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Histology of a dental implant with a platform switched implant-abutment connection

ABSTRACT

Background Peri-implant crestal bone must be stable for aesthetic reasons. Aim of this study was a histologic analysis of an implant with a platform switched implant-abutment connection. A 32-year-old male patient participated in this study. The patient needed a bilateral mandibular restoration. Four implants were used, and were immediately restored and loaded the same day of insertion. After a 6 weeks healing period, one implant with platform-switched abutment was retrieved with trephine. Before retrieval the implant was osseointegrated and not mobile. On one side of the implant, a 1 mm resorption of the crestal bone was present. On the contrary, on the other side no bone resorption had occurred and about 1 mm of bone was present over the implant shoulder. The bone-implant contact percentage was 65.1 ± 6.3 %. Platform-switching could help in maintaining the height of the peri-implant crestal bone.

KEY WORDS Crestal bone remodelling; Histology; Immediate loading; Microgap; Platform switching; Retrieved dental implants.

INTRODUCTION

The crestal bone level changes, frequently observed at dental implants, after exposure to the oral environment have become a topic of growing interest. The etiology of this peri-implant crestal bone resorption is still unknown, even if several causes have been proposed: surgical trauma, peri-implantitis, occlusal overload, formation of a biological width, macroscopic and microscopic characteristics of the neck of the implant, implant-abutment interface design, bacterial infiltration of the microgap, position of the microgap (1). Increasing esthetic demands require, frequently, a subgingival placement of restoration margins (2). The more apical positioning has, however, been associated with an increased crestal resorption of the alveolar bone (2). It has been shown that a crestal bone loss of about 2 mm occurs in the submerged 2-piece approach, dependent on the location of the microgap in relation to the bone crest (3).
This gap has been a matter of intense investigation and research in the past two decades (4-10). Less bone loss and inflammation were observed if the 2-piece implants were placed with the microgap exactly at the bone crest level, and the least bone resorption/peri-implant inflammation occurred if the microgap was located 1 mm above the crest (3,4). The placement of an interface in a location apical to the alveolar crest would result in the greatest amount of bone loss (4,11).
A bacterial colonization of the microgap has been described with the presence of an inflammatory cell infiltrate at the implant-abutment junction (IAJ) (4-10,12). The presence of infiltrated connective tissue (ICT) shows, probably, a response of the immune system to bacteria colonizing the IAJ (13). If the ICT is responsible for bone remodelling, shifting the

microgap inward would, probably, shift the ICT further from the alveolar crest (13). Moving the IAJ away from the external edge of the implant shoulder and from crestal bone could help to reduce bone resorption by containing the inflammatory cell infiltrate within the angle formed at the interface, away from the adjacent crestal bone (14). Moreover, with a platform-switched abutment, a 90° step is created, compared to what happens to implants with a matching implant-abutment diameter, where a 180° step is present; the resulting confined area may produce a restriction of the ICT to this region (15). This can be obtained with the use of platform-switched implants (PLS), in which an abutment smaller than the implant shoulder is used (16).
The aim of the present study was a histologic analysis of an implant with a platform switched implant-abutment connection.

MATERIALS AND METHODS

A 32-year-old male patient participated in this study. The study protocol was approved by the Ethical Committee of the UnG (University of Guarulhos, São Paulo, Brasil) and the patient signed a written informed consent form. The patient was partially edentulous and he needed a bilateral posterior mandibular restoration. Four implants were inserted: two implants in the right mandible (3i® implant with Nanotite surface; Implant Innovations, West Palm Beach, FL, USA), and 2 implants in the left mandible (Ankylos® plus implant; Dentsply-Friadent, Mannheim, Germany). All implants were loaded, without occlusal contact, with a fixed provisional prosthesis the same day of the implant surgery and immediately the same day of insertion. The implants had been splinted. One 3i® implant was retrieved, together with the abutment which was never removed, with a trephine bur after a 6 weeks healing period. Before retrieval the implant was osseointegrated and not mobile. The implant had been inserted 1 mm below the crest.

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) (17). 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. Three slides were obtained. The slides were stained with acid fuchsin and toluidine blue and then washed under tap water, dried, immersed in basic fuchsin for 5 min, and then washed and mounted.
Histomorphometry of bone-implant contact (BIC) percentage was carried out using a light microscope (Laborlux S, Leitz, Wetzlar, Germany) connected to a high resolution video camera (3CCD, JVC KY-F55B, JVC, Yokohama, Japan) and interfaced to a monitor and PC (Intel Pentium III 1200 MMX, Intel, Santa Clara, CA, USA). This optical system was associated with a digitizing pad (Matrix Vision GmbH, Oppenweiler, Germany) and a histometry software package with image capturing capabilities (Image-Pro Plus 4.5, Media Cybernetics Inc., Immagini & Computer Snc Milano).

RESULTS

A 1 mm resorption of the peri-implant crestal bone was present on one side with the bone located at the same height of the shoulder of the implant. A 0.6 mm gap was observed, on one side, between implant and bone, at the height of the shoulder of the implant. Inside this gap it was possible to observe newly formed bone trabeculae. The location of the first bone to implant contact (BIC) was found at about 0.7 mm from the implant shoulder (fig. 1). Inside this gap, there were no inflammatory cell infiltrate, osteoclasts or areas of bone resorption. Bone trabeculae were seen 1 mm above the level of the implant shoulder, about 1 mm from the implant.
A 0.2 mm gap was present between the shoulder of the implant and the newly-formed bone, on the other side of the implant. Inside this gap, osteoblasts were depositing osteoid matrix in an apico-coronal and implantopetal direction.
At the level of this portion of the interface, located near the shoulder of the implant, it was possible to observe only the presence of newly-formed bone. The BIC was located 0.3 mm from the implant shoulder (fig. 2). Also inside this gap no inflammatory cell infiltrate, osteoclasts, or areas of bone resorption were observed. At the interface with the abutment it was possible to observe the presence of connective tissue. A detachment of this connective tissue from the metal surface due, probably, to an artefact produced during retrieval or processing of the specimen, could be observed in some areas. This loose connective tissue presented only with a few, scattered inflammatory cells and a few small vessels (fig. 3).
Newly-formed bone was found at the interface with the implant, and osteoblasts deposited osteoid matrix directly on the implant surface (fig. 4, 5). In some portions of the interface, newly-formed bone was located in tight contact with the metal surface

(fig. 6). No gaps, connective fibrous tissue was found at the interface, and no epithelial downgrowth was present. The BIC percentage was 65.1 ± 6.3% (fig. 7).

DISCUSSION AND CONCLUSION

Peri-implant bone level has been used as one of the criteria for assessing the success of dental implants (14). It is an important prerequisite in order to preserve the integrity of the gingival margins and interdental papillae (14). The inward shift of the IAJ due to PLS, with a shift of the inflammatory cell infiltrate to the central axis of the implant, can be considered a desirable morphological feature that may prevent the horizontal saucerisation and preserve the vertical crestal bone levels (14,18,19). With PLS, the ICT is contained mainly above the implant platform and the peri-implant bone is shielded from the ICT (20).

In a study in dogs it was found that PLS was not able to reduce crestal bone level changes to a significant

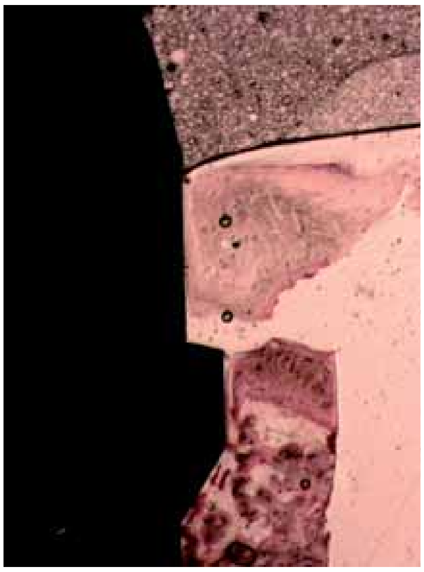

Fig. 1 *On one side of the implant, a 1 mm resorption of the crestal bone was present and the bone was located at the same level of the implant shoulder. Acid fuchsin-toluidine blue 25X.*

