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Implant-Supported Milled Bar Overdenture



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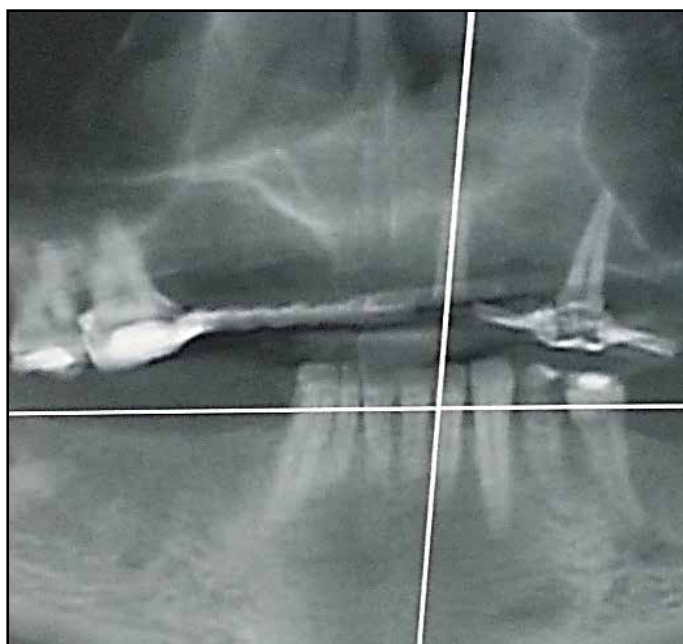
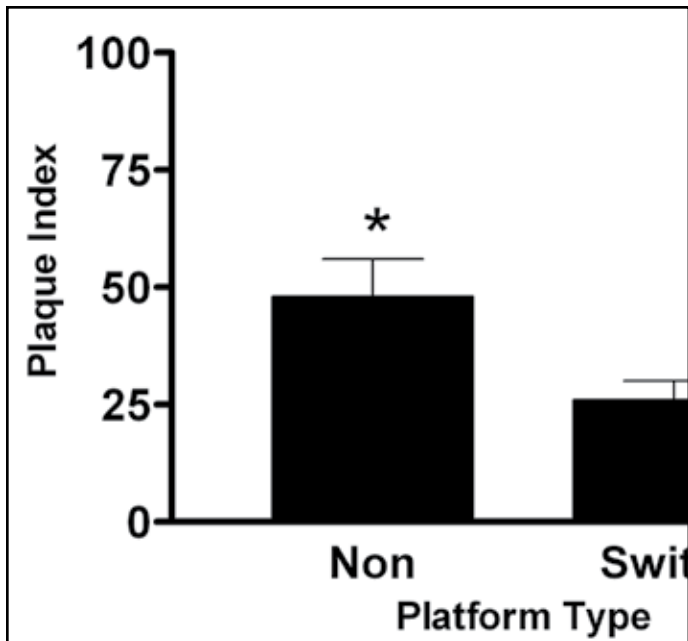


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Implant-Supported Milled Bar Overdenture

Dr. Les Kalman¹

Abstract

Background: Edentulism is a common condition affecting a significant portion of the population. A conventional approach to compensate for this condition is the fabrication and placement of dentures; however, traditional denture rehabilitation has its limitations. Implant-retained dentures provide increased retention, while implant-supported dentures provide ideal bracing and resolution of many patient complaints. The implant-supported milled bar overdenture is an alternative approach to rehabilitation in which the patient can easily remove and clean their denture, maximizing oral hygiene. This approach is technically demanding but provides an accessible, cost-effective option.

Methods: A 54-year-old healthy patient was treatment planned for rehabilitation with an implant-supported milled bar overdenture with five endosseous implants. Surgery was uneventful. Clinical and lab procedures

were completed for the predictable delivery of the milled bar and the overdenture.

Results: Short-term surgical and prosthetic issues were minimal due to ideal case selection, proper treatment planning, and treatment delivery. Long-term evaluation indicated no mechanical issues and minimal soft tissue concerns. Radiographically, bone levels were maintained. Resolutions of the patient's complaints were successfully executed.

Conclusions: With proper case selection, treatment planning, and delivery, the milled bar overdenture can predictably and successfully rehabilitate the edentulous patient. The removability of the denture allows the patient the ability to maintain proper oral hygiene. Cost-effectiveness may offer increased access for patients to this alternative approach, while post-delivery adjustability may offer interest for clinicians.

KEY WORDS: Dental implants, prosthetics, milled bar overdenture

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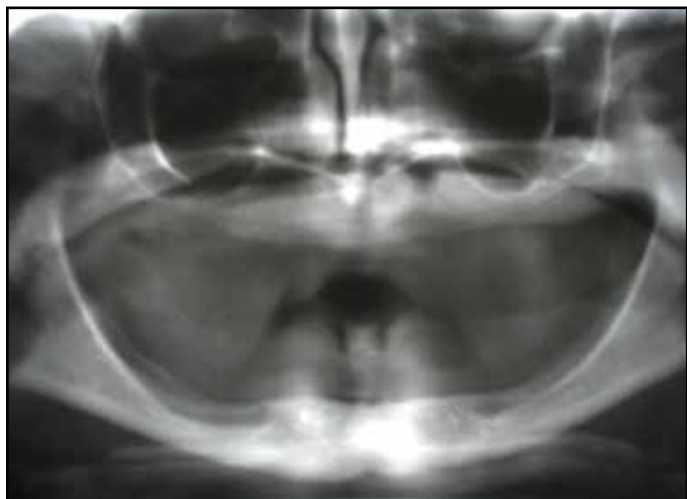


Figure 1: Pre-op radiograph of female patient.



Figure 2: Radiograph displaying the placement of five mandibular implants with cover screws.

INTRODUCTION

Edentulism affects about 6-10% of the world's population.¹ With the complete loss of teeth in an arch, especially the mandible, several issues manifest themselves. Reduced mastication strength, facial aesthetics, over-closure, and poor oral hygiene are consequences of edentulism.² The main causative agent is residual ridge resorption, which is primarily due to tooth loss.³ Although this process is irreversible, it may be minimized with the application of dental implants.³

Dental implants represent an elective phase of dentistry in which a biocompatible screw is osseointegrated into bone.⁴ Once integrated, the implant can help minimize bone resorption and provide an anchor for the attachment of intra-oral prosthetic components.⁵ From a single tooth implant-support crown to a full-arch hybrid denture, the implants can retain and support tooth replacements.³ Retention implies that the implants help withstand forces in tension, thereby keeping the prosthesis in place.³

Support implies that the implants serve to also resist the compressive forces that are frequently presented in these cases.⁶ With implant support, forces on the intra-oral tissues are minimized, ultimately maximizing patient comfort.⁷

Implant-retained prostheses provide some mitigation to the aforementioned issues;⁸ however, an implant-supported prosthesis can provide maximum resolution to the problems correlated with complete edentulism.⁹ The ideal solution for an edentulous patient is an implant-supported approach.¹⁰ Currently, there has been much progress with the fixed screw-retained hybrid denture. Although aesthetics can be favorable, the product has restraints due to technical difficulty, cost, adjustability and maintenance of oral hygiene.⁴ The milled bar overdenture serves as an alternative approach which yields the stability and retention of a fixed prosthesis, but also the convenience and flexibility of a detachable prosthesis.¹¹ This approach addresses cost and hygiene concerns, but the technical difficulty still remains.¹¹

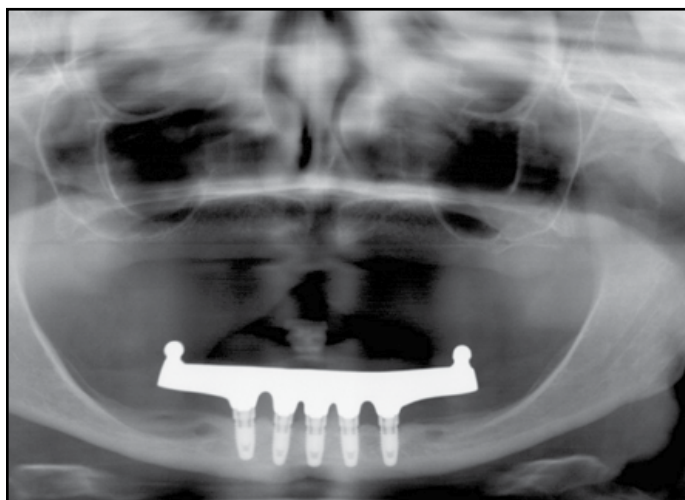


Figure 3: Panoramic x-ray capturing mandible with an implant-supported milled bar.

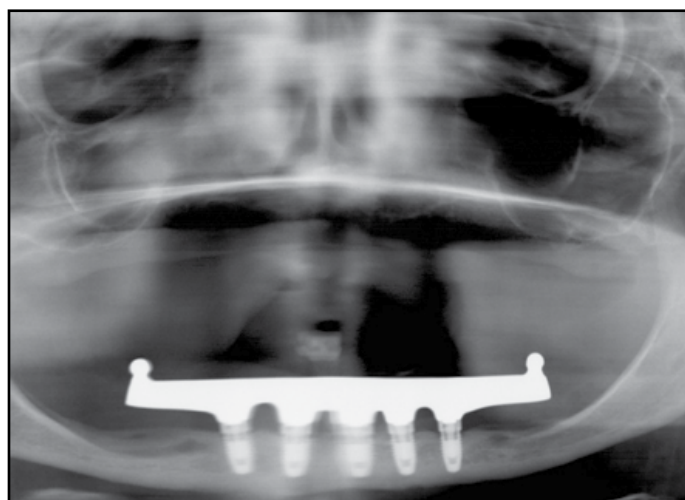


Figure 4: 12-year post-op view of female patient.

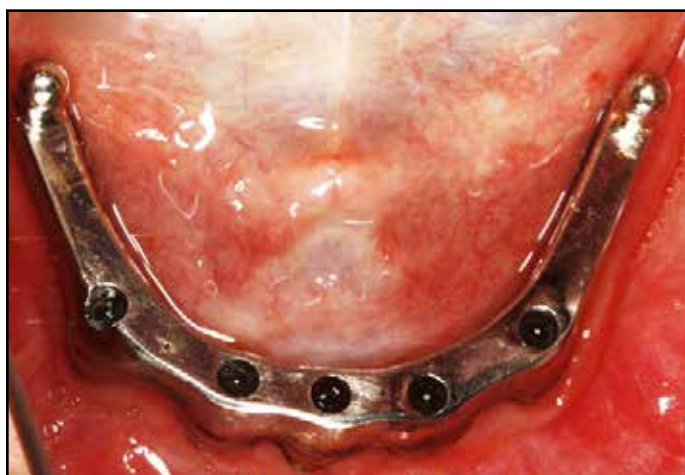


Figure 5: Top view of soft tissues demonstrates good oral hygiene.



Figure 6: Frontal view of implant-supported milled bar with overall good hygiene.

With the milled bar overdenture, the bar remains attached to the implants, while the complete denture has the ability of removal and reseating. This case study demonstrates the clinical aspects of the milled bar overdenture and evaluates the case 12 years post-operatively.

METHODS

Clinical

A 54-year-old female patient with complete dentures presented with the following chief complaints: 1. Her lower denture shifts 2. Her lower denture is painful on chewing, and 3. Her face appears aged and 'squished'. Thorough medical and dental histories were obtained and a



Figure 7: Left-side view of milled bar displaying surrounding healthy soft tissues.

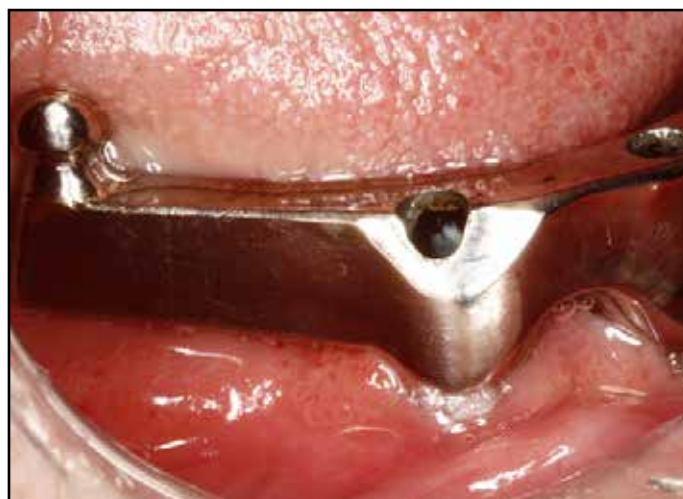


Figure 8: Right-side view of milled bar showing good hygiene of soft tissues.

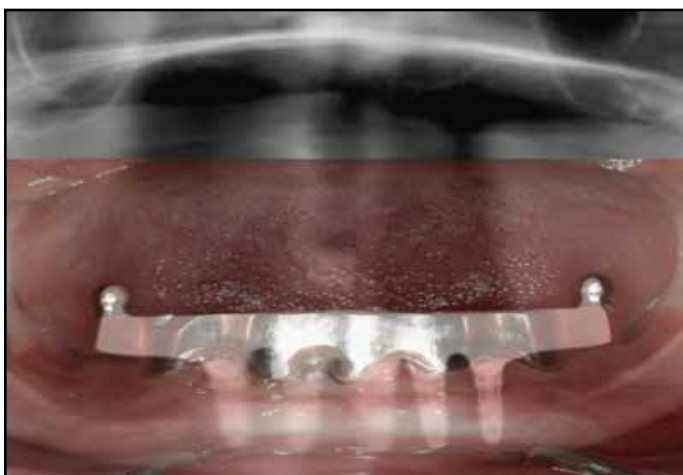


Figure 9: Composite image superimposed over panoramic radiograph to illustrate the clinical aspect of the bar to the radiographic placement of the implants.

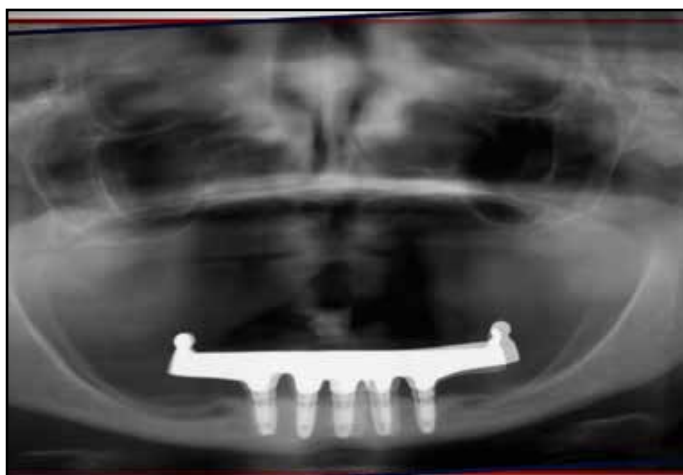


Figure 10: Composite image of post-op radiograph superimposed over 12-year panoramic radiograph to show bone maintenance levels over time.

complete dental examination with radiographs was executed (Figure 1). Diagnoses revealed the following: a severely atrophic mandible, loss of vertical dimension, and over-closure. Her medical history was non-contributory. Her maxillary denture fit well but appeared worn and discoloured. Tentative treatment plans were presented with an appropriate informed con-

sent. The patient elected for the fabrication of a new complete maxillary denture, an implant-supported mandibular denture, and five endosseous mandibular implants supporting a milled bar. Several appointments followed for the acquisition of records. Her existing dentures were soft-tissue lined and the teeth were built up with composite and triad, to compensate

for the lack of vertical dimension and compromised aesthetics. The patient was given several weeks to adjust to the new rehabilitation. Upon re-evaluation, vertical dimension was restored and facial aesthetics were improved.

Surgery

A mandibular cast was prepared with the proposed implant placement and was utilized as a simulation model. The patient was prepped for implant surgery under local anaesthesia in an office setting. A two-stage surgical approach was outlined and implemented. Vital signs were continually monitored. Local anaesthetic was delivered and a full thickness mucoperiosteal flap was reflected and secured. The mental foramen was identified. Execution of the surgery was performed freehanded with the use of the simulated model. Standard surgical principles were followed for the preparation of five osteotomies between the mental foramen. Depth and angulations were validated through guide pins and radiographs. Arrangement and installation of five 10mm implants (Nobel Biocare, Kloten, Switzerland) was followed by the placement of a cover screw (Figure 2). The incision was sutured and standard post-operative instructions were given with appropriate therapeutics (analgesics and antibiotics). Post-operative assessments were performed at a 48-hour and seven-day interval; they were uneventful. The complete mandibular denture was adjusted and tissue conditioner was replaced to minimize any force on the implants. A three-month period was granted for osseointegration, in which the patient was examined clinically to identify any issues and to uncover the implants. Local anaesthesia was delivered

and incisions were made around the implants. Healing abutments were placed to allow for soft tissue healing. Chlorhexidine rinse was dispensed and a 10-day healing period followed.

Prosthetic

Healing abutments were removed. Impression copings were placed and a full arch open-tray mandibular impression was taken with PVS. Maxillary and mandibular complete denture records were gathered for the manufacturing of new dentures. Healing abutments were inserted again and the impression was submitted to a laboratory. An implant position jig was lab fabricated, sectioned, and delivered for patient try-in. Each jig section was numerically coded to the implant. Healing abutments were removed and the jig was inserted into the implants. Seating was confirmed radiographically. The jig was then splinted together using light-cured resin (Triad, York, PA). The jig was removed as a single complete rigid unit. The healing abutments were replaced and the patient was dismissed. The jig was forwarded to the lab for the fabrication of the milled bar and complete lower denture. Once the patient returned, the healing abutments were removed and the milled bar was assessed for fit, accuracy, and suitability. Retention screws were lightly torqued and the position was radiographically verified. Retention screws were then torqued to specification. The maxillary and mandibular complete dentures were evaluated for form, fit, function, and esthetics. The mandibular denture was assessed for retention and support from the milled bar. Initially, O-rings were fastened to offer secondary retention but were later removed due to excessive retention. A base-

line panoramic radiograph was taken (Figure 3). Post-delivery instructions were given and follow-up assessments were achieved at 48 hours, one week, one month and three-month intervals.

