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Human Histologic Evaluation of a Six-year-old Threaded Implant Retrieved from a Subject with Osteoporosis

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Abstract

Aim: The aim of this case report was to present the evaluation of the bone-to-implant contact in an implant retrieved from a subject with osteoporosis after six years of load.

Background: Systemic conditions associated with osteoporosis have been postulated to contribute to the severity of alveolar bone loss. The increase in human life expectancy, the increased number of elderly subjects who are partially or totally edentulous, and the use of dental implants for oral habilitation in subjects with osteoporosis has raised several questions.

Report: A 68-year-old woman with postmenopausal osteoporosis received a prosthetic evaluation of an implant-supported restoration. Histologically, the peri-implant bone appeared healthy. The peri-implant bone appeared in close contact with the implant surface, whereas marrow spaces could be detected in other areas along with prominently stained cement lines. The mean of bone-to-implant contact was 62.51$\pm$1.96.

Conclusion: The results of the evaluation of the dental implant reported here suggest the presence of osteoporosis may not be a contra-indication for implant placement at least after osseointegration has already been established.

Keywords: implants, osteoporosis, human histology, retrieved implants

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Introduction

Osteoporosis is a metabolic bone disease characterized by low bone mineral density, deterioration of the microarchitecture of cancellous bone, and changes in the material properties of bone leading to bone fragility and, consequently, increase in the risk of fracture.[1] Osteoporosis is classified as follows:

A. Primary

1. Type 1 - postmenopausal osteoporosis
2. Type 2 - age-associated osteoporosis
3. Idiopathic - which can affect juveniles, pre-menopausal women, and middle-aged men

B. Secondary osteoporosis - resulting from an identifiable cause of bone mass loss.

The increase in human life expectancy, the increased number of elderly subjects who are partially or totally edentulous, and the use of dental implants for oral habilitation in subjects with osteoporosis has raised several questions.[2-5]

Since the changes in bone tissue metabolism that may occur in the jaw bones seem to be the same as those detected in the long bones such as the neck of the femur and forearm (radius and ulna) in both human[6] and animal studies,[7] osteoporosis can represent either a contraindication or a risk factor for osseointegration.[8] However, the relationship of bone mineral density in the lumbar spine or femur neck does not necessary imply the simultaneous presence of the same status in the bone of the jaws.[2,9]

On the other hand, several animal studies have described the influence of osteoporosis on the osseointegration process,[10-12] mainly in trabecular bone volume. In a series of studies Duarte et al.[11,12] attempted to create a simulated condition of osteoporosis in an elderly female population that received or would receive dental implants. The authors evaluated not only the influence of estrogen deficiency but also the estrogen therapy on bone-to-implant contact and bone density in implants inserted in the tibiae of rats with ovariectomy or sham surgeries. They showed estrogen deficiency may jeopardize bone healing around dental implants, while estrogen therapy may actually prevent the peri-implant bone loss. Therefore, as osteoporosis may represent a contraindication or a risk factor for osseointegration, the aim of this case report was to evaluate the bone-to-implant contact in an implant retrieved from a subject with osteoporosis after six years load. Since osteoporosis may represent either a contraindication or a risk factor for osseointegration the aim of this case report is to present the evaluation of the bone-to-implant contact in a six-year-old implant retrieved from a subject with osteoporosis.

Case Report

The Subject

A 68-year-old woman with postmenopausal osteoporosis determined by DPX-IQ AP in the lumbar spine and femoral neck (Figure 1) was referred for prosthetic evaluation of an implant-supported restoration. The diagnosis of osteoporosis was established based on criteria employed by the World Health Organization (WHO) which is a bone density (or bone mass) at least 2.5 standard deviations below peak bone mass. Standard deviation from the mean peak bone mass is termed the T score. Therefore, a T score of the lumbar spine of at least 2.5 standard deviations below the norm constitutes a condition of osteoporosis.