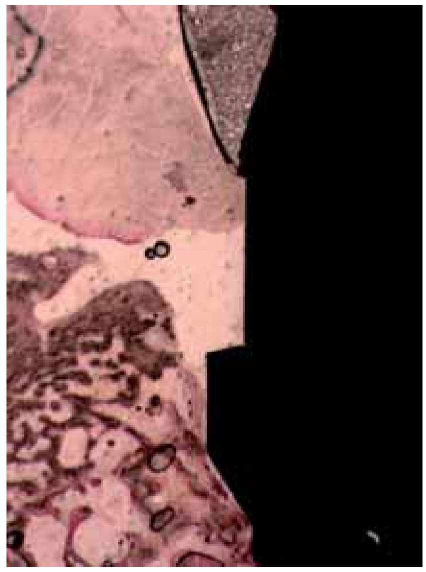

Fig. 2 *Bone trabeculae were seen 1 mm above the level of the implant shoulder and about 1 mm from the implant. Acid fuchsin-toluidine blue 25X*

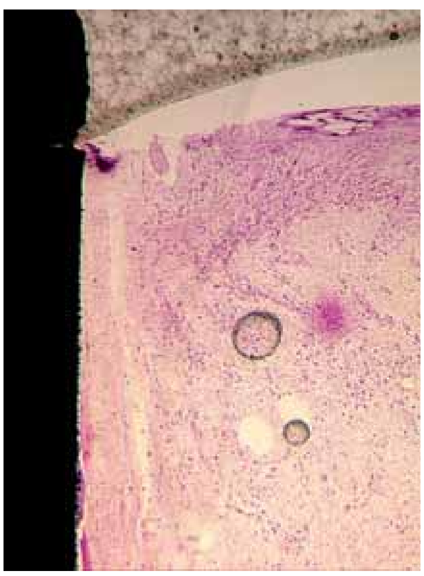

Fig. 3 *A detachment of the connective tissue from the metal surface of the implant caould be observed. This connective tissue presented loose with only a few, scattered inflammatory cells. Acid fuchsin-toluidine blue 40X*

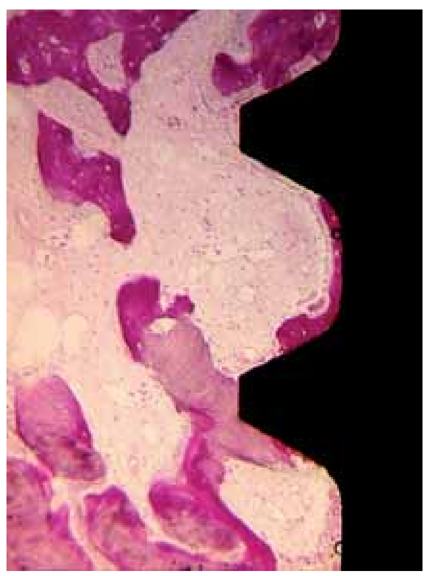

Fig. 4 *Newly-formed trabecular bone was found along the concavities and convexities of the implant threads. Acid fuchsin-toluidine blue 40X*

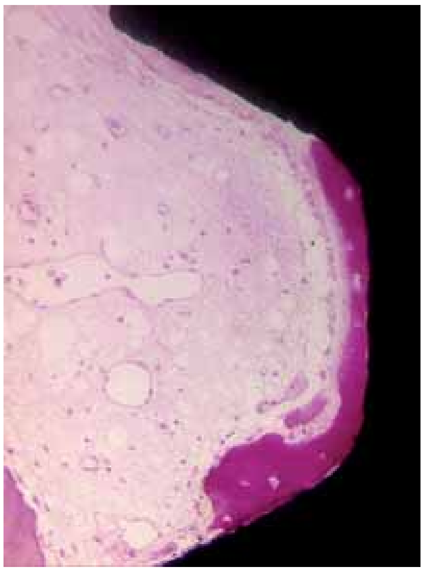

Fig. 5 *In the concavity of the implant threads osteoblasts depositing osteoid matrix directly on the implant surface could be observed. Acid fuchsin-toluidine blue 100X*

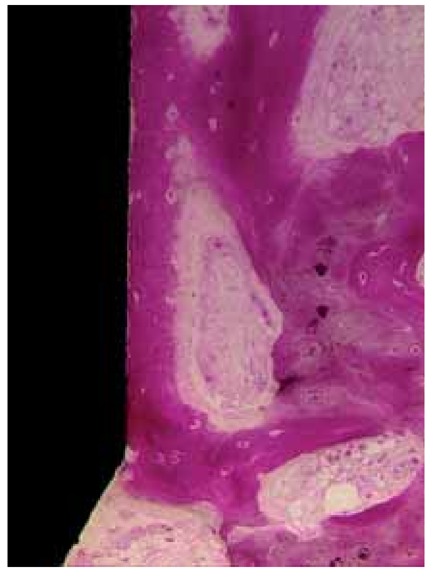

Fig. 6 *Newly-formed bone in tight contact with the metal surface, with no gap at the interface could be seen. Acid fuchsin-toluidine blue 100X.*

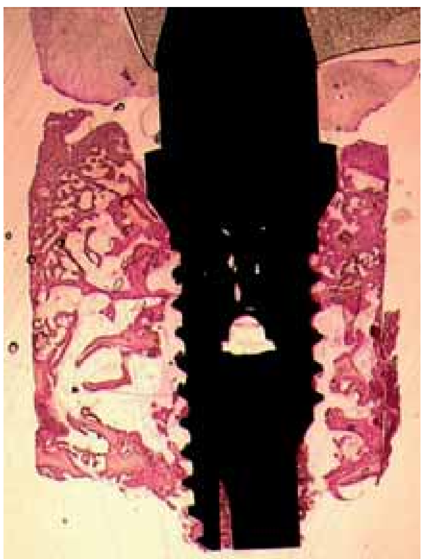

Fig. 7 *Trabecular bone with wide marrow spaces is present along the implant perimeter. Connective tissue, probably detached due to an artefact produced during retrieval or processing of the specimen, can be observed along the abutment. Acid fuchsin-toluidine blue 12X.*

level and it must be questioned if the concept of PLS may keep the adverse effects of microbial leakage away from the alveolar bone (12). On the other hand, several human radiographical and clinical studies have shown that PLS can determine a reduction of the vertical bone resorption vs conventional restorations with a matching abutment (18,20-25). In a histologic evaluation of a human dental implant, with a platform-switched abutment, Luongo et al. found no infraosseous pockets, Howship's lacunae nor osteoclasts on the coronal segment of the implant (13). Moreover, PLS produced a reduction in the dimension of the ICT and its extension in an apical direction (13). It is likely that PLS was able to reduce the immune response of the organism to the presence of the microgap (13).
The present study results showed that PLS could produce, around the implant shoulder, an area that could help to protect the peri-implant soft and mineralized tissues. This could, probably, determine the reduced bone resorption seen in the present histologic report. A very high BIC was found in the implant analyzed. This could be related to the fact that the implant had been immediately loaded and to the microstructured type of surface (26).
In conclusion, the use of PLS could help to maintain the height of the peri-implant crestal bone, and to partially reduce crestal bone remodeling.

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REFERENCES

1. *Vigolo P, Givani A. Platform-switched restorations on wide-diameter implants: a 5-year clinical perspective. Int J Oral Maxillofac Implants 2009;24:103-109.*
2. *Tan WC, Lang NP, Schmidlin K, Zwahlen M, Pjetursson BE. The effect of different implant neck configurations*