RESULTS

Short term

Surgical healing was uneventful with no complications. All implants osseointegrated. Prosthetically, vertical dimension was restored with no significant side effects. Form, function, fit, and aesthetics were within normal limits with no complaints from the patient or spouse. The mandibular denture was entirely supported by the milled bar. Retention was exemplary. In fact, the patient had to employ spoons to gently prop the denture off the milled bar. The patient was able to masticate foods with no concerns. Oral hygiene was exceptional and was maintained with interdental devices. The patient was very pleased with the outcome. Hygiene recalls were scheduled with radiographs and occlusal assessments, as needed.

Long term

The patient was assessed at numerous yearly recalls but a lengthy evaluation was accomplished at a 12-year follow-up. At that appointment, there were no complaints and no apparent issues with the implants, milled bar, dentures, or overall function. A panoramic radiograph was taken (Figure 4). No pathology was noted and bone levels remained relatively unchanged. Clinical examination suggested that the soft tissues, implants, and dentures were all within normal limits. Oral hygiene was also good to very good (Figures 5,6,7,8). A composite image was generated with the milled bar photograph

superimposed over the panoramic radiograph (Figure 9). This image offers a visual approximation of the clinical aspect of the bar to the radiographic position of the implants. Additionally, a similar composite image was produced of the postoperative panoramic radiograph and the 12-year panoramic radiograph (Figure 10). The principle here was to illustrate the maintenance of the bone levels over the time period.

DISCUSSION

The elective phase of tooth replacement for this case was selected as implant supported, with a milled bar, to remedy the chief complaints and address the diagnoses. The outcome of this case study was favourable, with the predictable and successful rehabilitation of an edentulous patient. Hygiene was maintained, with adequate patient education and motivation. Cost was considerably lower than alternative fixed treatment options. Adjustability of the lower denture was easily achieved.

The long-term assessment proposed that there were no mechanical issues with the implants, milled bar, or overdenture. This can be attributed to proper case selection as well as adhering to proper surgical and prosthodontic fundamentals. Radiographic evaluation implied that implant-supported prostheses can help preserve bone levels and minimize bone resorption due to tooth loss.

The milled bar overdenture represents as an alternative approach for implant-supported prostheses to rehabilitate an edentulous arch. Guided surgery consideration, with an appropriate CBCT, may prove beneficial. The clinical procedures require a strong collaboration and communication with a laboratory.

The clinical prosthodontic steps demand precision and attention to detail for predictable success. Careful case assessment should be completed in order to determine if this approach would be beneficial to the patient as a suitable alternative. With improved oral hygiene, a reduction in cost, and simple adjustability of the denture, the milled bar overdenture provides another option for an implant-supported approach to rehabilitation. ●

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Disclosure

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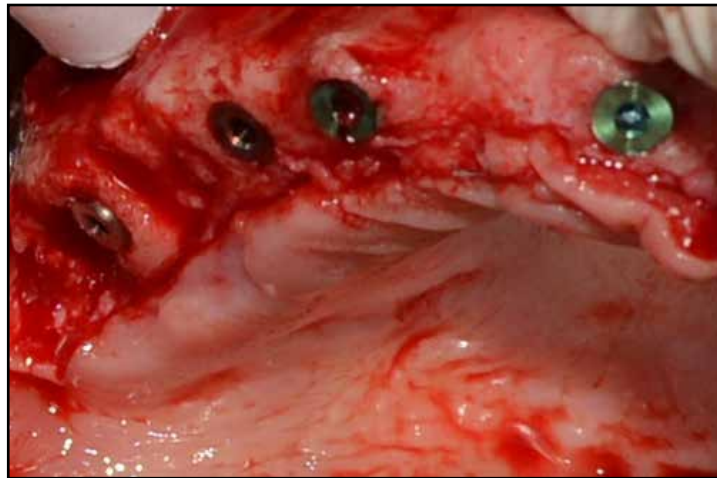
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Full Mouth Rehabilitation of Patient with Advanced Chronic Periodontitis: A Case Report

**Algabri RS, PhD¹ • Al Adashi OQ, Ms² • Alqutaibi AY, PhD³
Shandy M, PhD⁴ • Fahmmy A, PhD⁵**

Abstract



In rehabilitation of patients with advanced chronic periodontitis, a great concern to both patient and dentist is the effect of periodontal infection on the implant survival rate. In this case report, full mouth rehabilitation of patient with history of advanced chronic peri-

odontics was described. The treatment performed includes full arch maxillary fixed implant supported prosthesis, mandibular anterior fixed teeth supported prosthesis and mandibular posterior fixed implant supported prosthesis.

KEY WORDS: Dental implants, sinus lift, periodontitis

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Figure 1-a: Preoperative intra oral view.



Figure 1-b: Preoperative panoramic x-ray.

INTRODUCTION

Osseointegration, including initial and long-term stability, is the determinant factor for dental implant success. Periodontal diseases and periodontal pathogenic bacteria, among other factor that play a role in achieving and maintaining implant stability.¹ There is limited evidence suggests that the implant placement in patients with periodontal disease is at high risk of implant failure.² However, It has reported that there are only minor concern to install implants in patients with a previous history of periodontitis.^{3,4} This was based on a report of such patients after an evaluation period of 1–8 years. In a longitudinal study of implants installed in patients previously affected with periodontitis, the presence of putative periodontal pathogens at peri-implant and periodontal sites did not appear to predict future attachment loss or implant failures.⁵ To enhance bone volume for implant placement in patients with compromised edentulous ridge, there are several surgical techniques available. These procedures include bone grafting,⁶

Guided bone regeneration⁷, sinus lift procedures,⁸ and distraction osteogenesis.⁹ Recently, the idea of “Prosthesis driven implant dentistry” have emerged not merely to consider the available residual bone, but also proper positioning of the planned implants.¹⁰ Therefore, the Dual purpose templates have emerged, those not only to be used for radiographic examination but also would be used for surgery and implant installation.¹¹ In this case report, full mouth rehabilitation of patient with history of advanced chronic periodontics was described. The treatment performed includes full arch maxillary fixed implant supported prosthesis, mandibular anterior fixed teeth supported prosthesis and mandibular posterior fixed implant supported prosthesis

CASE REPORT

A 49-year-old, partially edentulous (with severally atrophic maxilla) medically fit female patient presented to Prosthodontics Department, Faculty of Dentistry, Cairo University with history of un-retentive fixed partial acrylic bridge in Janu-

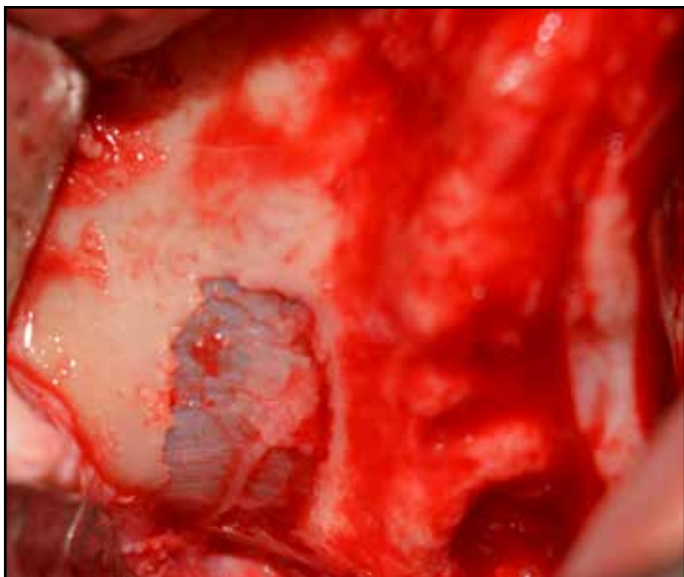


Figure 2a: Sinus lift procedure with bone graft.

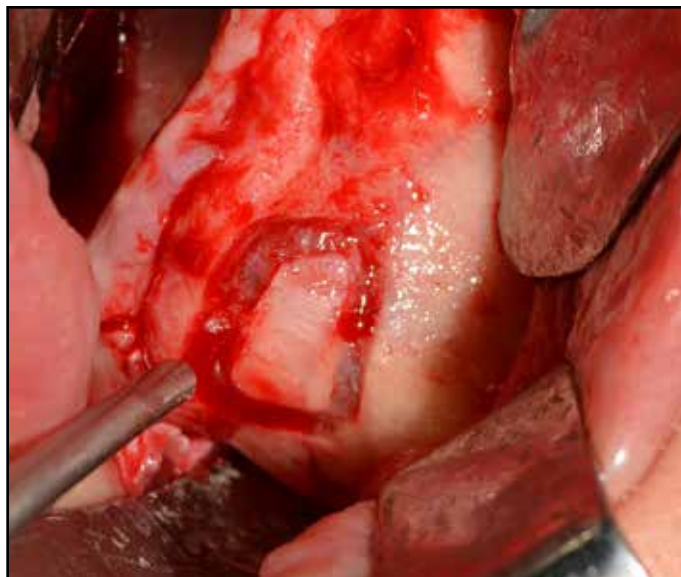


Figure 2b: Sinus lift procedure with bone graft.