The patient was referred for a clinical evaluation of a dental implant-supported fixed partial prosthesis in the area of the mandibular first molar. The patient reported the placement of the machined implant and fixed prosthesis six years previously. The radiographic evaluation revealed a high level of bone loss around the implant (Figure 2). The decision was made to remove the implant due to an inadequate restoration design and presence of the cantilevered prosthesis.

Histologic and Histomorphometric Evaluation

The implant was removed using an internal 4.25 mm wide trephine. The implant together with surrounding bone tissue was immediately stored in 10% buffered formalin and processed to obtain thin ground sections using the Precise 1 Automated System (Assing, Rome, Italy). The specimen was dehydrated in an ascending series of alcohol rinses and embedded in a glycol

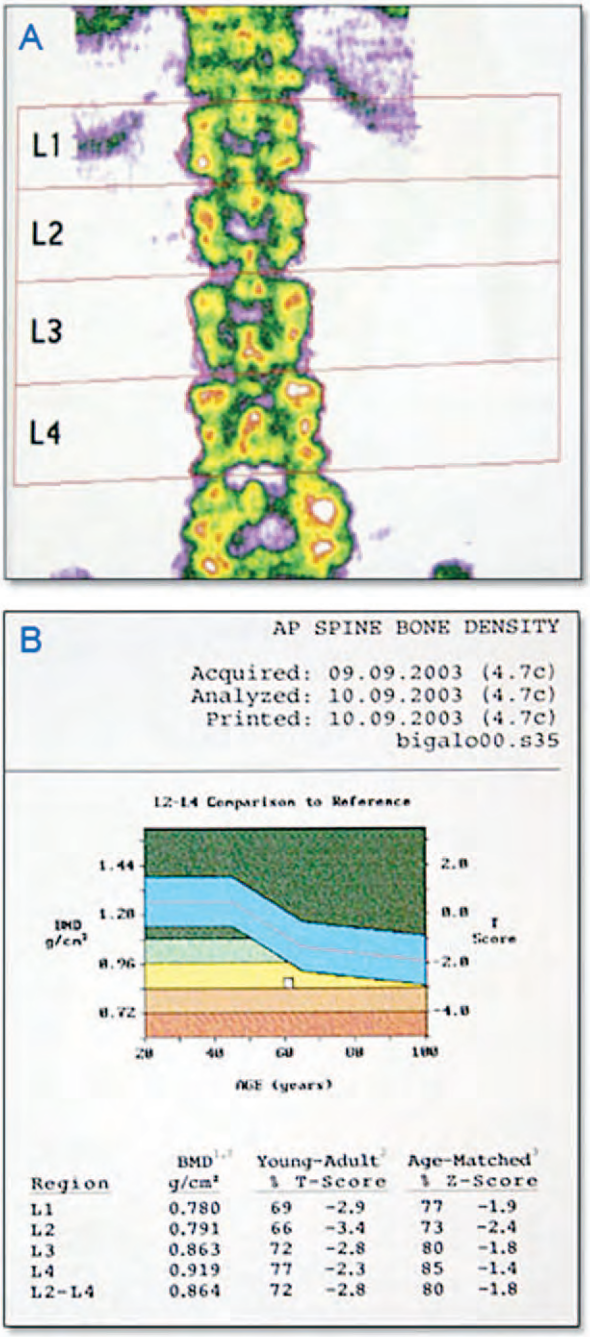

Figure 1. A. Determination of osteoporosis in the patient by means of DPX-IQ AP in the lumbar spine according to the spine bone density reference shown in **B**.

methacrylate resin (Technovit® 7200 VLC, Kulzer, Wehrheim, Germany). After polymerization, the specimen was sectioned longitudinally along the major axis of the implant with a high-precision diamond disk at about 150 μm and ground down to approximately 30 μm. Three slides were obtained for this implant.

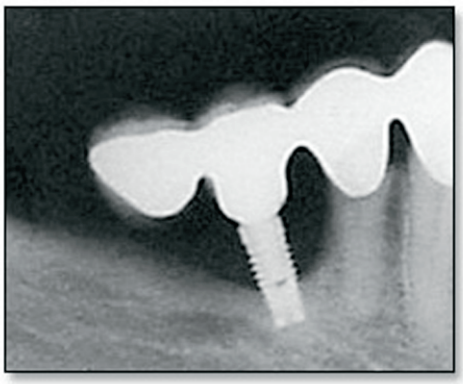

Figure 2. Radiographic aspect of the peri-implant bone loss.

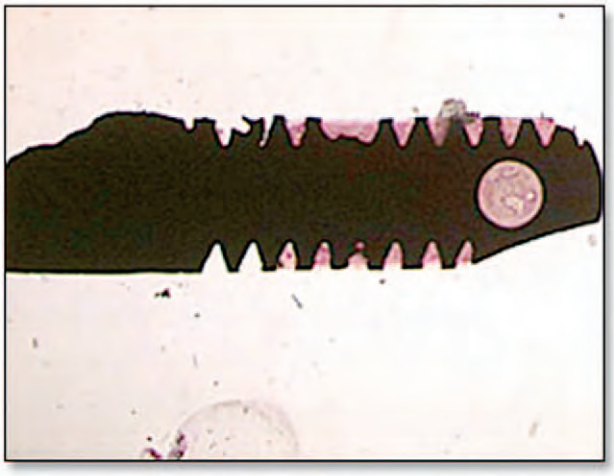

Figure 3. Ground section of the retrieved implant with remaining pristine bone along the implant surface. (Acid fuchsin and toluidine blue, original magnification x20).

The slides were stained with basic fuchsin and toluidine blue. Histomorphometry of bone-implant contact percentage was performed using a Laborlux S® light microscope (Leitz, Wetzlar, Germany) connected to a 3CCD® high-resolution video camera (JVC KY-F55B, Milan, Italy) and interfaced to a monitor and personal computer (Intel Pentium III 1200 MMX). This optical system was associated with a digitizing pad (Matrix Vision GmbH, Milan, Italy) and Image-Pro Plus® 4.5 histometry software package with image-capturing capabilities (Media Cybernetics Inc., Immagini & Computer Snc, Milan, Italy).

Histologically, the peri-implant bone appeared healthy (Figure 3). The bone tissue was mostly compact, and several osteocytes were present in their lacunae either in pristine or in the newly formed bone.

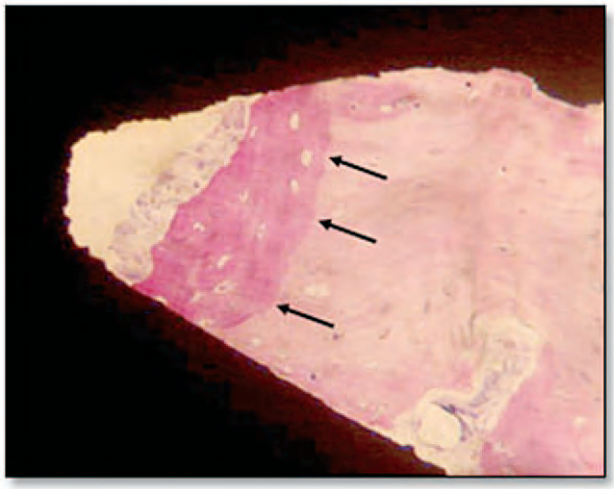

Figure 4. Cement lines suggesting bone remodelation (arrows). (Acid fuchsin and toluidine blue, original magnification x100).

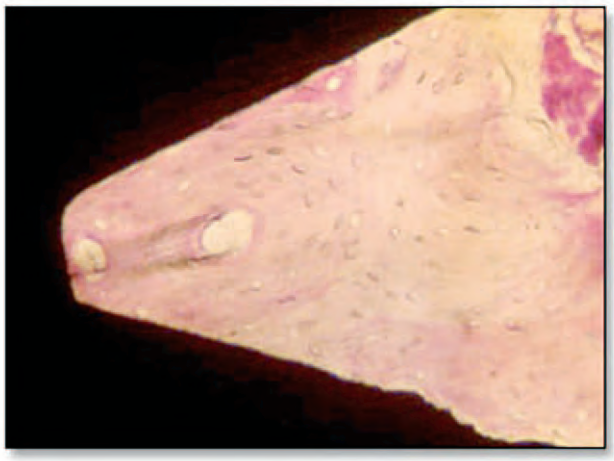

Figure 5. Bone tissue in direct contact with implant surface. (Acid fuchsin and toluidine blue, original magnification x100).

