EGYPTIAN DENTAL JOURNAL

VOL. 63, 3575:3583, OCTOBER, 2017

I.S.S.N 0070-9484

FIXED PROSTHODONTICS, DENTAL MATERIALS, CONSERVATIVE DENTISTRY AND ENDODONTICS

www.eda-egypt.org • Codex : 80/1710

COMPARISON OF PERI-IMPLANT CLINICAL INFLAMMATORY PARAMETERS AMONG SCREW RETAINED CAD/CAM METAL BAR AND ZIRCONIA BAR FOR PATIENTS WITH RECONSTRUCTED MANDIBLES

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ABSTRACT

Background: Segmental resection of the mandible results in severe disturbance of chewing function. Advances in microvascular surgeries and CAD/CAM technology helped with the prosthetic rehabilitation of reconstructed mandibles.

Purpose: The aim of this study was to assess metal bar versus zirconia bar in patients with reconstructed mandibles that were rehabilitated with implant retained mandibular removable partial overdenture concerning the peri implant gingival index and probing depth.

Materials and methods: fourteen patients were selected according to the inclusion criteria, the participants were stratified equally into two groups, patients were assigned to receive either metal bar or zirconium bar. Preparation of implant sites started with pilot drill followed by sequential drilling under copious refrigerated irrigation. Monthly follow up appointments were scheduled for each patient. After second stage surgery, abutments were secured to implant fixtures. Open top impression technique was used for bar fabrication using CAD/CAM technology. The bar was screwed in the patient's mouth and checked for passive fit. Construction of the implant assisted removable partial overdenture took place in the conventional way. Female part were picked up directly in the patient's mouth. Patients were recalled one week, 3,9 and 12 months after delivery for assessment of gingival index and probing depth.

Results: Mann-Whitney U test was used to analyze the gingival index score between the two groups metal bar and zirconium bar. The metal bar group mean and standard deviation was 0.40±0.48 after 1 week and 0.36±0.32 after 3 months, 0.30±0.42 after 9 months, 0.20±0.42 after 12 months. While for zirconium group 0.30 ± 0.70, 0.28± 0.42 ,0.25±0.32, 0.10±0.32 respectively after 1 week,3 months ,9 months and 12 months. There was a statistical significance between the groups in 9 and 12 months, where P value was <0.01. Wilcoxon signed rank test was used to test for significance within each group during the time interval. There was a statistical significance inside each group during the time interval. Unpaired t test was used to analyze probing depth to test

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for significance between the two groups, the mean and standard deviation was 2.51± 0.10, 2.1± 0.10,1.61± 0.11 and 1.59± 0.13during 1 week,3 months,9 months and 12 months respectively for the metal bar group and 2.34± 0.12, 1.98± 0.10,1.4± 0.10 and 1.2± 0.10 for zirconium bar group .there was a statistical significance difference at 95%confidence intervals at 3 months,9 months and 12 months where P value was less than 0.01.

Conclusion: Within the limitation of this study, zirconia metal bar is considered more biocompatible than the metal bar.

KEYWORDS: Reconstructed mandibles, splinted implant screw retained bar, zirconia, CAD/CAM.

INTRODUCTION

Mandibular defect is the defect affecting mandibular integrity following surgical removal of oral Neoplasm or trauma. When the continuity of the mandible isn't restored, the proprioception will be lost leading to uncoordinated, imprecise movements of the mandible, inability to achieve stable interocclusal position and chewing function is adversely affected.[1-4] As a result of advances in the field of microvascular surgery, free flaps were introduced. The most significant advantage of this flap is its improved blood supply for the tissue being transferred and to the recipient site. Moreover, the fibular bone is an excellent recipient for dental implants.[5-9] High implant survival rates in reconstructed jaws are evident as implants demonstrated normal integration comparable to those implants placed in the native bone. Bar attachments widely distribute forces anteroposteriorly, help with abutments splinting and stress distribution.[10-14]

Computer aided design/computer aided manufacturing "CAD/CAM" technology helped with the fabrication of accurate and passively fitting frameworks. Zirconia bar attachment was reported in a finite element study to reinforce a fixed partial denture. Implant supported removable partial overdentures are preferred as the denture flange helps to improve facial appearance and provides daily access for hygiene maintenance of implant abutments.[15-19]

The advantages of ceramic abutments include less mucosal discoloration compared with metal abutments, [20] less bacterial adhesion compared with titanium abutments, and, in animal studies, more favorable soft tissue integration compared with titanium abutments. [21]

Although high-strength ceramics such as alumina and zirconia have high fracture resistance, zirconia, in particular, has sufficient fracture resistance for use as an abutment material. Zirconia abutments supporting anterior and premolar single crowns have shown high survival rates in some studies,[22-24] and a high 5-year survival rate was reported in a randomized-controlled clinical trial of zirconia and titanium abutments in posterior regions. [25] However, the effects of the implant abutment material on the peri-implant mucosa, have not been clarified.

Following the plaque aggregation on the implant surface, a large number of inflammatory cells spatter onto the reticulum below the epithelium. When a mass of plaque spreads apically, clinical and radiographic symptoms of tissue destruction will be visible. The oral hygiene and removal of plaque around the implants are very important in the maintenance of tissues adjacent to the implants. Easily ulcerated sulcular epithelium representing inflammation from plaque is the primary cause of bleeding on probing. The peri-implant tissue health is important for the long-term success of implant-retained mandibular overdentures. Clinical parameters such as plaque scores, bleeding scores, and probing depths are important indicators of peri-implant tissues health and implant survival. [26]

Stable marginal bone levels around oral implants are the key determinant of a successful treatment outcome. The scientifically sound interpretation of radiographic evaluation of marginal bone is of utmost importance for the long-term evaluation of oral implants. Moreover, the evaluation of technical problems and maintenance service is very important for the ultimate choice of attachment type for implant overdentures. Naturally, for the implant prosthodontic treatment to be justified, it should be successful over a long period with preservation of peri-implant tissues and reduction of prosthodontic complications. [26]

In this study, therefore, we selected zirconia, which is used widely as an implant abutment material because of its excellent esthetic properties and biocompatibility, and compared the effects of zirconia and metal abutments on the peri-implant soft tissue.

MATERIALS AND METHODS

Fourteen patients having unilateral reconstruction of their mandibles either with vascularized fibula or non vascularized iliac crest bone graft were selected to participate in this study. However, patients with total glossectomy, claustrophobic patients and those with cardiac pacemakers were excluded. Precise medical history was taken from all the patients. The timing of mandibular reconstruction, type of bone graft used and inquiries about history of recurrence was taken from the patients. Examination of the temporomandibular joint was carried out. Tongue size, position, and motor functions were examined. Any abnormal soft or hard tissue, mucosal inflammation, signs of infection or recurrence, ulcers, hyperplasia and flabby tissues were also detected if present. The participants were stratified equally into two groups; patients were assigned to receive either metal bar or zirconium bar using the balanced computerized randomization method. The panoramic radiographic evaluation was done. A temporary removable partial denture was made to each patient. For each case, an overall alginate impression* was made while the patient was wearing the removable partial denture for fabrication of a radiographic stent used in the Cone-beam computerized tomography and later converted to surgical stent. Prophylactic antibiotic** was given to the patients and anesthetized***.

A flap was reflected, and the surgical stent was placed in the patient's mouth to mark the implant sites. Preparation of implant sites started with pilot drill followed by sequential drilling under refrigerated copious irrigation. The flap was then sutured. After second stage surgery, abutments were secured to implant fixtures. Open top impression technique was used for bar fabrication in both groups.

Gingival stimulating material**** was injected in the impression and poured. A verification jig was made, tried in the patient's mouth and checked for passive fit. In cases where passive fit was absent, the jig was cut between the implants and joined using Duralay. The gingival mask, titanium bases and the stone model were scanned and introduced into the software. For the metal bar the wax pattern was milled and then casted in the conventional way. For the zirconium bar, bar design was selected from the software library, milled and sintered. Easy seating for the bar over the titanium bases was verified. Cementation of the bar to the titanium bases took place using adhesive resin*****. The bar was screwed in the patient's mouth and checked for passive fit. Construction of the implant assisted removable partial overdenture took place

* Tropicalgin regular set alginate. Zhermack, Italy
** Augmentin 1gm, Medical Union pharmaceuticals, Abu Sultan, Egypt.
*** Mepiccaine local anathesia, Alexandria, Egypt
**** Soft tissue Moulage, Kerr dental products, United states of America
***** SuperCem, Self-adhesive resin cement, South Korea

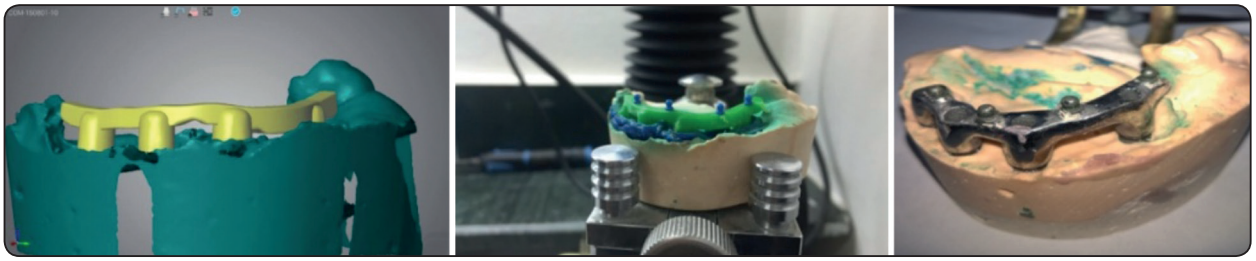

Fig. (1): Metal bar construction

Fig. (2): Zirconia bar construction

in the conventional way. Female part were picked up directly in the patient's mouth. Patients were recalled one week,3,9 and 12 months after delivery for assessment of gingival index and probing depth fig (1,2)

The Gingival Index (G.I.) The gingival tissues around the implants were isolated and gently dried by a piece of gauze. For each implant, the buccal and lingual surfaces were individually scored. This was done according to the gingival scores described according to Mombelli et al as follows: G.I. 0: represents normal healthy gingiva. G.I. 1: represents mild gingival inflammation with slight change in color, slight edema and/or bleeding on probing. G.I. 2: represents moderate gingival inflammation with redness, glazing, and bleeding on probing. G.I. 3: represents severe gingival inflammation with marginal edema and redness, ulceration and spontaneous bleeding. The mean values of the scored surfaces for each implant were then calculated, tabulated and statistically analyzed.

The pocket depth A periodontal probe was used to measure the pocket depth around each implant (PD). The measurements were recorded at the mid-buccal and mid-lingual for each implant.

RESULTS

Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows. While Gingival index is considered non parametric so Mann-Whitney U test was used to analyze the gingival index score between the two groups metal bar and zirconium bar. The metal bar group mean and standard deviation was 0.40±0.48 after 1 week and 0.36±0.32 after 3 months, 0.30±0.42 after 9 months, 0.20±0.42 after 12 months. While for zirconium group 0.30 ± 0.70, 0.28± 0.42, 0.25±0.32, 0.10±0.32 respectively after 1 week, 3 months , 9 months and 12 months. There was a statistical significance between the groups in 9 and 12 months, where P value was <0.01. Wilcoxon signed rank test was used to test for significance

® SPSS, Inc.,an IBM company.
® IBM Corporation, NY, USA.

within each group during time interval. There was a statistical significance inside each group during the time interval. Numerical data concerning pocket depth were explored for normality by checking the data distribution, calculating the mean and median values, evaluating histograms and normality curves and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data were presented by mean, standard deviation. Independent t test was used for comparison between groups. The significance level was set at $P \leq 0.05$. Unpaired t test was used to analyze probing depth to test for significance between the two groups , the mean and standard deviation was 2.51± 0.10,2.1± 0.10,1.61± 0.11 and 1.59± 0.13 during 1 week, 3 months, 9 months and 12 months respectively for the metal bar group and 2.34 ± 0.12, 1.98± 0.10, 1.4± 0.10 and 1.2 ± 0.10 for zirconium bar group .there was a statistical significance difference at 95%confidence intervals at 3 months, 9 months and 12 months where P value was less than 0.01.as shown in table (1,2).

TABLE (1) Gingival index

Bar material	Metal	Zirconium	P value
1 week	0.400.48±	0.30 ± 0.70	0.56
3 months	0.360.32±	0.28± 0.42	0.32
9 months	0.30±0.42	0.25±0.32	0.01
12 months	0.20±0.42	0.10±0.32	0.01

TABLE (2) Probing depth

Bar material	Metal	Zirconium	P value
1 week	2.51± 0.10	2.34± 0.12	0.0004
3 months	2.1± 0.10	1.98± 0.10	0.0038
9 months	1.61± 0.11	1.4± 0.10	0.0001
12 months	1.59± 0.13	1.2± 0.10	0.0001

DISCUSSION

Precise selection of the patients was carried out. Iliac crest as a donor site offers a sufficient amount of bone to receive dental implants. Free fibula flap offers lots of advantages as its length, the multiple osteotomies that can be done, the improved blood supply of this flap and being a good recipient of dental implants. (No history of radiotherapy following reconstruction was mandatory as irradiation of the free flap has shown significant association with implant failure as supported by several studies. [27-30].Precise medical history and medication list were taken from each patient. Temporo-mandibular joint was examined as pain may cause the patient to have preferred chewing side. Visual inspection and palpation of the intra-oral tissues were performed. Amount and consistency of saliva were evaluated as xerostomia is accompanied by decreased tissue tolerance. [31,32] Cone-beam CT scan was reported to be a reliable method for proper selection of implant size, and Preoperative and postoperative medications were prescribed to all patients to minimize the risk of implant failure. Sequential drilling of the osteotomy site under refrigerated copious irrigation and vertical intermittent pressure were essential to reduce heat generation that may affect postoperative wound healing and osseointegration. Parallelism was mandatory to allow even distribution of stresses through the longitudinal axis of the implant and to avoid prosthetic challenges during bar construction. [33-36] Implant assisted removable partial overdentures were preferred to conventional tissue borne removable partial dentures due to compromised load bearing capacity of the denture bearing area. Furthermore, implant assisted removable partial overdentures were preferred than implant supported fixed partial dentures as overdentures provided daily access for hygiene measures of implant abutments helping to minimize peri-implant soft tissue problems. [1,18,19] Bar attachment was the one of choice as it distributes forces anteroposteriorly, provides even support over

