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Influence of abutment material on peri-implant clinical parameters: a prospective study

Influência do material do abutment sobre parâmetros clínicos periimplantares: um estudo prospectivo

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ABSTRACT

Objective: This study evaluated the peri-implant clinical parameters of zirconia versus metallic abutments for standardized custom-made implant-supported single-tooth restorations. **Material and Methods:** Sixteen subjects received 30 dental implants on esthetic region of upper jaws. Test group had 14 implant-supported single-tooth restorations with ceramic abutment and control group had 16 restorations with metallic abutment. Peri-implant clinical parameters were recorded after 110 ± 10 days in function at six sites by each implant, in each subject. The means of clinical measures: probing depth (PD) and clinical attachment level (CAL); mean of percentages of sites with visible plaque (VP), bleeding on probing (BOP) and suppuration (SU) were recorded to each subject. To verify differences between groups Mann Whitney U-test was selected PD and CAL and k-light test VP, BOP and SU. **Results:** One zirconia implant-supported single-tooth restoration fractured at insertion time. The mean of PD, CAL, and BOP of the samples sites were lower to test group than control ($p < 0.05$). There were no differences of mean levels of VP and S between test and control group ($p > 0.05$). **Conclusion:** Clinical parameters around implant-supported restorations were influenced by abutment type with better results to zirconia abutments, at least, after short time period evaluation.

KEYWORDS

Metallic abutments; Zirconia abutments; Implant abutment; Ceramic abutment; Implant.

RESUMO

Objetivo: O objetivo deste estudo foi avaliar os parâmetros clínicos peri-implantares de próteses unitárias implantossuportadas em região anterior e posterior confeccionadas sobre pilares de zircônia versus metálico. **Material e métodos:** Dezesseis indivíduos receberam 30 implantes dentários na região estética da maxila. Para o grupo teste confeccionou-se 14 coroas sobre implante utilizando pilares de zircônia e para o grupo controle confeccionou-se 16 coroas sobre implante utilizando pilares de metal. Os parâmetros clínicos peri-implantares foram avaliados após 110 ± 10 dias em função. A média das medidas clínicas: profundidade de sondagem (PD) e nível clínico de inserção (NCI); média da porcentagem de sítios apresentando placa visível (PV), sangramento à sondagem (SS) e supuração (SUP) foram computados para cada indivíduo assim como entre os grupos avaliados. As diferenças foram avaliadas pelos testes de Mann-Whitney para PD e NCI e k-light para PV, SS e SUP. **Resultados:** Uma coroa com pilar de zircônia fraturou no momento da inserção. A média de PS, NCI e SS foi menor para o grupo teste em relação ao controle ($p < 0,05$). Não houve diferenças entre PV e SUP entre os grupos teste e controle ($p > 0,05$). **Conclusão:** os parâmetros clínicos ao redor das próteses implantossuportadas foram influenciados pelo tipo de pilar com melhores resultados para a zircônia, pelo menos no período avaliado.

PALAVRAS-CHAVE

Pilares metálicos; Pilares de Zirconia; Pilar de implante; Pilar cerâmico; Implante.

INTRODUCTION

The facial esthetics and proper phonetic function have direct influence on social and psychological human behavior. The premature loss of upper anterior teeth can negatively alter this aspect [1]. The implant-supported restorations have been used as an alternative solution with high success rates [2]. However, these restorations are influenced by some clinical factors such as smile line design, biotype and color of peri-implant mucosa and must be analyzed before surgical treatment to achieve optimal esthetics results [3,4].

Besides the anatomic similarities of soft tissue around teeth and implants such as the presence of an oral epithelium, continuous with a junctional epithelium, there are some differences [6]. Collagen fiber bundles run perpendicularly to the in teeth surface, while around implants, they are parallel oriented to the implant surface [6]. Histological studies [6,7] have shown that that the peri-implant soft tissue junction epithelium and connective tissue attachment are important barriers between the oral environment and the internal structures of the body.

On the other hand, the material of the abutment affects the peri-implant tissue behavior [8]. Titanium abutments are gold standard material for implant prosthetic reconstructions [9,10]. Mucogingival recession caused by bone tissue loss after dental extraction or congenital defects [11] can result on very thin buccal gingiva, resulting on non-esthetic grayish color [12], because peri-implant soft tissue cannot block light reflection of abutment metallic surface [13].