on soft and hard tissue healing: a randomized-controlled clinical trial. Clin Oral Impl Res 2011;22:14-19.
3. *Hermann JS, Schofield JD, Schenk RK, Buser D, Cochran DL. Influence of the size of the microgap on crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged implants in the canine mandible. J Periodontol 2001;72:1372-1383.*
4. *Piattelli A, Vrespa G, Petrone G, Iezzi G, Annibali S, Scarano A. Role of the microgap between implant and abutment: a retrospective histologic evaluation in monkeys. J Periodontol 2003;74:346-352.*
5. *Broggini N, McManus CM, Hermann JS, Medina R, Schenk RK, Buser D, Cochral DL. Peri-implant inflammation defined by the implant-abutment interface. J Dent Res 2006;85:473-478.*
6. *Persson LG, Lekholm U, Leonhardt¬ A, Dahlen G, Lindhe J. Bacterial colonization on internal surfaces of Branemark system implant components. Clin Oral Impl Res 1996;7:90-95.*
7. *Quirynen M, Bollen CM, Eyssen H, van Steenberghe D. Microbial penetration along the implant components of the Branemark system. An in vitro study. Clin Oral Impl Res 1994;5:239-44.*
8. *Jansen VK, Conrads G, Richter EJ. Microbial leakage and marginal fit of the implant-abutment interface. Int J Oral Maxillofac Implants 1997;12:527-40.*
9. *Piattelli A, Scarano A, Paolantonio M, Assenza B, Leghissa GC, Di Bonaventura G, Catamo G, Piccolomini R. Fluids and microbial penetration in the internal part of cement-retained versus screw-retained implant-abutment connections. J Periodontol 2001;72:1146-1150.*
10. *Quirynen M, van Steenberghe D. Bacterial colonization of the internal part of two-stage implants. An in vivo study. Clin Oral Impl Res 1993;4:158-161.*
11. *Hermann JS, Buser D, Schenk RK, Cochran DL. Crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged and submerged implants in the canine mandible. J Periodontol 2000;71:1412-1424.*
12. *Becker J, Ferrari D, Mihatovic I, Sahmn, Schaer A, Schwarz F. Stability of crestal bone levet at platform-switched non-submerged titanium implants: a histomorfphometrical study in dogs. J Clin Periodontol 2009;36:532-539.*
13. *Luongo R, Traini T, Guidone PC, Bianco, Cocchetto R, Celletti R. Hard and soft tissue responses to the platform-switching technique. Int Periodontics Restorative Dent 2008;28:551-557.*
14. *Atieh MA, Ibrahim HM, Atieh AH. Platform switching for marginal bone preservation around dental implants: a systematic review and meta-analysis. J Periodontol 2010;81:1350-1366.*
15. *Hurzeler M, Fickl S, Zuhr O, Wachtel HC. Peri-implant bone level around implants with platform-switched abutments: preliminary data from a prospective study. J Oral Maxillofac Surg 2007;65 (Suppl.):33-39.*
16. *Lazzara RJ, Porter SS. Platform switching: a new concept in implant dentistry for controlling postrestorative crestal bone levels. Int J Periodontics Restorative Dent 2006;26:9-17.*
17. *Piattelli A, Scarano A, Quaranta M. High-precision, cost-effective system for producing thin sections of oral tissues containing dental implants. Biomaterials 1997;18:577-579.*
18. *Fickl S, Zuhr O, Stein JM, Hurzeler MB. Peri-implant bone bone level around implants with platform-switched abutments. Int J Oral Maxillofac Implants 2010;25:577-581.*
19. *Canullo L, Pellegrini G, Allievi C, Trombelli L, Annibali S, Dellavia C. Soft tissues around long-term platform switching implant restorations: a histological human evaluation. Preliminary results. J Clin Periodontol 2011;38:86-94.*
20. *Cappiello M, Luongo R, Di Iorio D, Bugea C, Cocchetto R, Celletti R. Evaluation of peri-implant bone loss around platform-switched implants. Int J Periodontics restorative Dent 2008;28:347-355.*
21. *Trammel K, Geurs NC, O'Neal SJ, Liu PR, Haigh SJ, McNeal S, Keneally JN, Reddy MS. A prospective, randomized, controlled comparison of platform-switched and matched-abutment implants in short-span partial denture situations. Int J Periodontics Restorative Dent 2009;29:599-605.*
22. *Rodriguez-Ciurana X, Vela-Nebot X,Segalà-Torres M, Calvo-Guirado JL, Cambra J, Mendez-BlancoV, Tarnow DP. The effect of inter-implant distance on the height of the inter-implant bone crest when using platform-switched implants. Int J Periodontics Restorative Dent 2009;29:141-151.*
23. *Veis A, Parissis N, Tsirlis A, Papadeli C, Marini G, Zogakis A. Evaluation of peri-implant marginal bone loss using modified abutment connections at various crestal level placements. Int J Periodontics Restorative Dent 2010;30:609-617.*
24. *Vela-Nebot X, Rodriguez-Ciurana X, Rodado-Alonso C, Segalà-Torres M. Benefits of an implant platform modification technique to reduce crestal bone resorption. Implant Dent 2006;15:313-320.*
25. *Cocchetto R, Traini T, Caddeo F, Celletti R. Evaluation of hard tissue response around wider platform-switched implants. Int J Periodontics Restorative Dent 2010;30:163-171*
26. *Orsini G, Piattelli M, Scarano A, Petrone G, Kenealy J, Piattelli A, Caputi S. Randomized-controlled histological and histomorphometric evaluation of implants with nanometer-scale calcium phosphate added to the dual acid-etched surface in the human posterior maxilla. J Periodontol 2007,78:209-218.*