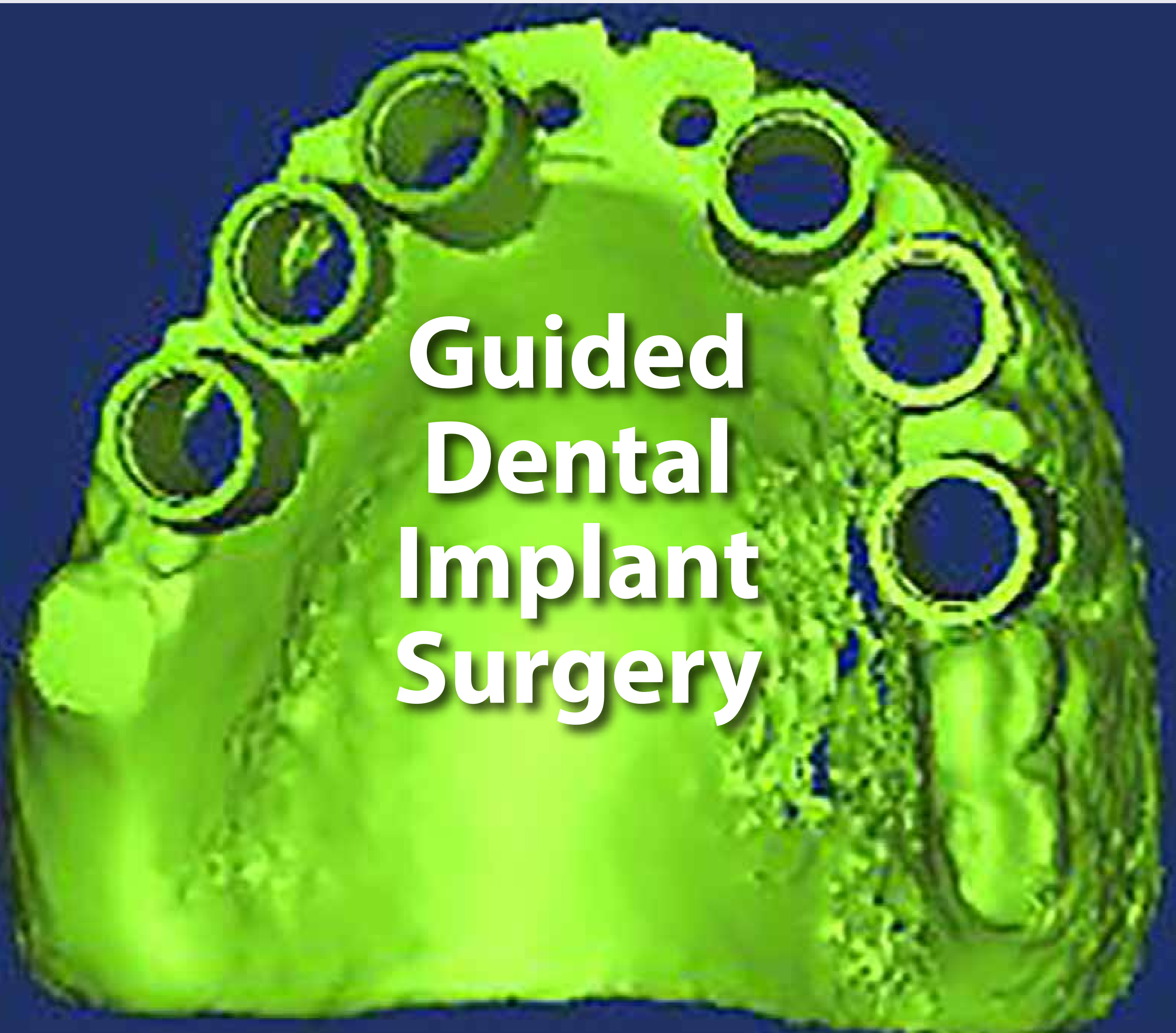
Volume 8, No. 2 April 2016

JIACD

The Journal of Implant & Advanced Clinical Dentistry



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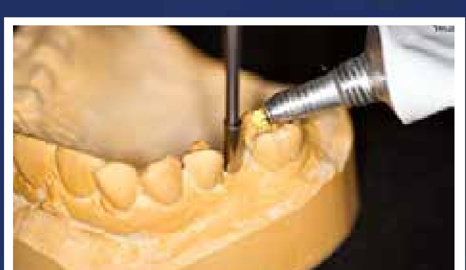

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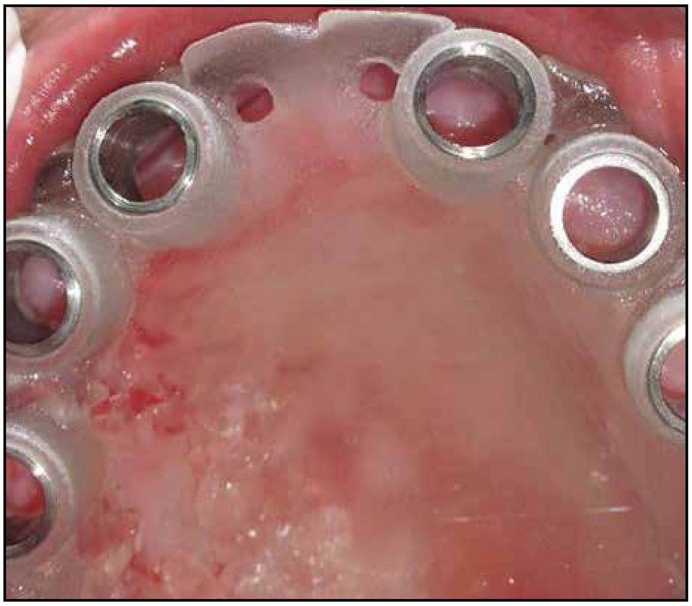

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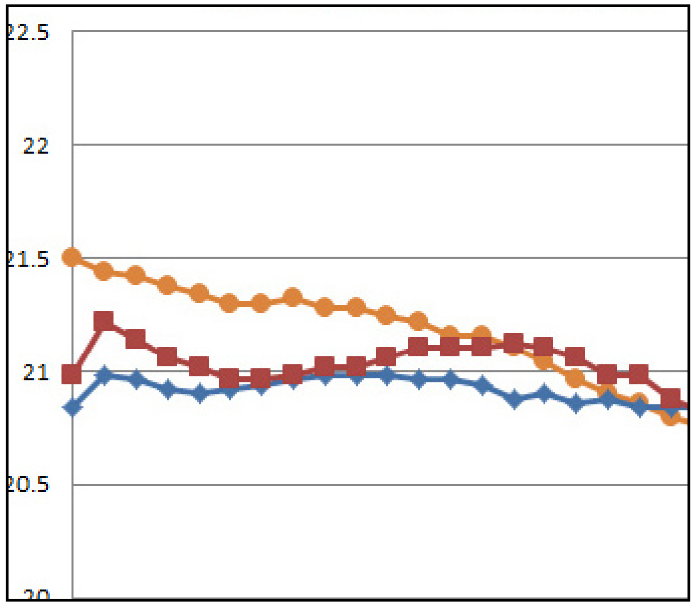

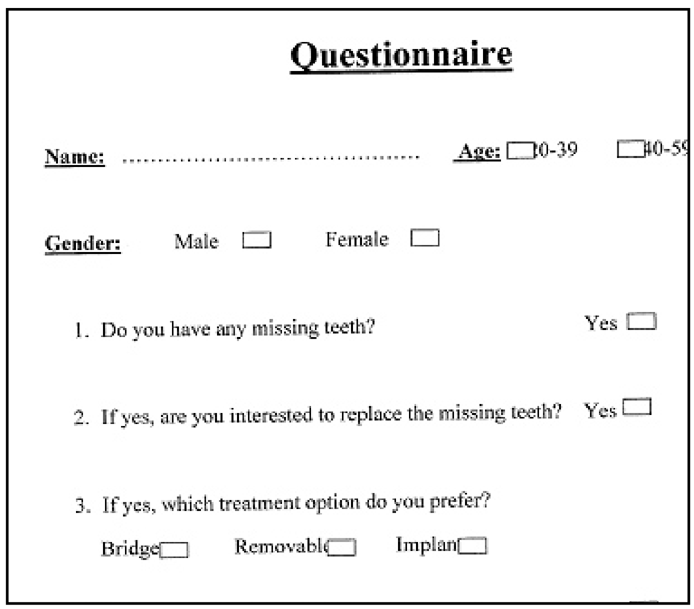
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Gender: Male ☐ Female ☐

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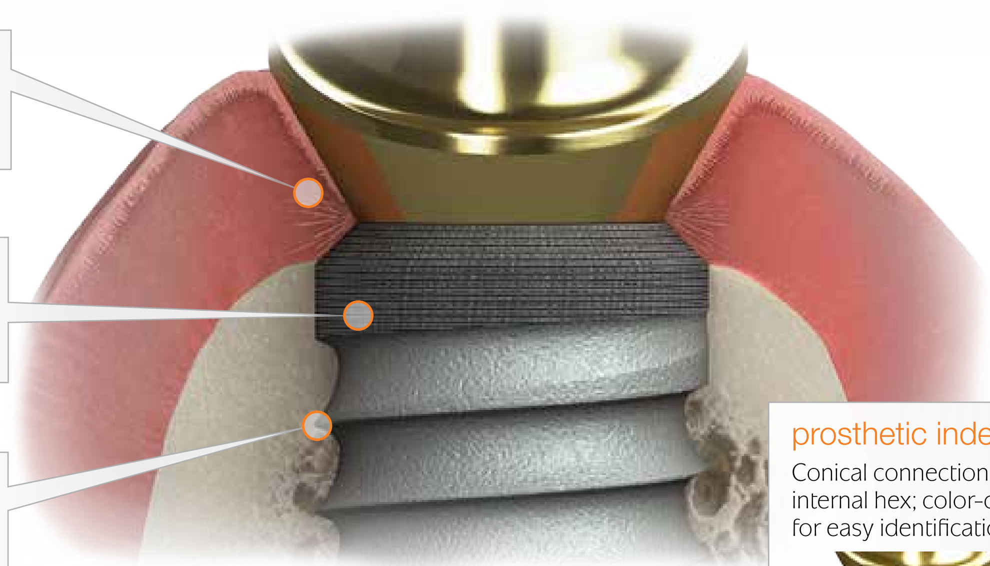

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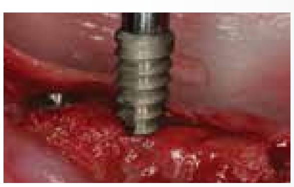

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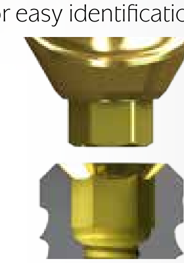

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The Effect of CAD/CAM versus Conventional Casting Frameworks on the Passivity of Fit for Screw Retained Implant Supported Maxillary Prostheses

Heba E. Khorshid, BDS, MS, PhD[1] • Hamdy Aboul Fotouh Hamed, BDS, MS, PhD[2] • Essam A. Aziz, BDS, MS, PhD[3]

Abstract

Background: The Target of this work was to study the effect of two different techniques of framework construction; Conventional Cast Metal Technology and the CAD/CAM Technology on the passivity of fit of screw-retained prostheses placed in the completely edentulous maxillae.

Methods: In this study, a total of seventy-two implants were placed in twelve patients with completely edentulous maxillae. For each patient, six implants were placed in the lateral incisor/Canine region, first premolar and first molar region. Bone height measurements and Osstell values around each implant was performed at zero, four, eight and twenty-four months after prostheses delivery.

Results: At base line; there was no statistically significant difference between the bone height measurements in the two groups ($p=0.051$). After 4 months ($p=0.002^*$), 8 months ($p=0.001^*$) and 24 months ($p=0.001^*$); the CAD/CAM group showed statistically significant higher mean bone height measurements than the conventional casting group. Regarding the implant stability quotient value (ISQ) values obtained by the Osstell device, there was a statistically significantly higher mean ISQ values in the CAD/CAM group than the conventional casting group after 8 and 24 months.

Conclusion: CAD/CAM restorations yielded a more favourable bone reaction at the bone/implant interface than the Conventional Casting group thus should be considered as a viable alternative to cast restorations for implant frameworks. CAD/CAM restorations are a predictable treatment modality as it attempts to control the level of stresses transmitted to the damaged crestal bone, preserving the peri-implant bone height and improving the integration of implants within bone.

KEY WORDS: Dental implants, prosthetics, CAD/CAM, design, bone

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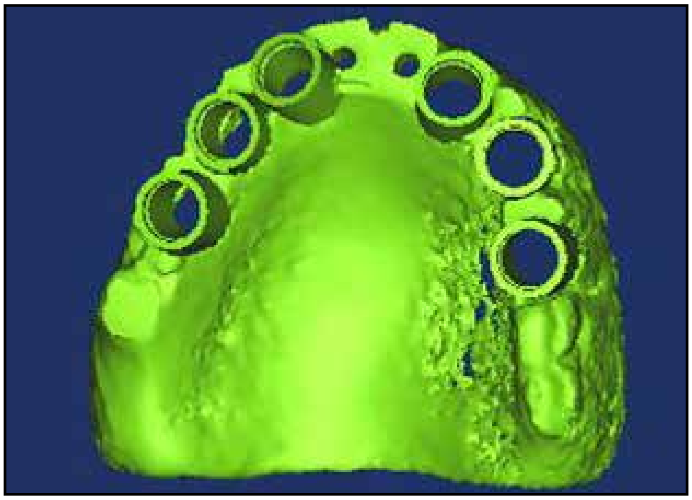

Figure 1: The final virtual stent.

Figure 2: The computer guided surgical stent fixed in place using three fixation screws.

INTRODUCTION

The ideal goal for modern dentistry is to restore the patient to the normal facial contour, function, esthetics, speech, health and comfort.[1] Studies by Keith et al and Guichet et al.[2-3] noted that the fit of one-piece conventional cast metal frameworks continues to be controversial when passive fit is a criteria for clinical acceptability. Cast metal frameworks are subject to expansion and contraction that may result in porosity, warpage, lack of passivity and/or distortion of individual castings as reported by Takahashi, Yoko and Kar.[4-6] For these reasons, Interest in Computer-Aided Design/ Computer-Aided-Manufacturer technology for implant restorations is increasing because the frameworks and abutments may be machined from solid blocks of material, that are more homogenous and with better physical properties than conventional castings. These technologies have eliminated conventional waxing, casing, and finishing procedures, along with the inaccuracies associated with these procedures as reported by Al Fadda[7] and Drago et al.[8]

MATERIALS AND METHODS

Twelve male patients were selected from the outpatient clinic of the Prosthodontics Department , Faculty of Oral and Dental Medicine, Cairo University. Patients were with Completely Edentulous Maxillae showing normal maxillo-mandibular relationship (Class I Angle classification), with no para-functional habits and systemically free from any medical conditions. The pre-surgical preparation required the construction of conventional maxillary complete dentures which were duplicated to obtain radio-opaque scan appliances. The patients' maxillae were radiographed using Cone Beam Computed Tomographic (CBCT) scanning machine (Sanora 3D Soredex, Helsinki, Finland). DICOM files obtained from the CT scan were loaded into the Mimics software (Mimics, Materialise HQ, Technologielaan 15, 3001 Leuven, Belgium) whereby coronal and sagittal reformatting and panoramic views were obtained. The desired implant sites were identified through the radiolucent channels previously prepared in the radiographic stent at the pros-

Figure 3: Osteotomy performed using the classical drilling sequence (pilot, intermediate and final drills).

Figure 4: Implants after being surgically installed and stent retrieval.

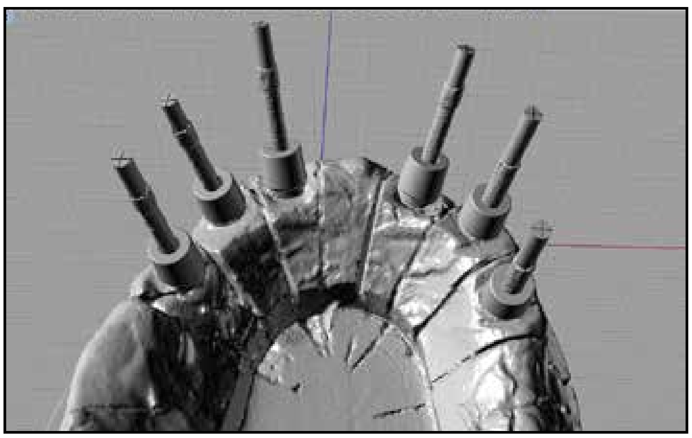

Figure 5: Virtual abutments placed over each implant.

Figure 6: The CAD/CAM Zirconia frameworks tried in the Patient's mouth.

thetic teeth centers. The bone volumes at each of the six potential sites were evaluated for sufficient bone height, width and density. For each patient, six implants were to be planned in the lateral incisor/Canine region, first premolar and first molar region according to the available bone height and width. All Implants were with standardized height; 13 mm for the four anterior implants and 10 mm for the two posterior implants. The virtual STL files of the implants were imported into the MIMICS software and then virtual planning was performed at the proposed implant sites. The resultant 3D virtual stent (Fig.1) was then exported as an STL (Sterolithiographic) file for 3D printing machine (Invision Si2, USA) to build the stent from a photo curable resin material. Metallic sleeves were fitted into the designed holes of the fabricated stent.

At the time of surgery, infiltration anesthesia was injected at each implant site. The stent was fixed in place using three fixation screws (Biomet M Fix, USA) (Fig.2). Osteotomies were then prepared using the classical drilling sequence (pilot,

Figure 7A: The screw-retained implant supported prostheses delivered in the patient's mouth for GROUP A.

Figure 7B: The screw-retained implant supported prostheses delivered in the patient's mouth for GROUP B.

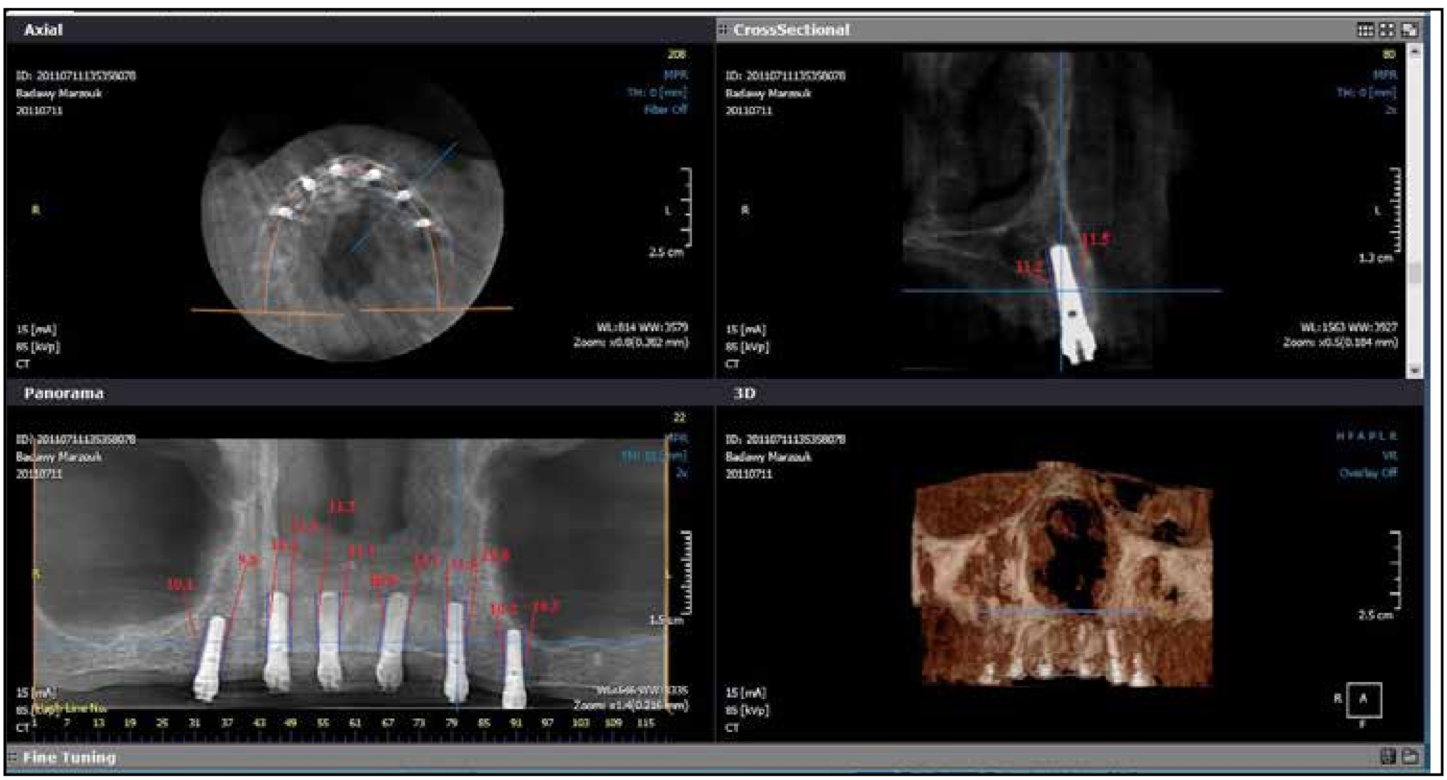

Figure 8: Recording buccal, palatal, mesial and distal bone height.

intermediate and final drills) and were irrigated with sterile saline after each drill (Fig.3). For every drill a specially designed "drill guide" was used. The implants were then inserted manually through the stent till manual tightening met resistance and further tightening was completed with a ratchet. The primary stability of each implant was checked to be 30 Ncm using a Torque wrench and then the stent was retrieved (Fig.4). The patient's maxillary denture was relieved opposing each Implant site and soft liner (Mollosil® plus, DETAX GmbH & Co. KG , Carl-Zeiss-Str. 4 , 76275 Ettlingen , Germany) was performed chairside. The patient was then allowed to wear his denture for 4 months until satisfactory osseointegration was reached.

After 4-6 months, the patients were recalled and the Implants were checked for adequate osseointegration using "Osstell" ISQ device (Osstell AB, Gamlestadsvägen 3B, SE415 02, Sweden.). Preliminary impressions were then taken using a closed tray technique. Temporary Titanium abutments were then screwed over the implant analogues within the primary cast and then splinted together using DuraLay resin material (DuraLay™, Reliance, Dental MFG Co. Worth, IL, USA) to produce a verification index. The Verification index was then tried in the patient's mouth and checked for passivity. If any areas were detected with lack of passivity, sectioning of the duralay splint was performed and then re-connected intraorally again using Duralay. The radiographic stents were then modified by opening windows at areas of the implants and used as a special tray. An open tray impression technique was then performed and again the implant analogues were screwed over the temporary titanium abutments.

FRAMEWORK CONSTRUCTION

Patients were divided into two equal groups: For Group A: Screw-retained fixed detachable frameworks were constructed using the conventional cast metal technology. For Group B: Screw-retained fixed detachable frameworks were constructed using the CAD/CAM technology.

Procedures of Framework construction for GROUP A:

Plastic castable abutments (Plastic burnout-sImplants, ImplantDirect™ LLC Spectra-System Dental Implants Calabasas Hills CA, USA) were fastened to the analogues. The plastic abutments were connected with Duralay resin to form a rigid frame. Final waxing up was done to produce a final pattern which was then invested and cast into chrome cobalt alloy.

Procedures of Framework construction for GROUP B:

Over each implant, long screws; used for the open tray technique; were screwed over each implant. Scanning of the cast was then performed using the D710 3Shape Dental scanner (D710 3Shape Dental scanner Holmens Kanal 7. 1060 Copenhagen K Denmark). The STL file for each cast was then imported into the software called Rhinoceros (Rhinoceros® North Seattle, WA 98103 USA). The virtual plastic Burnout abutment specific for the ScrewIndirect Implants were dragged to reach the points representing the implant's finish line (Fig.5). The 3D Virtual frameworks were then milled from Zirconia blocks (Whitepeaks Dental Systems GmbH & Co. KG, Langeheide Essen, Germany) using ROLAND DWX-50® 5 axis milling machine, Roland DG Corporation, Hamamatsu-shi, Shizuoka-ken Japan). The actual frameworks were then tried on the actual casts and patient's mouth and then checked for passivity (Fig.6).

FINAL PROSTHESES DELIVERY

The frameworks for both groups were checked individually for fit and passivity using the one screw test was performed (Fig.6). The detection of any gap is an indication that sectioning with a disc, and fastening separately to the implants, re-connecting with Duralay resin and and soldering (or welding) is required. Bite registration was then performed using the Wax wafer registration method. Acrylic teeth were set on the framework following the IPO guidelines in accordance with Misch's[1] recommendations. Visio-lign Veneering (Visio-lign, Bredent GmbH & Co.KG, WeissenhornerSenden, Germany) light cured system was used to construct the gingiva using a free-hand technique. After the build-up is complete, the screw-retained implant supported prostheses were screwed intra-orally and fine occlusal adjustments were made. The prosthetic screws were tightened to 30Ncm with a torque wrench. The access holes were partially plugged with rubber pieces and completely blocked with light-cured composite resin restorative material (Figs.7A and Fig. 7B).

RESULTS

The results of this study were statistically analyzed to evaluate the changes that occurred in the supporting structures of the implants placed in the maxilla as a result of two different techniques of framework construction; the conventional casting technique and the CAD/CAM technique. Bone Height measurements and Osstell values (Implant Stability Quotient ISQ) surrounding each implant were used to evaluate the hard tissue reactions in both groups at zero, four, eight and twenty four months after definitive prostheses delivery. A total of 69 implants were integrated with a total success rate of 95.8% (two implants in two patients from the conventional casting and one implant from the CAD/CAM group).

Statistical Methods

Numerical data were explored for normality by checking data distribution, histograms, calculating mean and median values and finally using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data were presented as mean and standard deviation (SD) values. Osstel data and bone height measurements showed parametric distribution. Repeated measures ANOVA test followed by Tukey's post-hoc test was used to compare between the two groups and to study the changes by time within each group. Mann-Whitney U test was used to compare between percentage changes in different parameters of the two groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

Bone Height Results

The mean values (m) and standard deviation (St.D) of the bone height in CAD/CAM group were 11.1±0.2mm, 10.8±0.2mm, 10.6±0.2mm and 10.9±0.2mm at zero, four, eight and twenty four months of prostheses delivery in this study respectively. The mean values (m) and standard deviation (St.D) of bone height in the Conventional Casting group were 11.5±0.4mm, 10.1±0.3mm, 9.8±0.3mm and 10.1±0.2mm at zero, four, eight and twenty four months of prostheses delivery in this study respectively. At base line; there was no statistically significant difference between the bone height measurements in the two groups (p=0.051). After 4 months (p=0.002*), 8 months (p=0.001*) and 24 months (p=0.001*); the CAD/CAM group showed statistically significant higher mean bone height measurements than the conventional casting group (Table 1) (Fig 9).

Table 1: The mean, standard deviation (SD) values and results of repeated measures ANOVA test for comparison between bone height values in the two groups and changes by time in each group.

Period	CAD/Cam		Conventional		*P*-value (Between groups)
	Mean	SD	Mean	SD	
Base line	11.1*	0.2	11.5*	0.4	0.051
4 months	10.8^b	0.2	10.1^b	0.3	0.002*
8 months	10.6^b	0.2	9.8^b	0.3	0.001*
24 months	10.9^b	0.2	10.1^b	0.2	0.001*
P-value (Within group)	0.024		< 0.001		

**Significant at P ≤ 0.05, different superscripts in the same column are statisctically significantly different*

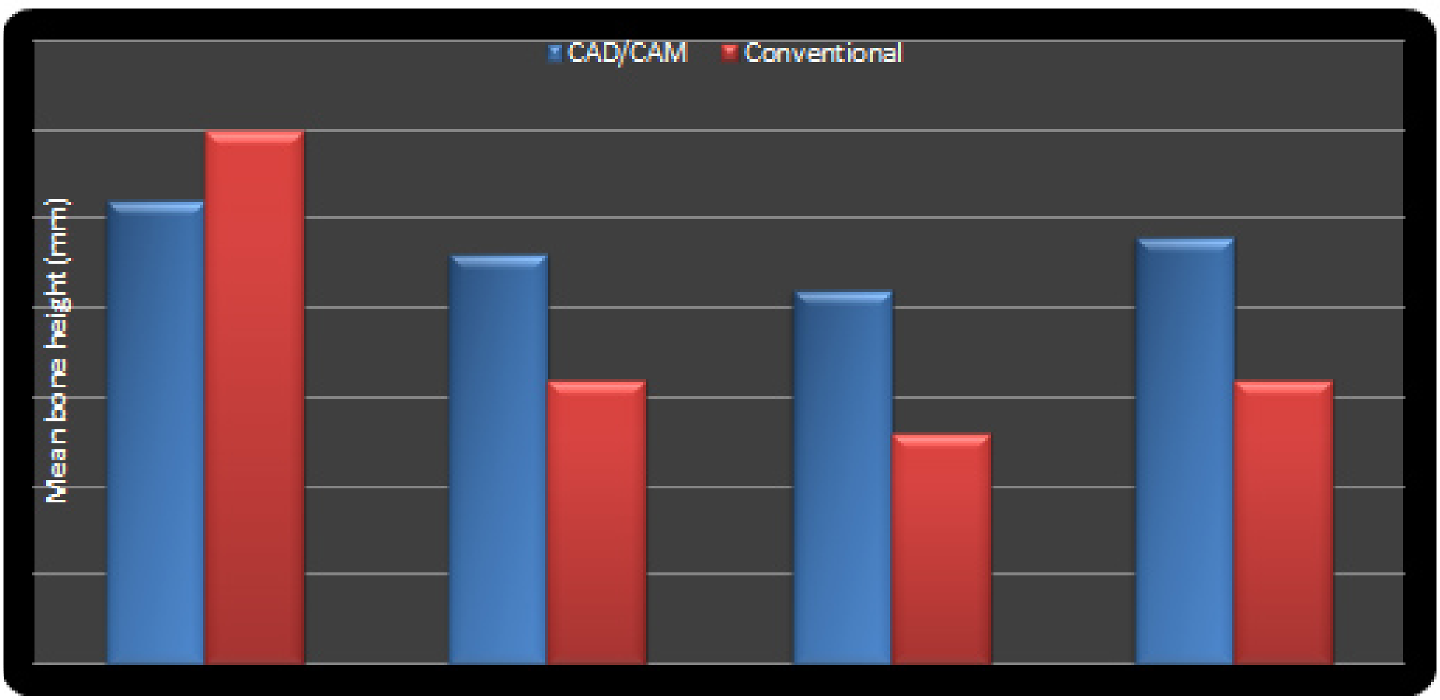

Figure 9: Bar chart representing mean bone height values in the two groups.

Osstell Results (ISQ Values)

The mean ISQ values (m) and standard deviation (St.D) in the CAD/CAM group were 57.6±2.9, 59.4±2.6, 60±2.6 and 59.7±2.2 at zero, four, eight and twenty four months of prostheses delivery in this study respectively. The mean values (m) and standard deviation (St.D) of bone height in the Conventional Casting group were 60.5±3, 56.4±3.6, 54.3±3.1 and 54.1±2.7 at zero, four, eight and twenty four months of prostheses delivery in this study respectively. At base line ($p=0.147$) and after 4 months ($p=0.177$); there was no statistically significant difference between ISQ values in the two groups. After 8 months ($p=0.014$*) and 24 months (0.007*); the CAD/CAM group showed statistically significantly higher mean ISQ values than the conventional casting group (Table 2) (Fig 10).

DISCUSSION

Bone Height

Statistical analysis showed a statistically significant difference in the crestal bone height between the CAD/CAM group and the Conventional Casting group where there was a more favorable bone reaction in the CAD/CAM group along the whole study period. These results may be attributed to the relatively inadequate Passivity of the conventional casting frameworks which can result in bio-mechanical complications such as fracture of the components of the system, screw loosening, bone resorption, soft tissue alterations and even loss of osseointegration.[9-11] If the marginal gaps between the screw-retained frameworks and abutments are excessive, large external preloads are introduced on the implant abutments and fixation screws creating a lever arm that inevitably causes overloading of all components of the neighbouring implant.[12,13] Accordingly, these built-in stresses from the casted frameworks transmit continuous, non-intermittent lateral forces to the bone implant interface that may thus compromise its integrity. The amount of load transmitted in the conventional casting group might have been beyond the physiologic limits of bone; "pathologic overload zone" as reported by Frost[14] thus overstressing the bone system leading to bone resorption and bone density reduction in the crestal bone where the greatest stresses concentrate. The results obtained in this study indicate that the CAD/CAM Zirconia frameworks had better precision and superior passivity when compared with the conventional casting frameworks. This might be explained by the fact that the CAD/CAM technologies have eliminated conventional waxing, casting, and finishing procedures, along with the inaccuracies, porosities and distortions associated with these steps thus obtaining more passively fit superstructures. This was in accordance with multiple studies[37-39,15-16] who reported that the CAD/CAM frameworks achieve implant/framework fit superior to those obtained with cast metal framework. The results also demonstrated that the crestal bone height seemed to have stabilized in both groups in the study period of 8-24 months which is in accordance with Vercruyssen and Quirynen[20] who concluded that the amount of annual bone resorption is reduced after the first year of initial bone remodeling.

Osstel

Regarding the Resonance Frequency Analysis records obtained by the Osstell device,

Table 2: The mean, standard deviation (SD) values and results of repeated measures ANOVA test for comparison between ISQ values in the two groups and changes by time in each group.

Period	CAD/Cam		Conventional		*P*-value
	Mean	SD	Mean	SD	(Between groups)
Base line	57.6[b]	2.9	60.5*	3	0.147
4 months	59.4[a]	2.6	56.4[b]	3.6	0.177*
8 months	60.0[a]	2.6	54.3[b]	3.1	0.014*
24 months	59.7[a]	2.2	54.1[b]	2.7	0.007*
P-value (Within group)	0.009		< 0.001		

**Significant at $P \leq 0.05$, different superscripts in the same column are statisctically significantly different*

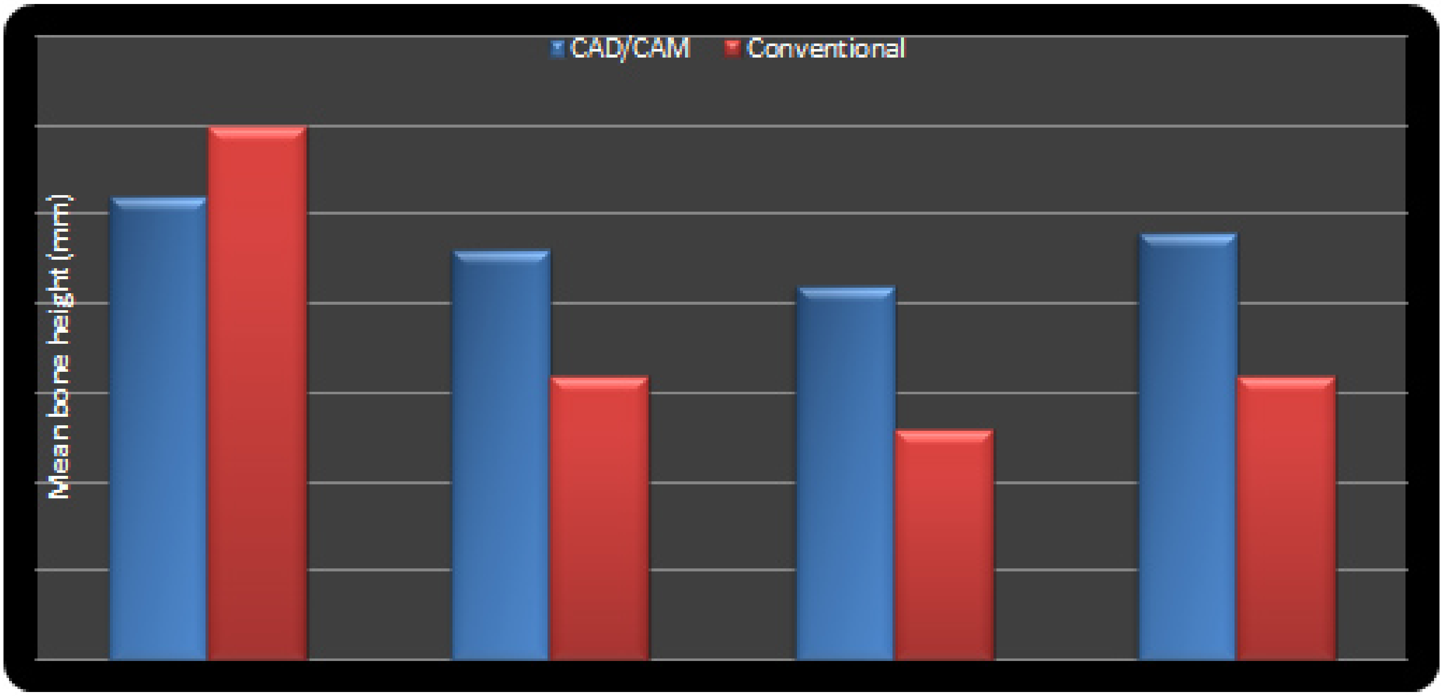

Figure 10: Bar chart representing mean ISQ values in the two groups.

there was no statistically significant difference between implant stability quotient value (ISQ) values in the two groups at base line and after 4 months while after 8 and 24 months, the CAD/CAM group showed statistically significantly higher mean ISQ values than the conventional casting group.

The determination of a defined implant stability quotient value (ISQ) might be relevant to predict the level of the osseointegration of a given implant[21, 22] and is related to the stiffness of the implant in the surrounding bony tissues.[23,24] The bone quality and quantity thus greatly influences the ISQ values.[25,26] We can therefore conclude that the greater the amount of bone loss around any implant, the poorer the implant stability and osseointegration within bone and hence the less the ISQ value that will be recorded by the Osstell device around this specific implant. This explains why after 4 and 8 months, the CAD/CAM group showed statistically significant higher mean ISQ values than the conventional casting group as this was in accordance with the amount of bone loss which was greater in the conventional casting group than the CAD/CAM group. These results obtained were in accordance with two studies performed by Lachmann et al.[27] and Turkyilmaz et al.[28] where on correlating implant stability values to marginal bone level, it was found that the osstell device can detect marginal bone loss of greater to or equal to 2mm. The Osstell device was not able to record differences in the ISQ values in the time period of 0 and 4 months but was able to record a statistically significant difference in the time period of 8 and 24 months because the amount of bone resorption was not sufficient to be detected by the Osstell device during 0 and 4 months study periods but was sufficient eight and 24 months after restoration delivery in the conventional casting group.

CONCLUSION

CAD/CAM restorations yielded a more favorable bone reaction at the bone/implant interface than the Conventional Casting group throughout a short-term study period. CAD/CAM restorations are thus a predictable treatment modality as it attempts to control the level of stresses transmitted to the damaged crestal bone thus preserving the peri-implant bone height and improving the integration of implants within bone. Interest in the CAD/CAM technology for implant restorations is increasing because the frameworks and abutments may be machined from solid blocks of material that are more homogenous and with better physical properties than the conventional castings. The CAD/CAM technology has eliminated the inaccuracies and the long working hours needed from technicians associated with the conventional waxing, casing, and finishing procedures.

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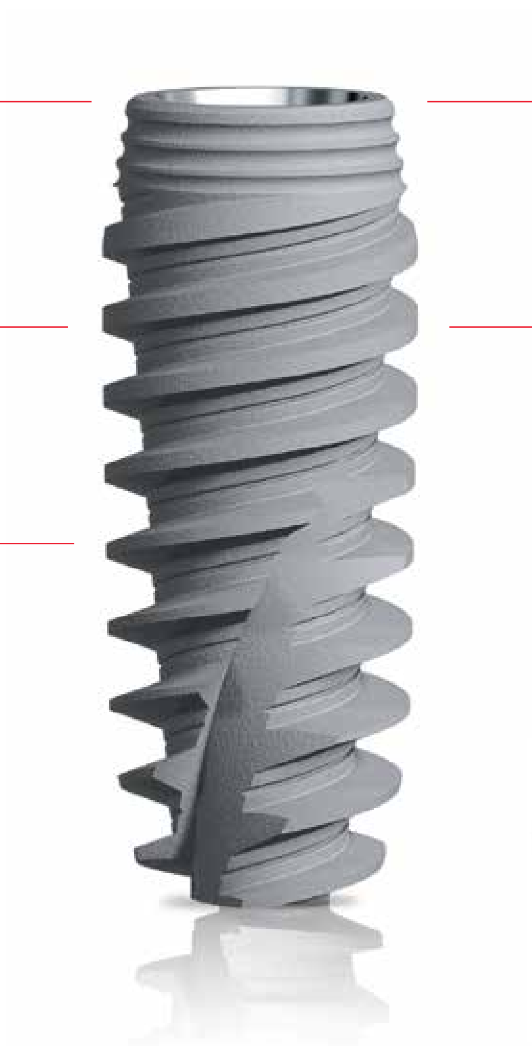

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Revisiting a Modified Chair-Side Radiographic and Surgical Stent for Template-Assisted Surgery: A Case Report

Dr. Les Kalman, BSc(Hon), DDS, GPR, DICOI, (AA)FAAID [1] • Kyung-ah Jang[2]

Abstract

Background: The prosthodontic driven implant has become the standard in dentistry. Prosthesis location should dictate the implant site in diagnosis, treatment planning and surgery in implantology. Although there are several methods to achieve a prosthodontically-driven result, through guided and assisted surgery, there can be various barriers to the technology.

Methods: This report builds upon previous work and presents a simple, low-tech, cost-effective approach to reinforce the basic fundamentals of dental implant surgery. A chair-side combined radiographic and surgical (RS) stent is presented as an alternative template-assisted approach for implant surgery and is illustrated with a clinical case.

Results: The rigid, occlusally-stabilized RS splint provides a stable stent with little to no flex or distortion. The ability to custom build the stent allows the clinician to have control of his/her implant surgery by determining implant position and angulation. The RS stent is inexpensive, accessible and provides immediate fabrication.

Conclusions: The RS stent guides the two dimensional placement of a pilot drill during an osteotomy and provides the clinician a simple method to treatment plan and deliver a prosthodontically-driven result through a template-assisted approach to implant surgery. The stent aims to assist with the delivery of ideal implant placement, which still remains a difficult challenge in dentistry.

KEY WORDS: Dental implants, surgical stent, surgery, custom

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Figure 1: Buccal pre-op view.

Figure 2: Occlusal pre-op view.

Figure 3: Pre-op radiograph.

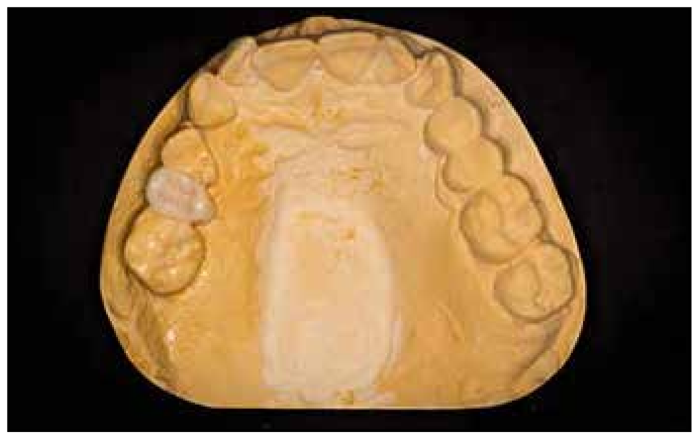

Figure 4: Cast and wax-up.

INTRODUCTION

The prosthodontic driven implant has become the standard in dentistry.[1] Prosthesis location should dictate the implant site in diagnosis, treatment planning and surgery in implantology.[1] Although there are several methods to achieve a prosthodontically-driven result, through guided and assisted surgery, there can be various barriers to the technology.[2–3] The issues of cost, operator confidence a nd c ompetence and fabrication time may limit use.[4–5] This report builds upon the technique, presented by Montrose, and presents a simple, low-tech, cost-effective approach to reinforce the basic fundamentals of dental implant surgery.[6] A combined radiographic and surgical (RS) stent is presented as an alternative template-assisted approach for implant surgery.

CLINICAL CASE

A healthy 58-year-old patient presented for the tooth replacement at the maxillary right second premolar site. Clinical (Figs. 1–2) and radiographic (Fig. 3) examinations were performed

Figure 5: Buccal view of wax-up.

Figure 6: Close up of wax-up.

Figure 7: Resin borders.

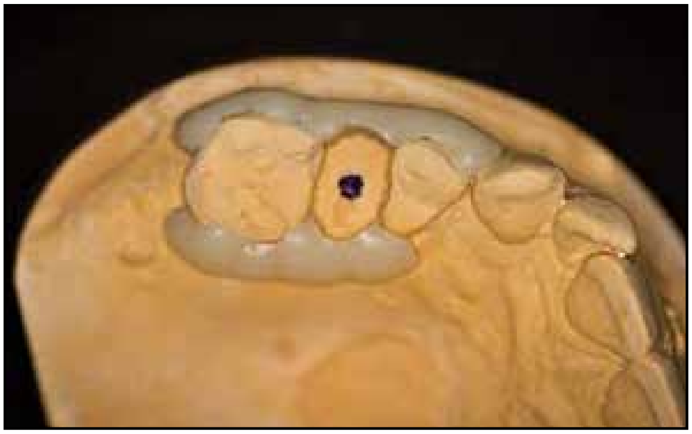

Figure 8: Surgical location marked with resin borders.

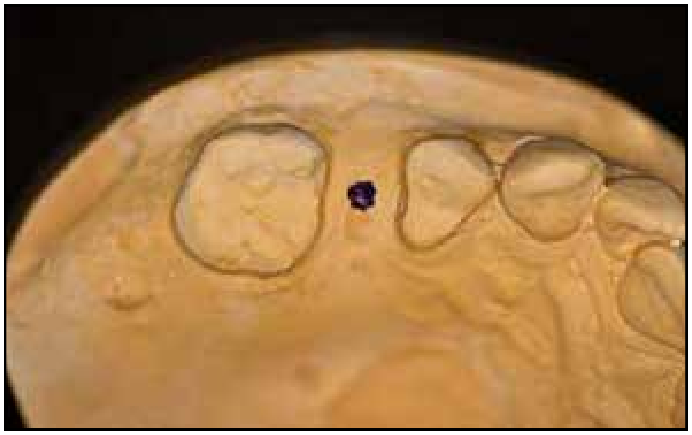

Figure 9: Prosthodontically-driven location of implant.

Figure 10: Cast osteotomy.

Figure 11: Guide pin.

Figure 12: Guide pin placement.

Figure 13: Flowable clear gel.

Figure 14: Gel placement.

and the treatment options presented: no treatment, a removable partial denture, a fixed bridge and an implant supported crown. After a lengthy informed consent, the patient decided to have the implant supported crown. Appropriate records were obtained and the case was mounted for evaluation. Treatment planning indicated that an implant supported crown was only possible with a limited diameter implant. A combined RS guide was then fabricated.

MATERIALS AND METHODS

Laboratory Component

A maxillary stone cast was fabricated (Fig. 4) and lubricated with petroleum jelly. The prosthetic tooth was completed as a standard wax-up (Figs. 5–6) to ensure suitability. Form, function and occlusion were assessed. Integrity BIS-acryl based self-cure resin (Dentsply-Caulk, Millford, DE) was utilized and a small amount was dispensed along the buccal and lingual borders of the teeth into the embrasures (Fig. 7). A span of one to two teeth on either

Figure 15: Occlusal view of gel placement.

Figure 16: Buccal view of RS stent.

Figure 17: Occlusal view of RS stent.

Figure 18: Final RS stent.

side of the edentulous space was adequate. This provided a reference of the buccal and lingual extent of the planned prosthesis. The resin was cured and removed. The wax up was gently removed from the cast and the resin borders were placed back on the cast. The ideal location of the implant site was selected and marked (Figs. 8–9). A round bur was utilized in a slow speed handpiece to create an osteotomy into the cast, simulating the implant surgery (Fig. 10). The depth was sufficient enough to stabilize the drill. The drill was gently removed from the handpiece and remained in the cast. A standard 10mm length surgical guide pin (Fig. 11) was then selected (Biomet 3i, Palm Beach Gardens, FL) and placed over the drill (Fig. 12). Triad VLC flowable clear gel (Fig. 13) (Dentsply-Caulk, Milford, DE) was utilized and a small amount was dispensed around the guide pin (Fig. 14) and onto the occlusal surfaces. The resin was spot cured. Incremental resin build-up and curing created a controlled fabrication and locked the surgical pin in place (Fig. 15). This process created an occlusally-stabilized

Figure 19: Buccal view of RS stent intraorally.

Figure 20: Occlusal view of RS stent intraorally.

Figure 21: Panoramic image of stent.

Figure 22: Post-op view of implant placement.

stent. Care was required not to introduce resin into the undercuts. The stent was gently shaped and polished (Fig. 16–18) and retested for fit. The stent was then sterilized for patient try-in.

Clinical Component

The patient presented for stent evaluation (Figs. 19–20). The RS stent was fitted intraorally and assessed for fit, stability and proposed location mesial-distally and buccal-lingually. A periodontal probe was used to project the intended surgical path intraorally. Once the position was confirmed, the patient had a panoramic radiograph taken (Fig. 21) with the stent in place. The RS stent was assessed radiographically by projecting the pin projection into the edentulous space. Distortion of the image can be determined, by the measurement of the radiographic and actual lengthen, of the guide tube. Position was confirmed as acceptable. Implant surgery proceeded uneventfully (Fig. 22). Prosthodontic procedures followed with the placement of a cement retained PFM crown.

DISCUSSION

The RS stent does not deliver fully guided surgery. It guides the two dimensional placement of a pilot drill during an osteotomy. It may not suite the needs of all clinicians, as it allows some degree of freedom during implant placement. The stent also has limitations for completely edentulous arches and for full mouth rehabilitation.

The RS stent is an alternative that provides the clinician a simple method to treatment plan and deliver a prosthodontically-driven implant. The RS stent provides a template-assisted approach to implant surgery, with a guide for the pilot drill. The stent enables the precise positioning in a mesial-distal and buccal-lingual dimension. Depth is not controlled, but may be assisted by utilizing a drill stop. The rigid, occlusally-stabilized splint provides a stable stent with little to no flex or distortion. The ability to custom build the stent allows the clinician to have control of his/her implant surgery by determining implant position and angulation. In addition, the surgeon has the ability for mild tweaks of the osteotomy to optimize position. The simulated cast surgery reinforces the fundamentals of implant surgery and the importance of location. The RS stent is inexpensive, accessible and provides immediate fabrication. The stent aims to assist with the delivery of ideal implant placement, which still remains a difficult challenge in dentistry.[7] ●

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Disclosure
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Exothermic Reaction Temperatures of Various Volumes of Calcium Sulfate Bone Graft Material

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Abstract

Background: Root-end resection can create bony crypts needing grafting. Anecdotal reports indicate calcium sulfate may fail because of exothermic reactions. The purpose of this study was to evaluate setting heat from 3 mm diameter x 7 mm deep and larger volumes.

Methods: Three different size holes in a microstone block simulated bony defects. Calcium sulfate "grafts" filled the various sized cavities, with temperature recorded every 30 seconds for 11.5 minutes. This was repeated a total of five times per group, giving a total of 15. A follow-up study of 5 large "grafts" was performed at body temperature baseline.

Results: A two tail t-test was performed on the mean of each group. Group 1 means were compared and no significant difference was. Results of the follow-up study were similar.

Conclusion: The alpha hemihydrate form of calcium sulfate is not exothermic during setting.

KEY WORDS: Dental implants, calcium sulfate, dental materials, dental implantation, tooth socket, osteoconductive

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BACKGROUND

Root-end resection is a surgical procedure in which a dentist accesses the tooth end laterally through the gingiva and cortical plate to amputate the root end and the underlying bone. The purpose of this procedure is to remove inaccessible canal contents and inflamed or infected periapical tissue. Indications for root-end resection include the necessity for drainage, postoperative failure of conventional therapy, predictable failure with conventional therapy, impracticality of conventional therapy, and procedural accidents. Contraindications include surgical inaccessibility, short root length, poor bony support, missing cortical bone, a medically compromised patient, and an apprehensive patient.[1] Surgery is not indicated solely because a periapical lesion is present nor is it indicated just because there is a large lesion. Also, it should not be done just because the dentist believes a lesion may become cystic.[2]

The procedure for root-end resection includes reflecting a soft tissue flap to gain access to the root within the bone. In order for surgical success, there must be good vision of the operating field. In order to gain visualization, an osteotomy should be made above the roots to be resected, large enough for the surgeon to have easy access and good visibility.[3] Operating microscopes have allowed for microsurgical procedures to become more popular due to their conservative nature. If the osteotomy is large, a bone graft material may be used to encourage healing.[4] Autografts or allografts are popular for this purpose. Allogenic bone grafts have been used in periodontal therapy during the last 3 decades as either freeze-dried bone allograft (FDBA) or demineralized freeze-dried bone allograft (DFDBA) to successfully regenerate periodontal tissues.[5]

In addition to allografts, alloplastic materials such as calcium sulfate have been used in apical surgery. Lieberman and Friedlander noted that Dresmann first reported the use of plaster of Paris (beta hemihydrate form of calcium sulfate) in 1892 as the first substance used to fill bony defects in patients. He noted that bony voids filled with calcium sulfate showed radiographic evidence of bone ingrowth.[6] Pecora et al. in 1997 suggested placement of calcium sulfate as an osteoconductive barrier in periapical osteotomy sites. They suggested that the use of calcium sulfate in this way might enhance osseous healing. They cited several advantages of calcium sulfate, including low cost, ease of application, biocompatibility, and complete absorption of the material over time.[7]

Calcium sulfate exists naturally in the dehydrate form. Further dehydration of the dehydrate form by heating produces the hemihydrate form which sets to a solid material when mixed with water. Depending on the method of heating, alpha or beta crystal form hemihydrate is obtained. The alpha form shows large, rectangular shaped crystals that are compact and well formed while the beta form shows flaky small crystals. The alpha form has a higher density, is less soluble and stronger than the beta form. Conventional plaster of paris as used in dental laboratory procedures is beta calcium sulfate hemihydrate.[8] Although a very safe material, beta calcium sulfate hemihydrate used in orthopedic casts has had some adverse reactions. Such plaster of paris casts can cause burns due to the amount of heat generated.[9]

Alpha hemihydrate calcium sulfate appears to have the optimal characteristics of a bone grafting material. It is biocompatible, bioabsorbable, and osteoconductive. In addition, this material has good physical properties such as having good fluidity and high mechanical strength.[10] Once the material is implanted in a bone defect it immediately starts to degrade by passive dissolution caused by ion exchange with body fluids into calcium phosphate. The speed of degradation depends on defect size and location, but is in the range of 40-70 days.[11,12]

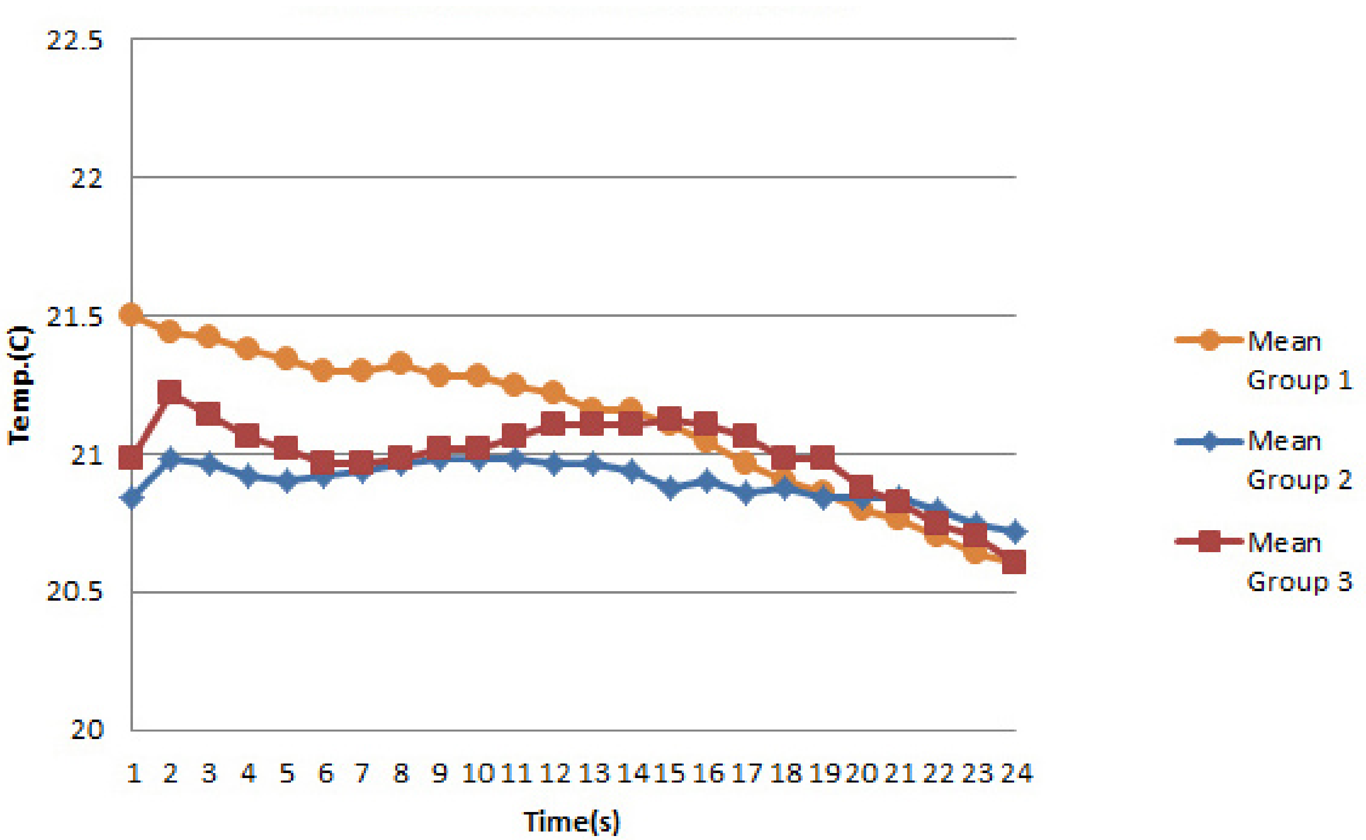
It has been reported that there is a 13.8-19.0% incidence of adverse inflammatory reactions to OsteoSet (Wright Medical Technology, Arlington, TN, USA) calcium sulfate in the alpha form. Lee and co-workers suggest that uniformity in crystalline shape and size affords predictable resorption rates; it may lead to accelerated graft resorption and accumulation of calcium-rich fluid which may be responsible for the inflammatory response.[13] They also propose an osmotic effect as an alternative explanation for the occasional serous drainage seen in response to OsteoSet pellets.[13] Robinson et al. also reported 3 cases in which severe inflammatory reactions developed. In one case serous drainage and an allergic reaction required graft removal. In another case, inflammation resolved two months following implantation. In the third case, wound breakdown occurred. Inflammatory complications should be considered when weighing the risk benefit ratio of using different types of bone replacement materials, and comparing allogenic grafts to synthetic ones.[14]

Eriksson and Albrektsson (1984) showed deleterious effects of heat on bone regeneration. The regenerative capacity of bone was almost lost by the thermal injury caused by exposure of the tissue to the temperature of 50C for 1 minute. Reducing the maximum heat to 47C for 1 minute reduced the adverse effects. Heating to 44C for 1 minute caused no significant o bservable d isturbances o f t issue regeneration.[15] A group headed by Eriksson in 1982 also showed that a temperature of 53C, below the denaturation point of alkaline phosphatase, caused an irreversible bone injury, yet healing occurred eventually from the surrounding tissue.[16] Other studies demonstrated that heat can cause tooth resorption and adjacent bone necrosis if increases in external root temperature exceed 10C.[17,18] There have been anecdotal reports of infections following the placement of calcium sulfate. These infections appear to be self-limiting, fairly benign and somewhat rare. The purpose of this study is to evaluate setting temperature differences in varying volumes of alpha hemihydrate calcium sulfate to see if this reaction reaches temperatures that may cause adverse reactions of the bone.

METHODS

A #3 round bur was used in a slow speed handpiece to make 3 separate holes of varying sizes in a block made of microstone (Whip Mix, Louisville, KY, USA). The holes were 3, 6, and 12mm in diameter and 7mm deep. The holes were to mimic small, medium and large osteotomies, approximately doubling the amount of calcium sulfate with each larger size. A light coat of petroleum jelly (Consumer Value Products, Temple, TX, USA) used as a separating medium was placed in each hole so that the set calcium sulfate could be easily removed after each measurement. This would ensure that the same volume of material was used for each sample per

Figure 1: Mean Temperature Change of Groups 1-3
No statistically significant difference
No clinically significant exothermic change



group. A total of 15 samples were divided into 3 groups of 5 samples each. Measurements for the small crypt (3x7mm) were labeled as group 1, the medium crypt (6x7mm) labeled group 2, and the large crypt (12x7mm) labeled group 3.

To evaluate the amount of heat produced by the setting reaction, a type K thermocouple measuring 0.003mm in diameter (Omega Engineering, Inc., Stamford, CT, USA) and an Omega HH11B system were used for data collection. The measuring device was calibrated prior to each measurement. A baseline reading was taken in the small crypt. Calcium sulfate hemihydrate (ACE Surgical Supply Co., Brockton, MA, USA) powder was then mixed with the recommended volume of regular set liquid and placed in the 3x7mm hole with the thermocouple in place. Temperature recordings were made every 30 seconds up to 11.5 minutes. (According to the manufacturer, the material hardens in approximately 1 minute). After return to baseline temperature, the set material was removed and then a new mix of calcium sulfate was placed in the same hole for a total of 5 measurements. The same procedure was performed for Group 2 and Group 3, each time confirming that the model returned to the starting temperature.

Also a follow-up study was performed with the large crypt at body temperature. The model was placed in an incubator at 37C and recordings were made on the large size osteotomy. This was undertaken to see if body temperature had a different effect. It was found that the temperature elevations achieved were similar, obviating need to repeat the body temperature experiments in smaller simulated crypts.

RESULTS

Figure 1 shows temperature changes of each sample in a group up to 11.5 minutes. The initial temperatures of each sample were subtracted from the temperature at 1 minute to establish clinical temperature change, as the material set time is 1 minute according to the manufacturer. The mean from each group was calculated. Recordings up to 11.5 minutes were made to make sure that the material did not undergo a delayed exothermic reaction. A two tail t-test was performed on the mean from each group. Group 1 was compared to Group 2, Group 2 to Group 3, and Group 1 to Group 3. No significant differences were found in any of the comparisons ($p > 0.05$, range 0.11-0.82).

Mean temperature changes shown in the Figure confirm that changes are clinically insignificant. This study showed that setting temperatures were not increased by doubling the volume of calcium sulfate. The temperatures that were reached in any group came nowhere near temperatures that could cause bone necrosis.

Table 1: Follow-up Study
Temperature within test cell at sequential times (in minutes), beginning at 32° C.
Note: No evidence of exothermic reaction

Time		Time	
0	32.9	6	31.5
0.5	30.4	6.5	31.5
1	31	7	31.5
1.5	31.1	7.5	31.4
2	31.2	8	31.4
2.5	31.4	8.5	31.4
3	31.4	9	31.3
3.5	31.4	9.5	31.3
4	31.5	10	31.3
4.5	31.5	10.5	31.2
5	31.5	11	31.2
5.5	31.5	11.5	31.2
change -1.9			

In the follow-up study shown in Table 1, the temperature of the internal aspect of the microstone crypt started at 32C. This was likely due to heat loss as the incubator door was slightly ajar to allow for the temperature probe. Also the crypt could have had an insulating effect, keeping the temperature cooler than the oven air. The temperatures recorded in the follow-up were all noted to be below baseline, with stability reached at the two minute recording. Never was the temperature rise more than 1.1 degree relative to the lowest temperature, which was recorded at the 0.5 minute time mark. This could be due to the coolant effect of the room air entering the oven or from the temperature of the liquid used in the mix. The possibility of an endothermic reaction cannot be ruled out. Statistical comparisons are noted in Figure 1 and Table 1. This confirms the evidence that clinical failures are not likely due to exothermic reaction.

CONCLUSION

Infections in the maxilla or mandible may cause large bony defects necessitating root-end resection, some calling for graft placement. Planned implant surgery, routine extraction, and cyst removal are among other indications for such grafting. Limiting surface area of the graft may be an indication for calcium sulfate instead of finely ground substances. During surgery, there is a temporary decrease in vascular supply due to the local anesthetic vasoconstrictor. This decrease in heat-dissipating blood flow may result in the osseous tissue being more heat sensitive and less resistant to injury.[19] If a large defect is left in the bone, a bone grafting material typically allows better repair of soft and hard tissue.[20] Alloplastic bone substitutes have been used successfully in the medical field for over 100 years. Most of the bone substitutes belong to one of two major groups. Products containing calcium phosphate mixtures are by far the larger group. The smaller group consists of calcium sulfate compounds. After mixing, the calcium phosphate or calcium sulfate material can be used as an allograft alternative. The paste-like materials have been described as slightly exothermic or perhaps isothermal reactions.[21] In this study, it was found that calcium sulfate cures though an isothermal reaction. Calcium sulfate alpha hemihydrate has an unusual property: when mixed with water at ambient temperatures, it quickly reverts to the dehydrate form, while setting to form a rigid and relatively strong gypsum crystal lattice.[22] Calcium sulfate has other desirable properties in surgery; it is osteoconductive. In a surgically created space in situ, it inhibits fibrous tissue ingrowth, it creates a slightly acidic environment that encourages angiogenesis and osteogenesis, and it dissolves at nearly the same rate as bone regeneration. A combined product containing osteoinductive demineralized allograft bone matrix and osteoconductive alloplast calcium sulfate has also been proven as a successful bone graft substitute material.[23] The present study showed that calcium sulfate alpha hemihydrate, in volumes typically used as a bone substitute, undergoes an isothermal reaction and not an exothermic reaction. Differing crystal sizes between the alpha and beta hemihydrate allow the material to accommodate different amounts of water. The change in the system occurred slowly enough to allow the system to adjust to the temperature of its surroundings. Notably, a rise in temperature of greater than 10 C was never achieved over a time period of 11.5 minutes. According to the manufacturer, the material hardens in approximately 1 minute. Doubling and quadrupling the mass of material did not increase the temperature of the setting calcium sulfate. In fact, the temperature in each sample only varied slightly from the starting temperature. A follow-up was performed in an incubator at 37C to mimic body temperature. This was undertaken to see if simulated in vivo conditions would be different from our study. As expected, temperature changes were very similar to what was found in the stone models. Therefore, based on the results of this study, temperature does not appear to be a factor when dealing with this material as a graft substitute. Calcium sulfate bone graft material is not exothermic. Reasons for the observed failure rate are not known at present.

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The Effects of Professional-Based Education upon the Interest of a Disadvantaged Population in Implant-Related Treatment

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Abstract

Introduction: The purpose of this project was to report the value of a strategy to motivate a disadvantaged population, limited in their opportunities for information, regarding dental and oral care with specific reference to dental implants.

Material and Methods: An informative lecture from a dentist about oral care, restoration of missing teeth and implants was conducted for 500 subjects who were inmates of the Sharjah Central Prison (United Arab Emirates). A survey instrument was completed by the subjects both before and after the lecture. The responses from the surveys were tabulated and analyzed.

Results: The interest of patients in replacement of missing teeth significantly increased after the lecture, $p < 0.001$. The preferred method of replacement changed significantly after the presentation, $p < 0.001$. The knowledge of the subjects regarding implants significantly increased after the lecture, $p < 0.001$. Some of the subjects requested implant treatment.

Conclusions: Instruction by a dentist significantly improved the interest of a population with limited education background and poor socioeconomic class in replacement of missing dentition with an implant.

KEY WORDS: Dental implants, survey, patient education, missing teeth

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INTRODUCTION

There is increasing awareness of the importance of oral and dental health. Its value is being increasingly accepted not only with regard to preventing or alleviating of pain but also with regard to nutrition and local and systemic disease. In addition, the value of an esthetic appearance and a healthy smile are today highly prized. As a consequence, the options for tooth replacement are of importance to the population.[1] With the development of technological improvements in implant dentistry, the options for treatment have been considerably expanded. The long term predictability of dental implants, because they are not vulnerable to dental caries, appears improved relative to that of the natural dentition. Thus, fixed prostheses supported by implants may have an excellent prognosis. In addition, implants provide further stability for removable prostheses.

It is important however that the public receive appropriate information regarding the advantages of the available options for tooth replacement. Today, the internet is an important form of education which much of the lay public utilizes for information and communication.[3] It offers opportunities to learn about prosthetic options including implants. However, this medium is more likely to be used by individuals in middle to higher socioeconomic strata.[4] The public sector having lesser economic resources who often are in greater need for prosthetic treatment are less likely to avail themselves of these services because of lack of education and limited finances.[5]

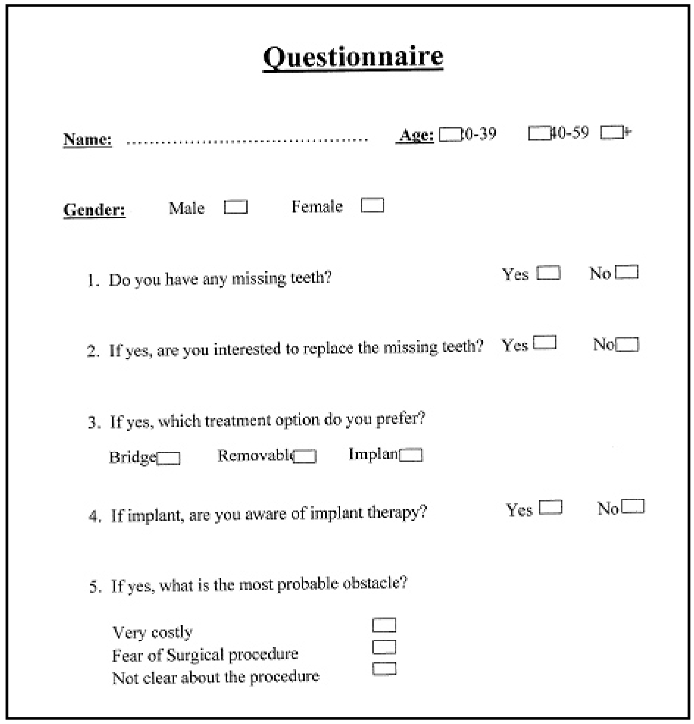
Other means of education may be employed. One possibility is education by dental professionals. Often, introductory explanations by dental health care professionals can allow the patients to seek further knowledge either from friends or via the internet. This approach will be most successful if the initial presentation or contact with the dental health care professional significantly increases the understanding and awareness of the patient.[4] This study examined the usefulness of a presentation by a prosthodontist/implantologist and a general dentist team to a prison population to increase their awareness and motivation in seeking further dental care for missing teeth.

METHODS

A cohort of 500 male prisoners was randomly selected to participate in the study. The cohort was not segregated by age, educational background, or reason for incarceration. All subjects agreed to participate in the study. The population was administered a questionnaire designed to identify the patient's interest in tooth replacement for missing teeth, the patient's preferred treatment modalities, and the patient's perceived obstacles to the preferred treatment. This questionnaire (Figure 1) which was available in 5 languages was administered both before and after a 1 hour standardized presentations by a dentist in the language that the prison cohort understood. The subjects of the presentation included general principles of oral health, the value of tooth replacement, the options for tooth replacements and the advantages of each restorative option. The questionnaires were scored and a cross tabulation test performed for the group using SPSS.[6]

RESULTS

The interest of the cohort in replacement of missing teeth was significantly increased after attending the educational lecture (Table 1, $p < 0.001$). The preferred method of replacement was influenced by the presentation. Before the lecture 30% of the patients chose a bridge, 17.2% a removable partial denture and 52.8% an implant. After the lecture, there was a significant change in the preferences of the subjects, Table 2. Only 21.2% of patients chose the bridge option while the rest, 78.8%, chose an implant as their preferable replacement option, $p < 0.001$. Before the lecture, 57.6% of patients had some received some information about implant therapy. This significantly increased to 95.2% after the lecture, Table 3, $p < 0.001$. However, both before and after the lecture, cost was the main reason for patients not selecting implants, Table 4. Before the lecture 34% of patients chose unclearness about implant procedure as an obstacle to treatment. After the lecture this number decreased to 10.8%.


Questionnaire

Name: .... **Age:** ☐20-39 ☐40-59 ☐60+

Gender: Male ☐ Female ☐

1. Do you have any missing teeth? Yes ☐ No ☐
2. If yes, are you interested to replace the missing teeth? Yes ☐ No ☐
3. If yes, which treatment option do you prefer?
   Bridge ☐ Removable ☐ Implant ☐
4. If implant, are you aware of implant therapy? Yes ☐ No ☐
5. If yes, what is the most probable obstacle?
   Very costly ☐
   Fear of Surgical procedure ☐
   Not clear about the procedure ☐

Figure 1: Questionaire used for study.

DISCUSSION

The opportunity to obtain further information and become aware of new options and opportunities for health improvement frequently has a significant impact both on attitudes and dental healthcare decisions. In general the internet is utilized by individuals of higher economic class who frequently are better educated. Individuals who economically or educationally disadvantaged are less likely to utilize these opportunities to gain information for dental healthcare decision-making[7,8] and thus other means of information surfing are needed. This study, utilizing a prison population, demonstrated the effectiveness of a presentation by a dental professional. The presentation to the population changed the perception of the group and motivated a significant number of the subjects to consider implant treatment as an option to improve their oral health and their appearance.

In a similar study, Alani et al.[9] showed that discussion and the opportunity to review options reflect upon the discussion resulted in a number of subjects reconsidering their original treatment decisions. The utilization of advanced technologies in health care such as dental implants in countries with large uneducated populations is challenging. In studies by Chowdhaty,[10] Al-Omiri,[11] and Shigli[12] lack of knowledge and the perception that implants were extremely costly was common and prevented third world populations from considering dental implants as a treatment option. Interestingly, however, even in more affluent countries, samples of Swedish, Japanese, and American populations reported that dental implants were too costly,[13] However, a relationship of trust between patient and dentist can improve the receptivity of patients to implant treatment.[14] These results are similar to those of Alani et al.[9]

Table 1: Percentage of Interest in Replacing Missing Teeth Before and After Informative Lectures

		Before	After	Significance Level
Interested in Replacing Missing Teeth	Yes	87.2%	97.6%	.000 Sig
	No	12.8%	2.4%	

Table 2: Percentage of Each Treatment Option Selected

		Before	After	Significance Level
Preferable Treatment Option	Bridge	30%	21.2%	.000 Sig
	Removable P.D.	17.2%	.0%	
	Implant	52.8%	78.8%	

who reported that reflection a nd d iscussion can make individuals reconsider their initial treatment decisions. As it relates to patient awareness of implant treatment options, almost half of patients in this study were unaware of the nature of implant procedures and their prognosis prior to the presentation. Pragati[15] reported that although around one million dental implants are inserted each year worldwide, the information available to the patients regarding the procedure and its success is often fragmentary. Chowdhary et al.[10] reported that only 23.24% of the Indian urban population had heard of dental implants as a treatment option for replacing missing teeth.

A further issue that requires consideration is the quality and accessibility of the information available to the consumer.[5] A variety of tools have been prepared by healthcare constituencies, but they vary in quality, i.e., the clarity and organization of the information. In addition, the accessibility of these tools may vary. Finally the education and background of the consumer may limit the opportunity to utilize these tools.4 Individuals in the lower socioeconomic levels may not have availability of the internet or lack the opportunity or the skills to use a computer for DVD or other electronic materials. Literacy may also be limited and thus the ability to read brochures and fact sheets may

Table 3: Percentage of Public Awareness About Implants				
		Before	After	Significance Level
Awareness of Implant Therapy	Yes	57.6%	95.2%	.000 Sig
	No	42.4%	4.8%	

Table 4: Percentage of Obstacles Affecting Implant Selection				
		Before	After	Significance Level
Most Probable Obstacle	Cost	52.4%	54%	.077 N.S.
	Fear.	9.6%	9.6%	
	Unclear	34%	10.8%	
	Cost and Fear	4%	25.6%	

be lacking. While labor-intensive, the use of personal interactions between healthcare personnel and the patient may be appropriate to assist many of these individuals. However the interaction between the healthcare provider and the patient also requires some examination.[4] Charles described three different types of medical decision-making. The first is doctor-centered. In this model, the healthcare provider has established credibility with the patient and makes the significant decisions. In the second type, patient-centered, the patient acquires sufficient information to become confident in his or her decision-making abilities. The third type, a combination of the first two, is one in which the healthcare provider and the patient jointly make the medical decision. This model appears to have been effective in this study. Dental care, as most health-related issues, requires patient commitment to complement the dental care provided by the clinician to be most effective. The increased awareness demonstrated by the subjects in this study suggests that the hour lecture was effective in providing the subjects with useful, quality, information that could influence the subjects' decision-making process. Indeed a number of the subjects in the study subsequently volunteered to be treated in the prison with dental implants as part of an implant training program for dentists. However, more than half of patients reported cost to be significant. This result is comparable to several other studies. Van der Wijk et al.[16] observed that the high cost of the implants is one of the major limiting factors in the willingness of patients to undergo treatment. This clearly indicates the necessity for dentists and the implant industry to take the necessary steps in reducing costs and thus creating opportunities for treatment.

In conclusion it would seem that personal interactions with health care professionals may be an effective way to motivate individuals whose opportunities to independently seek improved health are limited. While this approach is more resource-intensive, such initial contacts can motivate individuals to seek further information and opportunities for improved health care as a result of their initial encounters.

CONCLUSIONS

Conclusion 1: Information delivery was helpful in dental healthcare decision processes for a prison population. