Evaluation Study

A HISTOLOGIC EVALUATION OF FAILED DENTAL IMPLANTS FOR OVERLOADING

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ABSTRACT

Osseointegrated implants have shown excellent clinical results, demonstrating their effectiveness in various medical applications. However, it is important to note that about 3-10% of these implants fail within a 10-year period. This highlights the need to understand the histologic response to reduce the incidence of implant loss over time. The aim of the present study was a histological analysis of the features of the tissues surrounding implant-failed titanium implants to try to understand the causal determinants. Dental titanium screw-shaped implants were removed for mobility. The implant had been placed in the jaw three months earlier. The implant was retrieved with a trephine. In the most coronal and apical parts of the implants, no mineralized tissues were present in contact with the dental implant. At low magnification, bone was observed at 200µ distance to the implant. In conclusion, the histological aspect of the dental implant suggests that overload may be the most likely cause of failure in the present case. However, we cannot be certain that it is the only possible cause in every case.

KEYWORDS: *bone physiology, bone overheating, implant failure, dental implants*

INTRODUCTION

Osseointegrated implants have shown excellent clinical results, demonstrating their effectiveness in various medical applications. However, it is important to note that about 3-10% of these implants fail within a 10-year period (1). This highlights the need to understand the histologic response to reduce the incidence of implant loss over time.

It is critical to investigate the factors that contribute to implant failure. With a deeper understanding of these causes, we can improve the clinical performance and longevity of osseointegrated implants. This research is essential for developing strategies to minimize implant loss and improve implant survival. The placement of an implant invariably triggers an inflammatory response due to the surgical trauma involved. This initial inflammation is a natural part of the bone healing process, aimed at protecting the affected area and beginning bone repair. Nevertheless, managing this response effectively is important to ensure successful osseointegration and long-term stability of the implant. The persistence or reduction of a reaction to an implant is influenced by several factors, including the material used, the implantation site, and the mechanical

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loads applied. When a dental implant is inserted into bone tissues, an equilibrium must be established. This balance is crucial as the interactions between the implant and the surrounding tissues will dictate the subsequent development of these tissues around the biomaterial. In essence, these interactions determine the type of tissue, bone or fibrotic tissue, that will form around an implant.

The material of the implant plays a pivotal role in this process. Biocompatible materials like titanium are generally more favorable as they elicit a less severe immune response. Also, atraumatic surgery plays a crucial role in this process. The implantation site is also important; areas with rich blood supply and robust tissue structures are more likely to support healing. Additionally, the loads or stresses on the implant can affect its stability and the body's response, especially in the first healing phase. In the mandible, the most commonly observed bone type associated with implant failures is Type I bone (2). In jaws with high bone density, the overheating of the surgical site due to inadequate irrigation or blockage of the bur's internal irrigation by bone chips may determine a failure during healing (3). The importance of meticulously managing frictional heat through precise surgical techniques with the new drills has been emphasized (4). The aim of the present study was a histological analysis of the features of the tissues surrounding the failed titanium implant to try to understand the causal determinants.

MATERIALS AND METHODS

Dental titanium screw-shaped implants were removed for mobility. The implant had been placed in the jaw three months earlier. The implant was retrieved with a trephine. After removal, the specimen was immediately fixed in neutral buffered formalin to preserve its structure and prevent degradation. This fixation process is crucial for maintaining the integrity of the tissues for further analysis. The specimens were then processed using the "Precise 1 Automated System" (Assing, Montesilvano, Italy), which ensures precise sectioning of the sample.

Following fixation, the specimens underwent dehydration through a series of alcohol rinses. This step gradually removes water from the tissues, preparing them for embedding. The dehydrated specimens were then embedded in glycolmethacrylate resin. This resin provides a stable medium that supports the tissue structure during sectioning.

The embedded specimens were sectioned using a high-precision diamond disc, initially cut to a thickness of approximately 150 µm. These sections were then ground down to about 30 µm, creating thin slices suitable for microscopic examination. Three sections were cut for implant in a way parallel to the major axis. The microscope was equipped with a video camera, which was used to capture detailed images of the slides. These images are essential for documenting the findings and for further analysis.

RESULTS

After staining, the slides were examined under normal transmitted light using a Nikon microscope. This microscopy technique allows light to pass through the specimen, providing a clear view of the stained tissues.

In the most coronal and apical parts of the implants, no mineralized tissues were present in contact with the dental implant. At low magnification, bone was observed at 200µ distance to the implant (Fig. 1). At higher magnification, no osteoblasts were visible around the dental implant. No bacteria were observed (Fig. 2). No necrotic bone or partially demineralized was present. No pathological infiltration cells were observed in soft tissues.

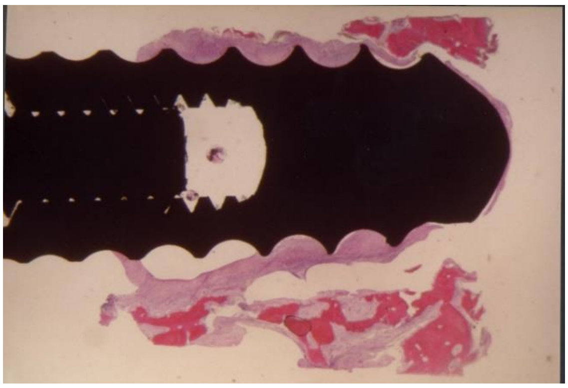

Fig. 1. *No mineralized tissues were present in contact with the implant. At low magnification, bone was observed at 200µ distance to the implant. At higher magnification, no osteoblasts were visible around dental implant. No bacterial was observed. Blue di toluidine and acid fuschin12x.*

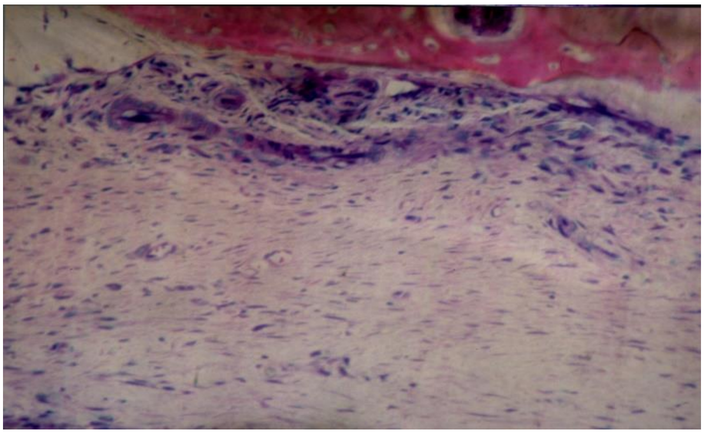

Fig. 2. *No bone necrosis was observed. Blue di toluidine and acid fuschin12x.*

DISCUSSION

Implant failure is a multifaceted issue influenced by various factors, including patient health, surgical technique, and implant characteristics (5). Common causes include lack of primary stability, poor bone quality, surgical trauma, and infection (6, 7). Specific risk factors identified include using proton pump inhibitors (PPIs), which may disrupt osseointegration (8). Early implant failure occurs before the prosthesis is delivered or within the first year of loading, often due to issues with osseointegration or surgical trauma (9). Late implant failure, occurring after one year of loading, is frequently associated with occlusal overload and biomechanical factors (10).

Research has shown that early failures are more common in the maxilla due to lower bone density, while late failures are linked to factors such as excessive loading and poor implant design. Patient health significantly impacts implant success. Conditions such as diabetes, osteoporosis, and chronic periodontitis increase the risk of implant failure (11). Smoking is another critical factor, with smokers exhibiting higher rates of marginal bone loss and implant failure compared to non-smokers (12). Additionally, a history of failed endodontic treatment at the implant site has been associated with higher failure rates (13). Also, the location of the implant plays an important role in its success. Bone quality and volume at the implant site are critical determinants of implant stability and success. Implants placed in the maxilla, particularly the anterior region, have higher failure rates due to lower bone density compared to the mandible (9). Treated implant surfaces have been shown to reduce failure rates compared to machined implants, likely due to improved osseointegration (14).

In our case, we observed soft tissue around the dental implant without pathological infiltration of inflammatory cells. This histological aspect may be due to:

a) a premature loading of the implant;
b) an apical migration of epithelium;
c) too much torque during implant placement;
d) a gap between the implant and bone site.

According to Chatzopoulos et al. (13), the major cause of implant failures is biomechanical overloading. Overloading is an important cause of implant failure (15), and research affirms that failure to obtain a tight bone-implant contact may be related to the use of unsuitable materials, traumatic surgery, and too-early implant loading. An important factor in avoiding bone overheating and dental failure is the use of minimally traumatic surgery with a careful surgical protocol and copious saline irrigation during drilling. It has been described that a 47°C exposure for 1 minute is sufficient to cause bone necrosis and that the temperature of no return for bone is around 60°C for 1 minute.

CONCLUSIONS

In conclusion, the histological aspect of the dental implant suggests that overload may be the most likely cause of failure in the present case. However, we cannot be certain that it is the only possible cause in every case. This is evidenced by the absence of necrotic bone, resorption lacunae, and the absence of osteocytes, presence of soft tissues, which indicate excessive stress on the implant. However, it is important to acknowledge that other factors could also contribute to implant failure. These may include biological factors such as infection, improper surgical technique, or patient-specific conditions like poor bone quality or systemic health issues. Therefore, while overload appears to be the most probable cause, it is essential to consider a comprehensive evaluation of each case to identify all potential contributing factors to ensure successful implant outcomes.

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