Figure 2c: Sinus lift procedure with bone graft.



Figure 2d: Sinus lift procedure with bone graft.

ary 2015, the remaining maxillary teeth were mobile with history of advanced chronic periodontitis. The remaining mandibular teeth were at moderate periodontal bone loss. The patient asked for fixed prosthesis for the upper and lower arch. Clinical and radiographic examination revealed severe resorption of periodontal

bone of maxillary remaining teeth in addition to atrophic edentulous posterior maxilla with horizontal and vertical bone deficiency (Fig.1).

PREOPERATIVE PLANNING

The patient sent to periodontics department for scaling and root planning. The mobile teeth were



Figure 3-a: Implant placement in maxillary arch.

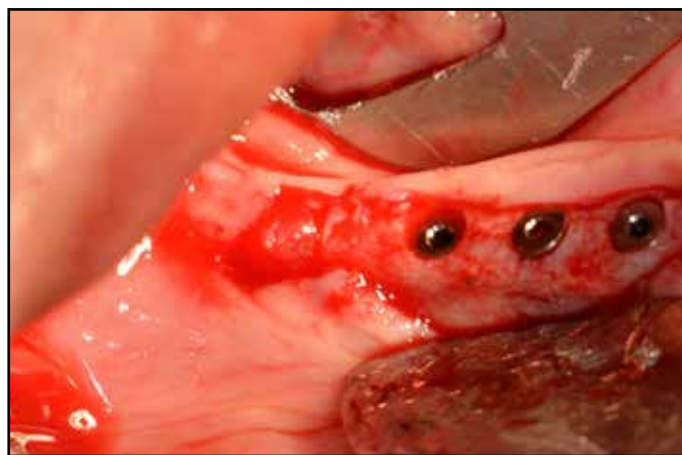


Figure 3-b: Implant placement in posterior mandible.



Figure 4: Panoramic x-ray after implants placement.

extracted, after two months the lower remaining teeth prepared for full ceramic fixed bridge. Primary impression taken after mandibular teeth supported bridge cementation. Diagnostic maxillary and mandibular casts were mounted on an articulator. A diagnostic wax up and set up was made to represent the anatomy and ideal posi-

tion of the planned implants. A duplicate of the wax up was then converted to a radiographic guide. The patient wore the radiographic guide during CBCT scan. The CBCT data was then imported into the computer planning software. Virtual planning of dental implants according to the patient's anatomy was then performed.



Figure 5: Intra-oral view of patient with maxillary and mandibular prosthesis after two months of function.

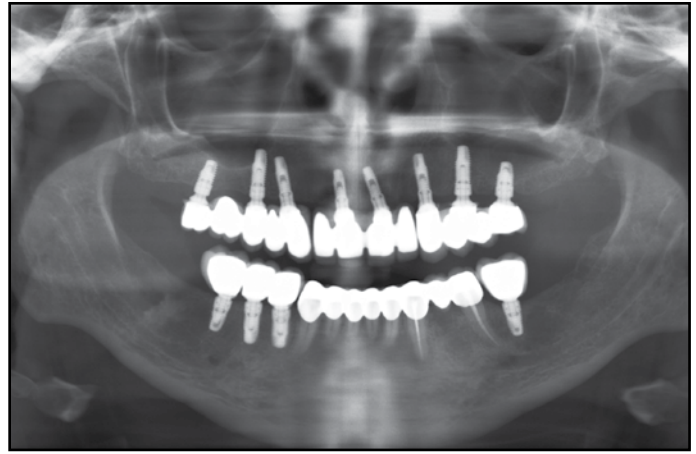


Figure 6: Panoramic x-ray after four months of function.

During the virtual planning it was evident from CBCT, that implant length at sites 16, 17, 26 and 27 (FDI tooth numbering system) was 6, 4, 6.5 and 3.5 mm respectively, so that this areas would require sinus lift procedure. Once completed, the planning was sent to the manufacturer for the fabrication of the surgical template to be used at the time of surgery.

SURGICAL PROCEDURE

Two hours before the surgery the patient received 2gm Amoxicillin; an additional dose of 1g twice a day for 1 week after surgery, was prescribed. Surgery was performed under general anesthesia. Flap incision and reflection for the maxillary arch and bilateral posterior mandible performed. For the upper arch the bilateral open sinus lift were done with placement of a biphasic synthetic bone graft material (Genex Paste, Biocomposites, UK). The surgical stent was then placed in the patient's mouth (Fig.2). The sequence of drilling was carried out according to the manufacture instruction. All the implants were installed in the proposed pre-operative planned sites and cover-

ing screws were placed to all implants (Fig. 3). Postoperative instructions were given as patients were instructed to apply ice packs for the first 24 hours and follow the antibiotic regimen for five days. 0.2% Chlorhexidine mouth wash solution was prescribed for the patients at least two times daily for 3 days. The patient upper denture was relieved and a soft liner (Acrostone, Acrostone Relining Materials) was applied to help in seating of the denture after implant installation. After one week the sutures were removed. After implant installation, a post-operative panoramic x-ray was made (Fig. 4). After 6 month of implant placement the classical steps of fixed prosthesis that include but not limited to, splinted impression, verification jig construction, metal framework fabrication and definite prosthesis delivery were followed. The final fit, stability and occlusion were evaluated. The patient was instructed on maintenance of the health of the oral tissues. The patient returned for a 1-week, 1-month, 6-months and 12-months post insertion appointments stating that she was satisfied with the esthetics and function of the maxillary and mandibular prosthesis (Figs. 5 and 6).

DISCUSSION

In this case report, full mouth rehabilitation of patient with history of advanced chronic periodontics was described. The treatment options available for this patient including: extraction followed by implant-supported prosthesis and tooth-supported overdenture. Depending on the existing condition of the remaining dentition and the patient preference, it was decided to construct full arch maxillary fixed implant supported prosthesis, mandibular fixed teeth supported prosthesis and mandibular fixed implant supported prosthesis. Although the results of some studies^{12,13} have revealed higher susceptibility for peri-implantitis in patients with a history of periodontitis, when compared to patients without such a history, there is limited evidence to support such a hypothesis.² In previous prospective longitudinal study compared the survival and success rates of two different implant systems for patients with history of advanced chronic periodontitis.¹⁴ Prior to implant installation, the patients had undergone periodontal therapy including surgery to eliminate all pathologically deepened pockets. Subsequently, the patients who were able to maintain high standards of oral hygiene were involved in a carefully monitored maintenance care program and followed up to 84 months. The result revealed that periodontally compromised patients, who have experienced a considerable loss of alveolar bony support, can be successfully treated with implants. Implant loss may be the result of multiple episodes of peri-implant infections¹⁵ and, hence, the incidences of peri-implantitis in populations with a history of periodontitis may also be significantly higher than in patients without such a history. In the present case report, promising results have been reported, the mean bone loss around

13 placed implants was 0.61 mm after one year of function. This promising result could be clarified as the patient was non-smoker and an effective preventive program that was followed for this patient with pre-implant maintenance program every 3 months in periodontics department. Several studies have been undertaken to determine risk factors for peri-implant bone loss such as, e.g. genetic markers. From the patient cohort followed in the Karoussis et al.¹⁶ study, interleukin-1 gene polymorphisms were determined and compared to the annual rate of bone loss in periodontally susceptible patients¹⁷. These studies revealed that IL-1 genotype positive smoking patients yield a higher risk for peri-implant bone loss than IL-1 negative smokers. Heavy smoking patients also significantly demonstrated higher rates of peri-implant alveolar bone loss than nonsmokers. ●

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Disclosure

The authors report no conflicts of interest with anything mentioned in this article.

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MMP-8 Levels in Peri-Implant Sulcular Fluid from Platform-Switched and Conventional Implants

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Abstract

Background: Despite clinical implications of the role of MMP-8 in gingival inflammation few studies have examined the correlation of MMP-8 to platform switching in implant dentistry. Objective: The objective of this study was to compare MMP-8 concentration in peri-implant sulcular fluid associated with non-platform-switched and platform-switched implants.

Methods: Twenty-one adult patients with implants placed for at least 4 months with crown restoration were enrolled in the study. Peri-implant sulcular fluid was sampled from 21 non-platform-switched implant sites and 13 platform-switched sites. Gingival crevicular fluid was sampled from 37 control sites. MMP-8 levels were determined by ELISA and results were statistically compared using probability at $P < 0.05$.