Zirconia material, was introduced as an option to metallic abutments implants because its white color [14,15]. The tooth-like color, biocompatibility and inherent strength of zirconia ceramics are also desirable characteristics among esthetics materials such as the low bacterial adhesion with better results than metallic abutment implants [16]. Complementary, zirconia has lower microbiolical impact on bacterial adsorption when compared with titanium material, resulting in better results in both clinical and immunohistochemical studies [17-21].

Zirconia abutments for implant-supported single-tooth restorations demonstrate good short-term technical and biological results [22]. Zirconia has high mechanical properties and such characteristic is important to canines and posterior teeth region [19]. However, there are limited controlled, randomized clinical studies comparing peri-implants clinical parameters of zirconia and metallic abutments for implant-supported single-tooth restorations [10,23].

Therefore, the objective of this prospective, longitudinal and controlled study was to evaluate peri-implant clinical parameters of zirconia versus metallic abutments for standardized custom-made implant-supported single-tooth restorations in esthetic maxillary region.

MATERIAL AND METHODS

Selection of the subjects

Sixteen subjects with a mean age of 51.1 ± 11.0 years presenting partially edentulous maxilla were included in this study. Two males and 14 females were included.

Subjects had to meet pre-established inclusion parameters: (I) two or four dental upper esthetic region elements missing, (II) reasonable to good oral and general heath, (III) not be pregnant or breath feeding; (IV) no history of irradiation on head and neck, (V) adequate amount of bone height for placement of implants with a minimum length of 11mm in a prosthetic optimal position, (VI) implant site free from acute infection or extraction remnants and primary stability >30N/cm.

Exclusion criteria included (I) local radiation therapy treatment, (II) absence of primary stability of the implant (<30Ncm), (III) previous bone augmentation in the implant site, moderate to severe chronic periodontitis

(i.e., suppuration, bleeding on probing in more than 30% of the subgingival sites or any site with probing depth > 5mm), (IV) diabetes or any systemic condition that could affect the bone healing. The Ethics Committee for Human Clinical Trials at Guarulhos University approved the study protocol (03206812.4.0000.5506), which was explained to each subject, and all patients signed informed consent.

Pre-operative work-up

A complete examination of the oral hard and soft tissues was carried out for each patient. Panoramic radiographs and, when necessary, computed tomography (CT) scans were taken.

Implant placement

A total of 30 dental implants (external hexagon, Conexão Sistemas de Próteses Dentárias, São Paulo, Brazil) were inserted according to a standard two-stage protocol [24]. Local anesthesia was obtained by infiltrating articaine 4 % containing 1:100,000 adrenaline. An extended crestal incision was made, with releasing incisions if necessary, and full thickness flaps were elevated exposing the alveolar ridge. When indicated, a flattening of the alveolar crest was performed with a bur, under irrigation with sterile saline, in order to obtain a larger and flat bony base. Implants were placed in each partially edentulous maxilla to restore the partially edentulous area. These implants were placed in a 30 days period. The preparation of implant sites was carried out with twist drills of increasing diameter (2.8 or 3.0 mm to place an implant with 3.75 mm diameter), under constant irrigation. Dental implants were positioned at the bone crest level. The healing abutments were inserted immediately after implant placement, reaching a non-submerged approach. The flaps were then repositioned and were secured around the abutments by interrupted sutures and allowed to heal for a period between 2 to 4 months.

Post-operative treatment

All patients received oral antibiotics (Clindamicyn, 900 mg each day) for 7 days Postoperative pain was controlled by administering 100 mg nimesulide every 12 h for 5 days. Detailed oral hygiene instructions were provided, with mouth-rinses with 0.12 % chlorhexidine administered for 7 days. The patients were instructed to avoid brushing and any trauma to surgical site. A cold and soft diet was recommended for the first day, and a soft diet for the first week. Suture removal was performed at 7 days after surgery.

Restorative procedures

Following implant healing, the implants in the same patient were randomized into the experimental group with zirconia (ZR) and metallic (ME) abutment. This randomization was made tossing a coin. The impression posts were tightened into the external hexagon implants. An impression was taken utilizing a silicon putty polyvinilsyloxane directly on the impression posts. Laboratory abutment analogs were attached to the modified surgical template (surgical template with resin fixed impression posts) and a master cast was fabricated.

Pre-fabricated implant components (UCLA abutments, Conexão Sistemas de Próteses Dentárias, São Paulo, Brazil) made of metal or zirconia was made directly on the master cast by the laboratory technician. The implant-supported restoration was placed direct on the hexagon. Screws were tightened according the manufacturer's instructions. Occlusal contacts were assessed by an articulating paper and adjusted if necessary. The screw access was then covered with light-cured provisional resin.

