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Immediately loaded screw implant retrieved after a 12-year loading period: a histologic and histomorphometric case report

ABSTRACT

Background Immediate loading of dental implants has shown promising results in man and experimental animals. It offers patients several advantages in terms of treatment cost and convenience, and eliminates the functional and psychological problems connected to dentures. The aim of the present study was the histological evaluation of the peri-implant tissues of a one-piece immediately loaded screw implant retrieved from a patient after a 12-year loading period.

Conclusion Mineralized tissue was present at the interface of the implant. Bone-to-implant contact was 75% ±4%. The histological data showed that osseointegration was obtained in an immediately loaded one-piece screw implant inserted into the maxilla and that this osseointegration was successfully maintained over a long period (12 years). The bone response was not disturbed by stresses and strains transmitted at the interface under functional loading.

Keywords Bone-implant interface, immediately loaded implant, retrieved implant.

INTRODUCTION

A 3-6 month healing period has traditionally been believed to be necessary to achieve mineralized tissues at the bone-implant interface. Immediate loading of dental implants has shown promising clinical results in man and experimental animals (1-19). It offers patients advantages in terms of treatment cost and convenience, and eliminates the functional and psychological problems created by wearing dentures.

Very high survival and success rates have been reported in immediately loaded implants, and this can be assigned in part to the characteristics of the implant surfaces (12-15). Occlusal force transmission patterns vary and a simple transposition of healing patterns from animal to man is not warranted and should be avoided; moreover, it cannot be assumed beforehand that immediately loaded implants will have identical bone healing and bone-implant interfaces (2,18). Histological evidence of osseointegration in clinically successful osseointegrated implants is very rare in the literature (20).

As far as osseointegration is concerned, retrieved implants are indispensable for

long-term evaluation of implants subjected to functional loading (20).
The aim of the present study was the histological evaluation of the peri-implant tissues of a one-piece immediately loaded screw implant retrieved from a patient after 12 years of loading.

CASE REPORT

A 42-year-old female patient presented with an advanced periodontal disease. The patient was a heavy smoker.
The radiographic examination showed that only a few periodontally involved teeth were present in the maxilla, where there was also a single standing screw implant (Fig. 1). This implant had been inserted 12 years before, and had been loaded the same day with a resin crown in occlusal contact; after 3 months a definitive prosthesis had been inserted.
The implant had functioned well for 12 years, was stable, and exhibited no peri-implant radiolucencies or crestal bone resorption. The peri-implant soft tissues appeared to be healthy and no pain arose upon percussion.
Since the patient wanted to have an implant-supported overdenture in the maxilla, it was decided to retrieve the implant with a 4 mm trephine bur. Upon removal, mineralized tissue appeared to be attached to the implant surface.

Processing of specimens

The implant and the surrounding tissues were stored immediately in 10% buffered formalin and processed to obtain thin ground sections with the Precise 1 Automated System (Assing, Rome, Italy) (21). The specimen was dehydrated in an ascending series of alcohol rinses and embedded in a glycolmethacrylate 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 disc at about 150 µm and ground down to about 30 µm.

Fig. 1 Panoramic radiography shows the screw-shaped implant and some hopeless teeth located in the maxilla.

Three slides were obtained; these were stained with basic fuchsin and toluidine blue. A double staining with von Kossa and acid fuchsin was done to evaluate the degree of bone mineralization, and one slide, after polishing, was immersed in AgNO3 for 30 minutes, and exposed to sunlight; the slides were then washed under tap water, dried and immersed in basic fuchsin for five minutes, and then washed and mounted.
Histomorphometry of bone-implant contact percentage was carried out using a light microscope (Laborlux S, Leitz, Wetzlar, Germany) connected to a high resolution videocamera (3CCD, JVC KY-F55B) and interfaced to a monitor and PC (Intel Pentium III 1200 MMX). This optical system was associated with a digitizing pad (Matrix Vision GmbH) and a histometry software package with image capturing capabilities (Image-Pro Plus 4.5, Media Cybernetics Inc., Immagini & Computer Snc Milano, Italy).

RESULTS

Radiographic analysis

The coronal 3 mm consisted of peri-implant soft tissues (pluristratified epithelium and connective tissue); in these tissues no acute or chronic inflammatory infiltrate was present. Bone resorption was present in the most coronal portion of the implant above the first thread (Fig. 2, 3). Few osteoclasts were actively resorbing bone. In this area there was a complete absence of osteoblasts (Fig. 4, 5). Only few small diameter capillaries were present.

Below the first thread and until the apex of the implant it was possible to see mineralized tissue at the interface of the implant. Bone to implant contact was 75% +/- 4% (Fig. 2).

All the peri-implant bone was analyzed

Fig. 2 Lamellar bone with many osteons near and in contact with the implant surface. Acid fuchsin and toluidine blue 12X.

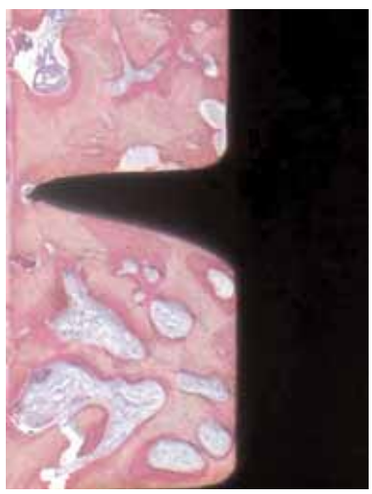

Fig. 3 No gaps or soft tissues are found at the bone-metal interface. Acid fuchsin and toluidine blue 50X.

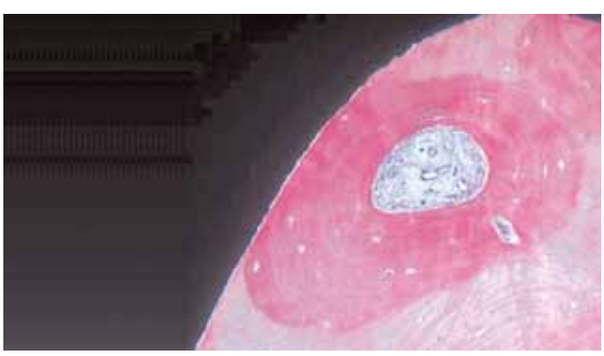

Fig. 4 An osteon is found in direct contact with the implant surface.
Acid fuchsin and toluidine blue 100X.

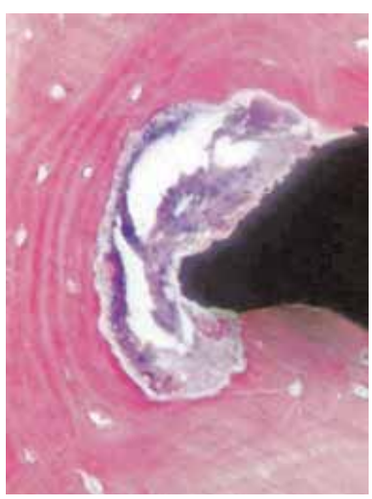

Fig. 5 An osteon with osteocytes around a thread.
About 4 - 20 bone lamellae have been laid down in concentric rings around the threads. Acid fuchsin and toluidine blue 200X.

under polarized light microscopy: 50% consisted of lamellar bone with well-defined osteonic structures and some of these osteons were in close contact with the implant surface. Woven bone constituted 20%; this bone was characterized by a strong affinity for acid fuchsin and wide osteocyte lacunae (Fig. 2). Marrow spaces constituted 30%. In the areas of remodelling bone it was possible to observe bone remodelling units with vessels, osteoblasts and osteoclasts. Lamellar and woven bone were separated by a well-defined irregular cement line (Fig. 6, 7, 8). Small marrow spaces or small resorption lacunae were located at the tips of all the threads. The bone surrounding these lacunae presented a strong affinity for the dyes, wide osteocytic lacunae and it appeared to be undergoing remodelling (Fig. 8). In this area, bone lamellae were organized in a concentric way around the point of the thread. No gaps or fibrous tissue were present at the interface (Fig. 4). Some of the marrow spaces abutted on the implant surface and some of the Haversian systems were in direct contact with the implant surface. No inflammatory infiltrate was present. No epithelial downgrowth was present.