Results: Mean plaque index was significantly higher in patients with non-platform-switched

implants (48%) compared to those with platform-switched implants (26%, $P = 0.0308$). MMP-8 levels in fluid sampled at initial visits were not different between controls (17.9 ± 1.7 ng/ml), non-platform-switched implants (15.1 ± 2.3 ng/ml), and platform-switched implants (16.1 ± 3.2 ng/ml). At re-evaluation, MMP-8 levels were significantly decreased in controls (11.6 ± 2.2 ng/ml), non-platform-switched implants (8.9 ± 1.7 ng/ml), and platform-switched implants (3.9 ± 2.2 ng/ml, $P < 0.05$ for all comparisons). However no difference in MMP-8 levels between implant platforms was observed.

Conclusions: MMPs play central roles in wound healing and inflammatory response. However the current study suggests that MMP-8 levels may not be a consistent diagnostic indicator to assess clinical response post-function where the goal is to compare different implant abutment platform designs.

KEY WORDS: MMP-8, peri-implantitis, platform-switch, implants, sulcular fluid

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INTRODUCTION

Lazzara and Porter¹ introduced the concept of platform switching, referring to the use of a smaller-diameter abutment on a larger-diameter implant collar, in implant dentistry as a measure to minimize the peri-implant inflammatory response and to preserve crestal bone. By positioning the implant-abutment junction away from the implant shoulder-bone contact a reduction of crestal bone loss and containment of inflammatory connective tissue infiltrate above the implant platform was achieved.² Two systematic reviews of clinical studies on the effect of platform switching on marginal bone loss revealed that platform switching may preserve marginal bone around implants. Additionally the severity of bone loss may be inversely related to implant abutment mismatch.^{3,4}

Peri-implant mucositis is defined as a reversible inflammatory lesion of the gingiva or oral mucosa surrounding a dental implant.⁵ Peri-implantitis not only involves soft tissues around an implant but results in bone loss.⁶ Peri-implant sulcular fluid (PISF) is equivalent to the gingival crevicular fluid (GCF) around native teeth. Additionally the composition of PISF is similar to gingival crevicular fluid (GCF) containing substances from the host as well as from microorganisms in the subgingival and supragingival plaque. PISF and peri-implant crevicular fluid (PICF) have been used interchangeably in the literature and in this report PISF will be used.

Among a host of other proteins, matrix metalloproteinases (MMPs) have been used as biomarkers in PISF for assessing inflammatory conditions and defining the presence of peri-implant mucositis.^{7,8} MMPs are a family of enzymes which degrade extracellular matrix and basement membrane components; MMP-8

(neutrophil collagenase or collagenase 2) targets the fibrillary collagens type I, II, and III.^{9,10} MMP-8 has been identified in PISF where it is thought to play a primary role in collagen type I destruction in the periodontium.^{11,12} In support of this several studies have demonstrated elevated levels of MMP-8 in PISF from patients with peri-implantitis.¹³⁻¹⁵ Although Arakawa et al.¹⁶ demonstrated that MMP-8 is the major collagenase present in PISF of active peri-implantitis sites, the authors cautioned that future studies with larger study samples are necessary to confirm MMP-8 as a predictor for active periods of peri-implantitis alveolar bone loss.

Despite the potential clinical importance of MMP-8, and the development of platform switching in implant dentistry, to our knowledge only one study has examined MMP-8 levels in PISF with respect to platform switching.¹⁷ In the report, peri-implant sulcular fluid samples were taken from implants and from periodontally healthy adjacent teeth thirty-six months after prosthetic rehabilitation. The authors found no statistically significant differences in MMP-8 values between the groups.

To provide additional evidence for the relationship between MMP concentration and implant type, the aim of this study was to compare the concentration of MMP-8 in PISF around non-platform-switched (conventional) and platform-switched implants. The hypothesis is that a reduction in MMP-8 will be observed in PISF of platform-switched implants as compared to non-platform-switched implants.

MATERIALS AND METHODS

Study population

This cross-sectional prospective study was reviewed and approved by the University of

Detroit Mercy Institutional Review Board (UDM IRB Protocol #1112-49). Study volunteers were informed of the risks and benefits of the study and signed an informed consent form prior to agreeing to participate in the study. Twenty-one patients who had implants were recruited from the University of Detroit Mercy School Of Dentistry. The following inclusion criteria were used to select study volunteers: 1) systemically healthy, 2) no active periodontitis, 3) no smoking, 4) no pregnancy, 5) no alcohol or drug use, and 6) received a conventional or platform-switch implant restoration within the last 4 months with final crown restoration. There was an average of 188 days between implant placement and restoration. Non-platform-switched implants ($n = 13$) were defined as a two stage implant system where the abutment and implant platform were of similar diameter. The platform-switched implant ($n = 8$) was defined as a two stage implant system where the abutment and implant platform diameters were different. Implants were evaluated with a conventional periapical radiograph to determine the platform connection and to characterize the implant system.

Study volunteer health history information that was collected included gender, age, periodontal diagnosis and prognosis, plaque index, gingival index, probing depth, generalized bone loss, smoking status, and implant system.

Sample collection

PISF from implant sites and gingival crevicular fluid (GCF) from native teeth as control were collected using the PerioPaper collection strip method (OralFlow Inc., Smithtown, NY, USA). Samples were collected from distal, facial, mesial, and lingual sites prior to periodontal probing to pre-

vent blood contamination. Sampling sites were isolated with cotton, and air-dried before the collection strip was inserted into the gingival sulcus for 30 seconds. The volume of PISF or GCF was determined using a Periotron 8000 (OralFlow). Collection strips were placed into a sterile tube and frozen at -80°C until analysis. For 17 of the 21 volunteers, after oral hygiene reinforcement and plaque control, PISF and GCF were collected again at a 6 to 8 week re-evaluation.

ELISA

PISF and GCF were analyzed for levels of MMP-8 using a commercially available ELISA kit designed to measure total MMP-8 (pro- and active forms) (R&D Systems, Minneapolis, MN, USA). Proteins absorbed to the collection strip were eluted at room temperature for one hour in 50 μL phosphate-buffered saline containing proteinase inhibitors (Sigma-Aldrich, St. Louis, MO, USA). Eluates were centrifuged at 3000g for 10 minutes to remove debris. MMP-8 levels were calculated as ng protein/ml PISF or GCF using a standard curve. Samples were run in duplicate.

Statistical analysis

Data was analyzed using t-test or ANOVA with Tukey post-test and probability value $P < 0.05$.

RESULTS

Twelve males and 9 females participated in this study; the average age was 50 years and the range was 25 to 70 years of age. Participants acknowledged over the counter or prescription drug use, but smokers and those with systemic health issues were excluded from the study. Oral health parameters of the study participants are summarized in Table 1.

Table 1: Study Participant Oral Health Parameters

Periodontal Diagnosis	Periodontal Prognosis	Bone Loss (%)	PI (%)	Implant System
1 Generalized moderate gingivitis with a history of generalized moderate periodontitis	Good	25	100	Conventional
2 Periodontal health	Good	25	40	Conventional
3 Generalized slight gingivitis with a history of generalized slight chronic periodontitis	Good	25	66	Conventional
4 Generalized moderate gingivitis with a history of generalized slight chronic periodontitis	Good	25	45	Conventional
5 Generalized slight gingivitis	Favorable	< 25	50	Conventional
6 Generalized slight gingivitis	Favorable	< 25	50	Conventional
7 Generalized slight gingivitis	Favorable	< 25	20	Conventional
8 Generalized slight gingivitis	Favorable	< 25	19	Conventional
9 Generalized slight gingivitis with a history of generalized slight chronic periodontitis	Favorable	25-50	40	Conventional
10 Generalized slight gingivitis	Favorable	25-50	100	Conventional
11 Periodontal health with a history of generalized slight chronic periodontitis	Favorable	<25	38	Conventional
12 Generalized slight gingivitis	Favorable	< 25	18	Conventional
13 Generalized slight gingivitis	Favorable	< 25	45	Conventional
14 Generalized slight gingivitis with a history of generalized slight chronic periodontitis	Favorable	25-50	35	Platform switch
15 Periodontal health	Favorable	< 25	35	Platform switch
16 Periodontal health	Favorable	< 25	26	Platform switch
17 Generalized moderate gingivitis	Favorable	< 25	10	Platform switch
18 Generalized slight gingivitis	Favorable	< 25	33	Platform switch
19 Generalized moderate gingivitis	Favorable	< 25	25	Platform switch
20 Generalized gingivitis	Favorable	25-50	33	Platform switch
21 Generalized slight gingivitis	Favorable	< 25	10	Platform switch

A total of 71 sites were sampled, 21 PISF samples were taken from non-platform-switched implants, 14 PISF samples were taken from platform-switched implants, and 36 GCF samples were taken from control teeth. Of the non-platform-switched implant sites, 19 (90%) had a gingival index of 0, and 2 (10%) had a gingival index of 1. The average probing depth was 2.9 mm with a range of 1 to 4 mm. Of the platform-switched implant sites, 9 (64%) had a gingival index of 0 and 5 (36%) had a gingival index of 1. The average probing depth was also 2.9 mm with a range of 1 to 4 mm. Of the control sites, 29 (81%) had a gingival index of 0 and 7 (19%) had a gingival index of 1. The average probing depth was 2.8 mm with a range of 1 to 4 mm. In general the largest average amount of fluid collected per site was from the non-platform-switched implants, followed by the platform-switched implants and then the control sites.

Wide biological variability was noted for MMP-8 levels in PISF and GCF. The mean MMP-8 concentration in control GCF was 17.9 ± 1.7 ng/ml, with a range of 1.4 to 31.3 ng/ml (Figure 1). The mean MMP-8 concentration in PISF in the non-platform-switched implants was 15.1 ± 2.3 ng/ml with a range of 1.5 to 33.2 ng/ml. The mean MMP-8 concentration in PISF in platform-switched implants was 16.1 ± 3.2 ng/ml with a range of 1.6 to 33.2 ng/ml. No difference in mean MMP-8 levels was observed, this is likely due to the wide range of values.

Following oral hygiene instruction and plaque control, at re-evaluation the mean MMP-8 concentration in control GCF ($n = 12$) was 11.6 ± 2.2 ng/ml, with a range of 1.0 to 24.8 ng/ml (Figure 2). The mean MMP-8 concentration in PISF in the non-

platform-switched implants ($n = 8$) was 8.9 ± 1.7 ng/ml with a range of 1.6 to 9.7 ng/ml. The mean MMP-8 concentration in PISF in platform-switched implants ($n = 7$) was 3.9 ± 2.2 ng/ml with a range of 1.2 to 15.7 ng/ml. Although no difference in mean MMP-8 levels was observed when comparing the implant platforms at re-evaluation, the concentrations were significantly lower compared to initial values ($P < 0.05$ for all comparisons).

In patients with the non-platform-switched implants the mean plaque index at initial evaluation was $48 \pm 7\%$ (Figure 3). For patients with platform-switched implants the mean plaque index at initial evaluation was $26 \pm 4\%$. The plaque index associated with the platform-switched implants at initial evaluation was significantly lower compared to the non-platform-switched implants ($P = 0.0308$). Following oral hygiene reinforcement and plaque control, at re-evaluation the mean plaque index for patients with the non-platform-switched implants was $45 \pm 5\%$ and for patients with the platform-switched implants $20 \pm 4\%$ ($P = 0.0300$).

DISCUSSION

Because MMP-8 promises to be an early signal of peri-implant inflammation¹⁸ it was rational to extend the body of knowledge regarding this phenomenon. Sorsa et al.¹⁹ demonstrated that healthy crevicular fluid samples present less than 14 ng of active MMP-8, while inflamed sites show values higher than 14 ng. These findings are in agreement with Prescher et al.²⁰ who demonstrated values of active MMP-8 ranging from 0 to 7.4 ng (mean value 1 ng) to be consistent with healthy periodon-

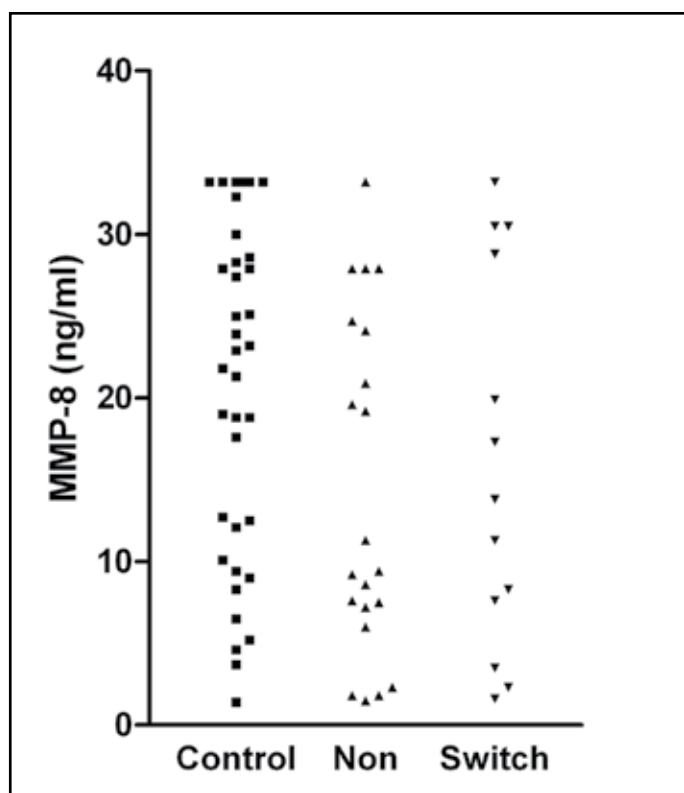


Figure 1: MMP-8 levels in PISF and GCF. Fluid samples from gingival crevices of healthy control teeth (Control), samples were taken from non-platform-switched implants (Non), and samples taken from platform-switched implants (Switch) were analyzed for MMP-8 concentration. Data are represented as a scatter plot to illustrate the wide biological variability of MMP-8 levels in control and treated teeth.

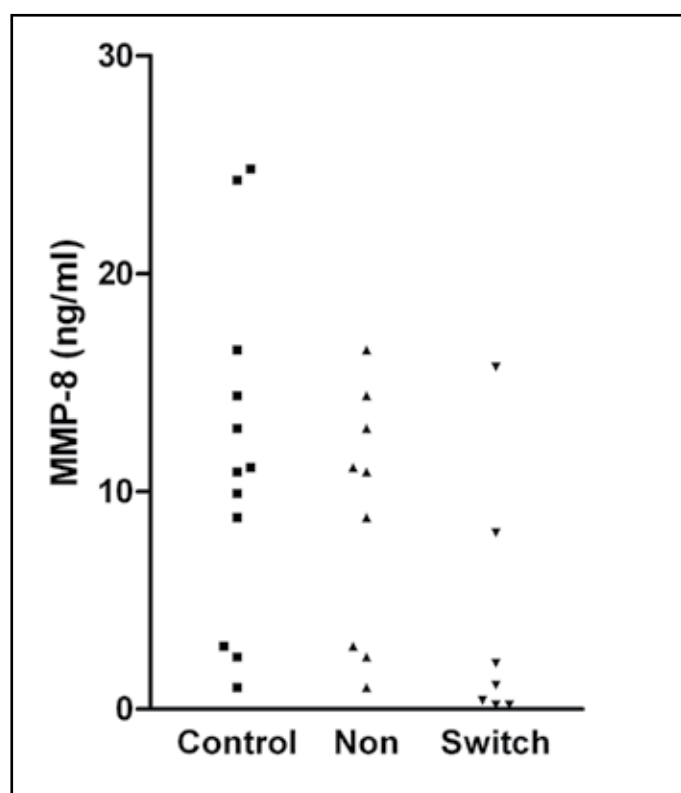


Figure 2: MMP-8 levels in PISF and GCF at re-evaluation. Fluid samples from gingival crevices of healthy control teeth (Control), samples were taken from non-platform-switched implants (Non), and samples taken from platform-switched implants (Switch) were analyzed for MMP-8 concentration. Data are represented as a scatter plot to illustrate the wide biological variability of MMP-8 levels in control and treated teeth.

tal sites and values ranging from 6 up to 65 ng (median 14.3) in the case of periodontitis. In the current study MMP-8 levels were greater in controls compared to implant sites, more prominently at re-evaluation. However it should be noted that in the current study both pro- and active-MMP8 species were measured thus direct comparisons between previous studies measuring only active MMP-8 cannot be done.

The aim of this study was to compare the concentration of MMP-8 in PISF around non-

platform-switched (conventional) and platform-switched implants with the hypothesis that MMP-8 levels would be reduced in PISF of the platform-switched implants. However in the present patient population there were no differences in PISF between the two implant platforms, either at the initial evaluation or at a re-evaluation; thus no support for the hypothesis was provided. This result is in agreement with Canullo et al.¹⁷ who reported no differences in MMP-8 concentrations in PISF derived

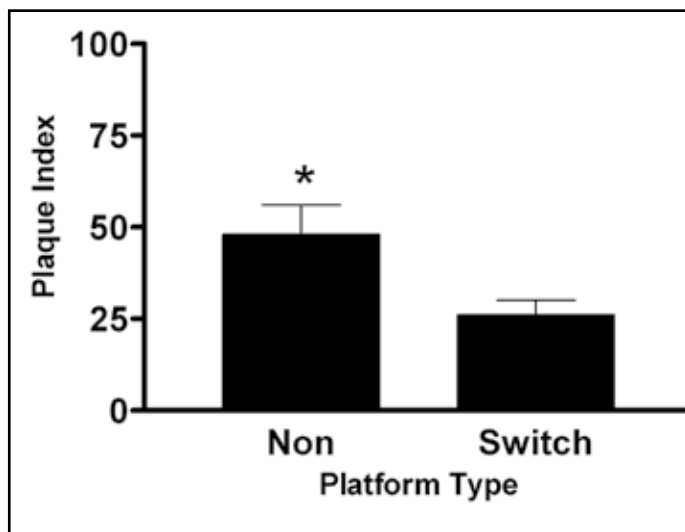


Figure 3: Plaque index scores related to implant platform. Analysis of plaque index, as percentage, of non-platform-switched implants (Non) compared to platform-switched implants (Switch) demonstrates a statistically significant increase in plaque in conventional implants (*, $p = 0.0308$).

from one of four implant-abutment mismatching parameters. In a study analyzing four different implant surfaces no differences in PISF MMP-8 levels were detected.²¹ Although MMP-8 levels in PISF may be useful in monitoring disease states, there is wide biological variability in levels of biomarkers in oral fluids, and therefore more evidence utilizing a large number of patients is needed to confirm MMP-8 utility.

Of the clinical parameters in this present study other than MMP-8 concentration, plaque index was significantly affected by the implant platform, with plaque significantly lower related to platform-switched implants. Total MMP-8 levels positively correlated with plaque and gingival scores at implant sites^{22,23} and in experimental gingivitis or mucositis total MMP-8 increased after undisturbed plaque accumulation.²⁴ In contrast, in a canine model no significant dif-

ferences in MMP-8 levels were detected in experimental mucositis induced by undisturbed plaque formation compared to mechanical plaque removal.²¹ In the present study no correlation between MMP-8 and plaque index could be determined because there were no significant differences in MMP-8 concentrations.

CONCLUSION AND CLINICAL IMPLICATION

Evidence suggests that MMPs play central roles in wound healing and the inflammatory response in oral tissues. However the present study suggests that MMP-8 may not be a consistent biomarker to assess clinical response post-function in implant abutment platform designs. ●

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Disclosure

The authors report no conflicts of interest with anything mentioned in this article.

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An investigation of the Availability of Consumer Prices for a Single Tooth Implant

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Abstract

Background: This study assessed the availability and costs of replacing a single tooth with an implant and crown in academic and private practices.

Methods: Two board certified prosthodontists in private practice from each state and the prosthodontics departments at all dental schools in the US were contacted. A standardized script was used, which identified the caller, expressed the need to replace a single tooth with an implant, and requested an estimate of the costs. Each practice was contacted three times on three different days before being categorized as an unsuccessful responder. All data were recorded and a statistical analysis was performed using two sample t-tests, a one-way ANOVA, chi-square, or Fisher's exact test when appropriate.

Results: Eighty private prosthodontic practices and 64 prosthodontic departments

were reached. Academic settings were more equipped to respond to the total price of placing and restoring an implant with a crown compared to private practices, and these differences were statistically significant (54.7% vs. 26.3% respectively, $p = 0.0005$). When looking at implant costs alone, dental offices from the Southwest and Southeast were more likely to provide estimated costs ($p = 0.0117$). The total cost in academic practices was significantly lower than in private practices (\$2,142.14 vs. \$3,983.33 respectively, $p < 0.0001$). Crown only costs were significantly higher in the Northeast (\$2,780.00, $p = 0.0002$).

Conclusion: Prosthodontic departments were more likely to disclose the costs of placing and restoring an implant, and were cheaper. Geographic locations influenced costs. Future research should focus on evaluating the difference in fees between general dentists and specialists.

KEY WORDS: Dental implants, price, academic, private practice, prosthodontics

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INTRODUCTION

Implant therapy for the replacement of missing single teeth has become an increasingly popular option throughout the United States. Wu et al.¹ using NHANES data found that the number of missing teeth declined from 8.19 in 1988-1994 to 6.50 in 2003-2004. Available critical research evidence shows that clinicians have the ability to safely and effectively provide implant replacements for teeth.^{2,3} A number of recent studies⁴⁻⁶ have reported on the short- and long-term success of dental implants; consequently, they are becoming a popular option for replacing missing teeth in partially edentulous patients. However, in a study⁷ where implant supported overdentures were offered at no cost to older patients, 27 out of 55 subjects refused implant treatment. Anxiety related to the need for surgical treatment was the primary reason for refusing treatment, followed by satisfaction with their dentures and, therefore, not seeing a need for implants.

Data concerning the price of dental implants are not well documented in the literature. Wang et al.⁸ studied public perceptions associated with dental implants and found that the cost of treatment was a major factor when choosing a treatment option. When asked about the disadvantages of implant therapy, a relatively recent study⁹ showed that 80.2 percent of respondents stated that high costs were a significant disadvantage. When implant costs have not been adequately reimbursed by dental insurance companies, patients are reluctant to accept this treatment for tooth replacement.¹⁰

Medical or dental tourism refers to the practice of traveling outside the country to receive care. In the medical community, the topic has been well studied.¹¹⁻¹³ Chavada et al.¹² cited lower

costs and higher availability of treatment as main reasons for seeking care via medical tourism.

In the dental field, little research has been done to establish the prevalence of dental tourism or the motivation of patients who practice dental tourism. However, there have been some reports of patients traveling across borders trying to find lower implant treatment costs.^{14,15} One study¹⁶ evaluated dental tourism associated with implant therapy and reported on a number of cases. In that study, the authors concluded that case specific variables, clinician training, and communication failures can result in poor outcomes for the patient.

To date, dental tourism within the United States for the replacement of a single tooth via an implant-supported crown has not been investigated. The aim of our study was to determine what information regarding treatment cost was available to a consumer and to also determine the actual cost of that treatment based on practice type, region, and city size.

MATERIALS AND METHODS

All 64 dental schools in the U.S. were identified and contact numbers were obtained for their prosthodontic departments. Using the American College of Prosthodontists 2015 membership directory, the offices of two board certified private practice prosthodontists were randomly selected from each state. When possible, care was taken to avoid calling two prosthodontists working in the same office building. Not all states had two board certified private practice prosthodontists listed in the directory. Some states had no private practice offices listed at all.

A standardized script was developed and used when contacting dental schools and private

practice offices. The script was submitted to the Institutional Review Board (IRB), and received a waiver for the study. The script contained fictional information about who the caller was, where he was from, and what dental care he needed. The fictional patient requested information regarding the cost of replacement of a lower premolar by a single tooth implant, followed by restoration with a crown. The caller also stated that he had no dental insurance and was prepared to pay cash for the treatment. When possible, the caller asked the practice for an estimate of the total cost of the treatment. Additionally, the caller also asked about the cost of anesthesia, placement of the fixture, and restoration of the fixture if the contact person had access to all that information.

All 64 dental schools and 80 private practices located in 43 states were contacted. All sites were contacted three times on three different days. If no communication was made after the third attempt, that site was excluded from the study. Private practices were selected using the American College of Prosthodontists (ACP) 2013 Membership Directory and contact information was obtained from the listing. Only board certified prosthodontists in private practice, not in retirement, not practicing at a University or Military setting, and not located in the same office as another ACP member, were selected. If more than two prosthodontists from one state met the inclusion criteria, 2 members were randomly selected to be included in the study. In total, 13 states had fewer than 2 qualifying prosthodontists and 5 private practice offices could not be reached by the third attempt. States with no qualifying board certified prosthodontists included: Delaware, Kentucky, New Hampshire, North Dakota,

Vermont, West Virginia, and Wyoming. States with only one qualifying board certified prosthodontist included: Hawaii, Idaho, Louisiana, Nebraska, Rhode Island, and South Dakota. We were able to contact all 64 dental school prosthodontic departments, but 29 (45.3%) were unable to give us useable information. All sites included in the study were documented and recorded by region (West, Southwest, Midwest, Southeast, Northeast) in the U.S., by city size (0-500,000 and 500,000+), and practice type (private/academic).

Our first null hypothesis was that since all responders were prosthodontists, that there would be no differences in costs of implant therapy provided by prosthodontists in academic institutions and private practice. The second null hypothesis was that there would be no difference in cost based on location in the US, or city size.

A statistical analysis was performed. A p-value of < 0.05 was used as the criterion for statistical significance, and $0.057 \leq p < 0.10$ was used as the criterion for marginal significance. Statistical analysis was conducted using the statistical package SAS[®] System version 9.3 (SAS Institute Inc., Cary, NC, USA). Comparisons of implant and crown costs between regions, city size, and private/academic practices were analyzed using the two-sample t-test and one-way ANOVA with post-hoc Tukey-Kramer test or the nonparametric Wilcoxon rank-sum test and Kruskal-Wallis test, as appropriate. Moreover, the differences in regions, city sizes and practice types between sites that responded and those sites that didn't respond to the total cost of implant and crown, cost of implant and cost of crown, were assessed using chi-square test or Fisher's exact test.

Table 1: Differences between responders who provided the total cost of implant and crown compared to responders who could not by region, city size, and practice type.

Variable	Responded to the Total Cost of Implant and Crown		P-Value
	Yes (%) N=56	No (%) N=88	
Region			0.3732
West	10 (33.3)	20 (66.7)	
Southwest	8 (57.1)	6 (42.9)	
Midwest	13 (35.1)	24 (64.9)	
Southeast	16 (47.1)	18 (52.9)	
Northeast	9 (31.0)	20 (69.0)	
City Size			0.0561^a
<500,000	30 (33.0)	61 (67.0)	
>500,000	26 (49.1)	27 (50.9)	
Practice Type			0.0005^b
Private	21 (26.3)	59 (73.7)	
Academic	35 (54.7)	29 (45.3)	

a. Marginally statistically significant ($0.5 \leq p < 0.10$) using chi-square test

b. Statistically significant ($p < 0.05$) using chi-square test

RESULTS

Eighty private practice dentists and 64 dental schools were contacted by telephone. When comparing responders who provided the total cost of implant and crown, academic settings were found to have a statistically significantly higher ability to do so compared to pri-

vate practices (54.7% vs. 26.3% respectively, $p < 0.0001$) (Table 1). City size greater than 500,000 was found to be marginally statistically significantly better at responding to the questions related to total cost amounts compared to cities less than 500,000 (49.1% vs. 33.0% respectively, $p = 0.0561$) as shown in Table 1.

Table 2: Differences between responders who provided the cost of implant placement compared to responders who could not by region, city size, and practice type.

Variable	Responded to the Cost of an Implant		P-Value
	Yes (%) N=17	No (%) N=127	
Region			0.0117^a
West	5 (16.7)	25 (83.3)	
Southwest	3 (21.4)	11 (78.6)	
Midwest	0 (0.0)	37 (100.0)	
Southeast	7 (20.6)	27 (79.4)	
Northeast	2 (6.9)	27 (93.1)	
City Size			0.6907
<500,000	10 (11.0)	81 (89.0)	
>500,000	7 (13.2)	46 (86.8)	
Practice Type			0.7728
Private	10 (12.5)	70 (87.5)	
Academic	7 (10.9)	57 (89.1)	

a. Statistically significant ($p < 0.05$) using Fisher's exact test

When evaluating implant costs alone, dental offices from the Southwest (21.4%) and Southeast (20.6%) were more likely to provide an estimated cost than any other region ($p < 0.0117$), as shown in Table 2. No differences were found when assessing the other variables for implant cost only.

Academic practices were found to have a statistically significantly lower response

rate when compared to private practices when asked about the cost of restoring the implant with a single crown (10.9% vs. 25.0% respectively, $p = 0.0317$), as shown in Table 3. No differences were found when assessing the other variables for crown cost only.

In this study, the total cost for treatment, that is surgically placing the implant and restor-

Table 3: Differences between responders who provided the cost of implant restoration with a crown compared to responders who could not by region, city size, and practice type.

Variable	Responded to the Cost of a Single Crown		P-Value
	Yes (%) N=27	No (%) N=117	
Region			0.5179
West	6 (20.0)	24 (80.0)	
Southwest	4 (28.6)	10 (71.4)	
Midwest	4 (10.8)	33 (89.2)	
Southeast	8 (23.5)	26 (76.5)	
Northeast	5 (17.2)	24 (82.8)	
City Size			0.9779
<500,000	17 (18.7)	74 (81.3)	
>500,000	10 (18.9)	43 (81.1)	
Practice Type			0.0317^a
Private	20 (25.0)	60 (75.0)	
Academic	7 (10.9)	57 (89.1)	

a. Statistically significant ($p < 0.05$) using chi-square test

ing it with a crown, was statistically significantly lower in academic practices (\$2,142.14) as compared to private practices (\$3,983.33) ($p < 0.0005$) as shown in Table 4. The cost of restoring the implant with a crown was statistically significantly higher in the Northeast (\$2,780.00) as compared to all other regions of the U.S.A. ($p = 0.0002$) (Table 4).

DISCUSSION

The cost of any treatment will always be a major determining factor when a patient is faced with treatment choices, especially if that treatment will not be partially or fully reimbursed by health insurance providers.¹⁰ Currently, the initial high costs and/or high copayments for implants and the fact that the cost may not

Table 4: Comparison of implant placement cost, restoration with

Variable	Total Cost of Implant and Crown (N=56)				P-Value
	Mean \$ (SD)	Median \$	Minimum \$	Maximum \$	
Region					0.1553
West	2561.70 (974.18)	2665.00	500.00	3900.00	
Southwest	3400.00 (834.95)	3450.00	2100.00	4500.00	
Midwest	2897.92 (1156.77)	2500.00	1500.00	5000.00	
Southeast	2408.44 (943.27)	2135.00	1190.00	4800.00	
Northeast	3288.89 (1594.67)	2750.00	1950.00	6600.00	
City Size					0.4592
<500,00	2908.23 (1200.79)	2725.00	500.00	5000.00	
>500,000	2745.31 (1078.92)	2500.00	1500.00	6600.00	
Practice					<0.0001^a
Private	2908.23 (1200.79)	2725.00	500.00	5000.00	
Academic	2745.31 (1078.92)	2500.00	1500.00	6600.00	
Variable	Cost of a Single Implant (N=17)				P-Value
	Mean \$ (SD)	Median \$	Minimum \$	Maximum \$	
Region					0.1154
West	2041.80 (939.39)	2000.00	1230.00	3600.00	
Southwest	2100.00 (173.21)	2000.00	2000.00	2300.00	
Midwest	-	-	-	-	
Southeast	1457.14 (954.13)	1200.00	700.00	3500.00	
Northeast	2600.00 (141.42)	2600.00	2500.00	2700.00	

a. Statistically significant ($p < 0.05$) using the two sample t-testb. Statistically significant ($p < 0.05$) using a one-way ANOVA

th a crown, and total cost by region, city size, and practice type.

Variable	Cost of a Single Implant (N=17)				P-Value
	Mean \$ (SD)	Median \$	Minimum \$	Maximum \$	
City Size					0.4430
<500,00	2015.00 (976.97)	2000.00	700.00	3600.00	
>500,000	1679.86 (656.20)	1379.00	950.00	2700.00	
Practice					0.0005^a
Private	2400.00 (699.21)	2150.00	1400.00	3600.00	
Academic	1129.86 (314.51)	1200.00	700.00	1600.00	

Variable	Total Cost of a Single Crown (N=27)				P-Value
	Mean \$ (SD)	Median \$	Minimum \$	Maximum \$	
Region					0.0002^b
West	1593.00 (434.99)	1675.00	908.00	2050.00	
Southwest	1737.50 (481.97)	1825.00	1100.00	2200.00	
Midwest	1650.00 (645.50)	1400.00	1200.00	2600.00	
Southeast	1030.00 (416.69)	1000.00	490.00	1600.00	
Northeast	2780.00 (701.43)	2700.00	2100.00	3900.00	
City Size					0.8612
<500,00	1655.29 (633.57)	1500.00	490.00	2900.00	
>500,000	1710.80 (1006.98)	1500.00	550.00	3900.00	
Practice					<0.0001^c
Private	1957.50 (684.85)	1900.00	1100.00	3900.00	
Academic	871.14 (299.26)	900.00	490.00	1350.00	

c. Statistically significant ($p < 0.05$) using the post-hoc Tukey-Kramer test

be reimbursed at all by health insurance companies, have resulted in American patients seeking care in Mexico or looking for a cost-effective dental practices within the U.S.^{14,15}

Using a single implant to replace a premolar rather than a fixed partial denture has been shown to be cost effective over time.^{10,17} Our first null hypothesis was that since all responders were prosthodontists, that there would be no differences in costs of implant therapy provided by prosthodontists in academic institutions and private practice. However we did not find this to be true as the cost of care in academic centers was cheaper than in private sector. In this study we found it was easier to get information on the cost of surgically placing implants and restoring it with a crown from practices based in dental schools rather than private practice. Many dental schools treat patients from lower socioeconomic circumstances who are more frugal and more likely to question the cost of care. Therefore, dental schools may be more used to potential patients asking about the cost of care and are more easily able to respond with that information during a telephone inquiry. The lowest cost in academic practice was \$500 at The University of Utah. The person answering our questions may have quoted us the price for an implant which would be placed by a student, and therefore may be a subsidized cost. We have been unable to verify this because when we called again recently we were quoted \$1,800 for the procedure.

The second null hypothesis was that there would be no difference in cost based on location in the US, or city size. However we did find that private dental offices from the West and South of the U.S. were more likely to provide an estimated cost than any other region. We can-

not suggest any explanation for this response. However, it was not surprising to find that the cost of crowns in the Northeast was higher than anywhere else in the country, because in general, the most expensive areas to live in the U.S. are Hawaii, Alaska, southern California and the Northeast.¹⁸ The only null hypothesis which was shown to be accurate was that we found no differences in costs of care between academic institutions and private practice with regard to city size.

CONCLUSION

More general dentists are placing implants and restoring them. In this study, the staff of academic practices set in prosthodontic departments were more organized and better prepared to disclose the costs of surgically placing and restoring a single implant compared to those in private practice. These academic practices were also cheaper. Geographic locations influenced costs and mirrored the cost of living. Future research should focus on evaluating the difference in fees between general dentists and specialists in private practice who place and restore single implants. ●

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Disclosure

The authors report no conflicts of interest with anything reported in this article.

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