be denied enormous contribution

of electron microscopy to understanding ultrastructure of normal tissue, its contribution in the routine diagnosis proved to be disappointing. Informations obtained by histopathological examination, could allow proper assessment of the period required for osseointegration, depending on the degree of affection. In this direction, extensive researches for standardization of results are needed. It is clear that patients with osteoporosis represent a biologically labile group that requires special therapeutic management, when implants are applied. Thus, histopathology could give valuable informations on the need to prolong the period of osseointegration of implants recommended by some authors in patients diagnosed with OP, depending on the degree of affection.

Conclusions

X-ray examination of mandibular bone in patients with osteoporosis detected with DXA at the femoral neck and/or the vertebrae did not provide sufficient information to assess the extent of damage to the jaw bone.

Patients with systemic osteopororosis detected by DXA at skeletal level (vertebrae, femoral neck) present histological changes of mandibular bone with varying degrees of damage depending by value of T-score.

Unlike other techniques of investigation of the mandibular bone mineral component, histopathology provides the advantage that offers detailed informations about the organic component and bone vascularization, crucial components in the incipient stages of osseointegration, mineralization being only the final stage.

Utility of histological examination in assessing of mandibular osteoporotic status is supported also by the fact that it mentions even incipient lesions, allowing a specific therapeutic approach for each patient and a correct appreciation of the period needed for osseointegration, depending on the degree of affection.

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