A periapical radiograph was made from the implant-supported restoration to check implant position and the coupling between prosthetic components.

The patients were scheduled for a 110 ± 10 days control visit. During the visit, prosthetic functionality and tissue healing were evaluated.

Clinical examination follow-up

At the 110 ± 10 days of follow-up visit, the following parameters were assessed

dichotomously at implants at six sites per implant (mesiobuccal, buccal, distobuccal, distolingual, lingual and mesiolingual): presence (1) or absence (0) of visible plaque (VP), bleeding on probing (BOP) and suppuration (SU).

The measurements of probing depth (PD, in mm) and clinical attachment level (CAL, in mm) were determined at six sites per implant and recorded to the nearest millimeter using a North Carolina periodontal probe (PCD 12; Hu-Friedy, Leimien, Germany). Gingival recessions were added to probing depth (mm) to distinguish this condition or subtracted when gingival hyperplasic were observed.

All clinical examinations were performed by one calibrated examiner (F.C.Z.). The intra-examiner mean SE variability was 0.1 mm for PD and 0.2 mm for CAL. This trained examiner was able to provide reproducible measures below 0.5 mm. The intra-observer agreement was between 0.88 and 0.97.

Statistical analysis

The mean of the six sites were used for each implant, then grouped according titanium or zirconia. Mann Whitney u-test was selected to verify differences between groups at the 95 % confidence level.

RESULTS

Table 1 shows peri-implant data of evaluated single-tooth implant-supported restorations for both groups with Mann-Whitney results. The probing depth (PD), clinical attachment level (CAL) and bleeding on probe (BOP) of the ME group was higher than ZR group ($p < 0.05$). There were no significant differences to visible plaque (VP) and suppuration (SU) between groups.

The comparisons of probing depth (PD) of buccal/lingual surfaces and proximal surfaces between ZR and ME are also presented in Figure 1. The mean (± SD) levels of the buccal PD were 2.25 (± 0.93) mm and 3.00 (± 1.18) mm for ZR and ME respectively ($p < 0.05$). The proximal probing depth of the samples sites was 2.85 (± 0.69) mm for ZR and 3.53 (± 0.75) mm and for ME ($p > 0.05$) (Figure 1).

Chart 1 - Peri-implant means (±SD) of evaluated single-tooth implant-supported restorations, Mann-Whitney test results

	Metalic (ME) 110 days n=16	Zirconia (ZR) 110 days n=14	P	
Clinical Parameters				
PD (mm)	3.35 ± 0.83	2.61 ± 0.67	0.018	s*
CAL (mm)	3.35 ± 0.83	2.76 ± 0.63	0.02	s*
% sites				
VP	2.20 ± 8.52	0.0 ± 0.0	0.78	ns
BOP	42.50 ± 25.92	19.93 ± 26.14	0.021	s*
SU	0	0		ns

*PD: probing depth; CAL: clinical attachment level; VP: visible plaque; BOP: bleeding probing, SU: suppuration; ns: not significant

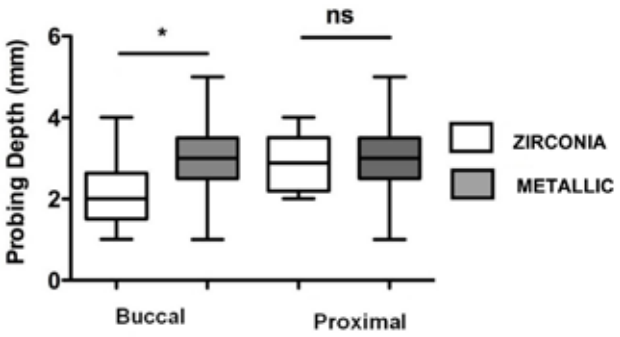

Figure 1 - Box-plots graphic of the mean probing depths (PD) and standard deviation around reconstructions supported by zirconia (ZR) and metallic (ME) abutments Mann-Whitney tests ($p < 0.05$)

DISCUSSION

The data of this study showed that zirconia abutments presented better periodontal parameters when compared to titanium abutments. These results could impact directly on peri-implant tissues mainly for the long-term follow-up.

Histologically, collagen fibers has a perpendicular orientation to the abutment surface until 200 μm from the surface, where they became parallel running in several directions and formed a three-dimensional network around the abutment [6]. This network of fibers may have clinical relevance as a mechanical

protection of the underlying peri-implant bone [6]. The collagen fibers orientation is in a perpendicular manner with no direct contact with the abutment surface. Then, the connective tissue adhesion at implant has a poor mechanical resistance as compared to that of natural teeth [8]. In addition, we could extrapolate that the abutment material, mainly in aesthetic regions, where these implants were placed deeply to provide better emergency profile, influenced this biological characteristics of the peri-implant soft tissue around dental implants, reaching these better periodontal parameters.

The esthetic result to implant-supported reconstructions has to analyze several different parameters such as gingival biotype, presence of papillae, and a convex contour of the alveolar crest [11]. If one of these conditions did not find a place in these restorations, the peri-implant soft tissue shall not block light reflection of metallic abutment surface and a non-esthetic result would be especially problematic at anterior upper teeth restoration [13].

The development of zirconia material as an option to implant abutments [23,10] had also an important goal the esthetic result. The white color and high mechanical strength compared to other ceramics materials have become zirconia abutments an option to metallic one [14,15] at anterior teeth rehabilitation. Zirconia abutments offer stability to implant-supported single-tooth reconstructions in incisor and premolar locations [25].

The interface between the abutment and the implant is generally located in the neighborhood of the alveolar bone level [8]. Stable marginal bone levels and healthy mucosal conditions documented at zirconia abutments [25], similarly to the our findings indicates favorable soft and hard tissue reaction. It has been reported that peri-implant soft tissue around zirconia might heal faster than in contact to titanium [7].

In addition, peri-implant collagen fibers began at the crestal bone in titanium implants [6]. Another important characteristic of zirconia is the lowest bacterial adhesion compared to titanium that was reported in both in vitro [26] and in vivo [27,28] studies and it could explain the significantly smaller bleeding on probe observed on zirconia abutment in our study. Zirconia is reported to present a similar soft tissue contact to that observed in metallic implants [5]. An earlier study showed that zirconia healing caps depicted lower inflammatory infiltrate with much lower extension that titanium healing caps [29], ratifying our data mainly probing depth and clinical attachment levels..

Mean probing depths around titanium abutments were deeper than around zirconia after 110 days (3.35 ± 0.83 mm versus 2.61 ± 0.67 mm) in agreement with previous study [28] that evaluates a 3-months follow-up results (2.2 ± 0.8 mm versus 1.7 ± 0.7 mm). The aforementioned study [28] also reported that between 2 weeks and 3 months after implant installation evaluation, the perimucosal undergo changes and probing depths decrease. Since there is a higher amount of bacteria around the metallic group associated with higher inflammatory infiltrate as previously presented [29] and slower healing peri-implant soft tissue around metallic material [7], the higher probing depths of metallic abutments compared with zirconia abutments could be explained by these data.

A three years follow-up demonstrated that the mean BOP was slightly higher around the reconstructions supported by zirconia abutments [22]. It has been reported mean BOP slightly higher at implant-supported single tooth reconstructions with zirconia abutments than at reconstructions supported by metallic abutments in 1-year follow-up [10]. Besides both clinical evaluations cited are considered short-term such as the present study, 110 days evaluation; both studies had implant-supported reconstructions with higher function period. The present study found lower BOP to ZR group. One possible explanation is the lowest inflammatory infiltrate caused by lowest amount of bacteria to early

stages [29]. It can be speculated that on future assays the zirconia group could present similar results compared to them, which were 1-year, and 3-years follow-ups [10,22].

However, the BOP was highest to ME abutments at 110 days follow-up. Since it has been reported higher inflammatory infiltrate around metallic healing caps after 6 months-healing period than zirconia heeling caps it can be supposed that the ZR group had a faster healing with better peri-implant clinical results to BOP [29].

It has been demonstrated that zirconia appears to be superior to titanium with less initial plaque accumulation [7]. Besides Sailer et al. [10] reported higher plaque presence around reconstructions supported by zirconia than by metallic abutment, they also reported low plaque accumulation at both zirconia and metallic in accordance with our data. Both abutments groups ZR and ME presented no significant differences on VP accumulation (2.2 versus 0 %) and it is in accordance with Zembic et al. [23] in a 3-years follow-up.

Parameters such as PD and BOP are clinically limited and histological data that are currently evaluated might reveal differences in soft tissue response. In conclusion, although, one zirconia abutment at single-tooth implant-supported restoration fractured at insertion, the clinical parameters around reconstructions implant supported were influenced by abutment type and better results may be expected to zirconia material.

CONCLUSION

The peri-implant clinical parameters were abutment type influenced, better results were showed to zirconia than metallic abutments, at least, after 110 days in function. However, these data must be read careffuly and further studies, with a long-term follow up must be conducted.

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DISCLOSURE

The authors have no interest in any of the companies or products mentioned in this article.

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