The peri-implant bone appeared to be in close contact with the implant surface, whereas marrow spaces could be detected in other areas along with prominently stained cement lines. Osteocytes could be detected in newly formed peri-implant bone indicating ongoing bone formation. Minor apposition of new bone at the implant surface could be found inside the implant threads. No foreign body reaction was found at the bone-to-implant contact. The bone-to-implant contact presents a mean of 62.51±1.96 (Figures 4 and 5).

Discussion

Implant-supported prostheses placed in the jawbones are affected by systemic factors in addition to several local factors such as the periodontal conditions of the remaining teeth, number and distribution of dental implants in the arch as well as the occlusion and bite forces. Although several studies relate the role of local and systemic factors in the long-term success of dental implants, less is known concerning factors affecting the stability of oral implants after abutment placement process and an occlusal load is applied.[13] However, the role of endogenous factors on cellular turnover and differentiation is even less well documented.[3]

Systemic conditions associated with osteoporosis have been postulated to contribute to the severity of alveolar bone loss.[14] The contraindication for dental implant placement in subjects with osteoporosis is based on the assumption osteoporosis may affect the human jaws in the same way it affects other parts of the skeleton. However, there may be some differences in bone healing and remodeling between the long bones and the jawbones after dental implant placement,[3,10] and to date there is a lack of conclusive studies to support an absolute contraindication for the placement of dental implants in patients with osteoporosis. Several studies have suggested osteoporosis is not a risk factor for osseointegration of oral implants, although osteoporosis is now regarded as a relative contraindication for dental implant placement.[2,4,8,15,16] Accordingly some authors,[16,17] based on several lines of evidence from human[4,17] and animal studies,[10-12] have proposed a unitary model for the pathophysiology of involutional osteoporosis due to estrogen deficiency as being responsible for the bone loss in both postmenopausal women and aging men.

In subjects with osteoporosis the decrease in net bone volume as well as the reduced ability to withstand an optimal occlusal load may be affected by a combination of modulated cellular activities influenced by lower levels of estrogen in post-menopausal osteoporosis.[10] In addition, the bone-to-implant integration gradually increases, and once it is established the accumulated rate of bone attachment to implants is maintained. Unlike regular bone remodeling occurring in the trabecular area, this phenomenon is not accompanied by the apparent turnover or resorption of bone.[18]

In the present case it was possible to evaluate the bone-to-implant contact in a patient classified as Type 1 osteoporosis according to criteria established by the WHO based on T-scores of <2.5 standard deviations. It is important to note the diagnosis of osteoporosis was made, according to the patient's anamnesis, after implant placement. The histomorphometric evaluation presented a considerable percentage of bone-to-implant contact and a healthy peri-implant bone.

In some clinical investigations factors such as gender and age of the subjects were not correlated with long-term failures.[2,16,19] This may suggest once bone-to-implant integration is established in these subjects there may not be a significant number of clinical failures.[4] In addition, the presence of the dental implant may create a distinct and unique cellular environment and a scaffold for bone marrow osteogenic cells to form new bone tissue mainly in the earlier stages depending on the microstructure of the implant surface topography,[20] the number of years the implant is subjected to an occlusal load, and the magnitude of occlusal force applied.

Conclusion

The results of the implant evaluation in the present case report suggest osteoporosis may not constitute a contraindication for implant placement. However, further studies are needed to elucidate these findings using a larger sample size of subjects with disorders such as postmenopausal and/or senile osteoporosis.

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