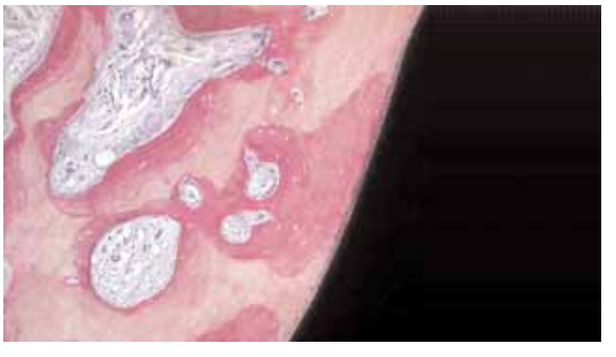

Fig. 6 Bone remodeling activity is found near the implant. Acid fuchsin and toluidine blue 50X.

Fig. 7 An osteoclast and remodelling bone are found near the implant. Acid fuchsin and toluidine blue 50X.

DISCUSSION

Immediately loaded implants have shown a clinical long-term predictability similar to that of conventionally loaded implants. Immediate loading shortens the total rehabilitation time with increased patient satisfaction and the avoidance of delays in the final rehabilitation with the accompanying difficulty of wearing a conventional denture during the healing phase.

Only rarely the histology of human retrieved immediately loaded implants have been reported in the literature (2, 4-8, 22). Even more rarely it is possible to find histological reports in the literature about immediately loaded implants with a long-

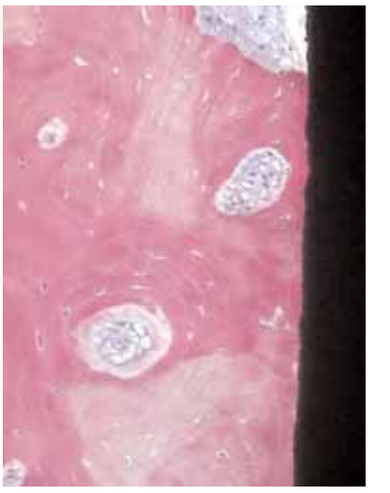

Fig. 8 The bone around the titanium is a woven bone with large osteocyte lacunae. Acid fuchsin and toluidine blue 100X.

term follow-up (23-26).

The present histological data show that osseointegration was obtained in an immediately loaded one-piece screw implant inserted into the maxilla, and that this osseointegration was successfully maintained over the long period (12 years). The bone response was not disturbed by the stresses and strains transmitted at the interface under clinical loading conditions, and mineralized tissues were present at the bone-implant interface.

In blade implants retrieved after 13 and 21 years of function, other researchers found mature bone in tight contact around most of the implant surface. Rigid splinting of immediately loaded implants has been advocated to decrease the amount of micromotion during the healing phase as critical for success.

In the present case, single-standing implant's high primary stability was a key factor in its long-term success. This stability to resist micromotion, i.e. the relative movements between the implant surface and surrounding bone during functional loading, was probably obtained by the large threads of the screw-shaped implant. An appropriate thread design makes a significant contribution to the initial stability of the implant during placement (17). Moreover, the closeness of initial fit and the percentage of implant surface in direct contact with bone influences the implant's capability to withstand functional loads in early healing situations.

These histological results could be explained by the fact that functional loading appears to stimulate bone apposition (27-30). Wolff's law (27-30) states that there is a direct link between mechanical loading and bone morphology and that increased stresses act as a stimulus to new bone formation while reduced stress tend to produce bone loss.

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