a great surface area, helps with implants splinting, minimizes prosthesis movement during function and overcomes the problem of vertical cantilever over the implants. Screw retained bars were used as they can be retrieved easily if biologic or technical complication occurs. Furthermore, cement retained bars are correlated with risk of bacterial colonization, cement dissolution, and gingival inflammation. For fabrication of the screw retained bar, multi unit abutments were tightened to the implants. The passive fit of screw retained bars was mandatory. The non passive fit of the bar results in screw loosening offering an opportunity for development of bacterial plaque in addition to the load applied to the implant/attachment system leading to bone loss.[37] Open top impression technique was followed, abutments were splinted, and polyether impression material was used. This technique provides the most accurate working cast especially when multiple implants are placed. After the impression was made, the gingival mask was fabricated to allow production of desired emergence contour for better patient hygiene procedures beneath the future bar. Verification jig was fabricated and tried in the patient's mouth to check the accuracy of the impression and to ensure passive clinical fit of screw retained framework. [38-40]. CAD/CAM technology was used for bar fabrication as it helps to produce more passive and accurate frameworks in comparison to casting technology. Zirconia was reported to be more biologic than cast metals or even machined titanium as it had less incidence for adhesion of bacterial biofilm. CAD/CAM technology helped to produce zirconia work pieces with good fit. Sand blasting of both substrates and priming were made to improve the bond strength. Adhesive resin cement was selected as it provides higher bond strength values than other available cement. [41-44]

The participants were stratified equally in 2 groups Patients were assigned to receive either zirconium bar or metal bar using the balanced computerized randomization method [45] to ensure pretreatment comparability of the groups concerning base line criteria. Stratification, randomization, and allocation of participants were performed by a dental personnel who was blinded to treatment groups.

Peri-implant tissue health gingival (GI) indices were recorded. The probing depth (PD) was measured using a periodontal probe as the distance between the free gingival margin and the apex of the probe. The GI and PD were recorded lingually, mesially, buccally, and distally around each implant. Pocket probing depth (PD) is associated with loss of attachment and supporting bone, and this is natural during the first year. [46]

The increased GI in metal compared to zirconium group may be attributed to several factors. For clip-retained overdentures, relieve spaces within the fitting surface of the dentures around the bars and abutments should be provided to permit apical and rotational movements of the overdenture during function and relieve stresses transmitted to the implants. These spaces provide hidden area for plaque to accumulate, complicate proper oral hygiene practice especially around the abutments and beneath the bar, and increase the risk of mucositis and mucosal hyperplasia. [47] Moreover, the rough surfaces of bar resulted from casting and finishing procedures enhance the electrostatic binding capacity and result in rapid plaque accumulation and bacterial colonization. [48]

The proportion of leukocytes in the barrier epithelium at ceramic (ZrO_2) abutments was smaller than that at Ti and cast-to abutments. This observation indicates that the ZrO_2 material provided appropriate conditions for epithelial attachment in the establishment of a proper mucosal seal. Another explanation may be related to differences in bacterial colonization on the abutment surfaces. Such a hypothesis was proposed by Rimondini et al. and Scarano et al. Rimondini et al. evaluated microbial colonization on titanium and zirconium discs in vitro and in vivo. While

only small differences were detected in bacterial adherence between the two surfaces in the in vitro test, the results from the in vivo model revealed that significantly larger amounts of bacteria were found on titanium than on zirconium discs. (49) Similar findings were reported by Scarano et al. They analyzed the percentage surface covered by bacteria on titanium and zirconium discs. The discs were mounted to removable acrylic devices that were adapted to the premolar–molar regions of 10 subjects. Scanning electron microscopy analysis of the discs that was performed after 24h revealed that the surface area covered by plaque was significantly smaller at zirconium than at titanium discs. (50)

Also, the results of this study go with another study which found out that Blood flow in soft tissue around zirconia abutments is similar to that around natural teeth, and significantly greater blood flow was maintained around zirconia abutments compared with metal abutments. Moreover, zirconia abutments could be advantageous for the maintenance of immune function by improving blood circulation. (51)

CONCLUSION

Within the limitation of this study, zirconia bar is considered more biocompatible then metal bar.

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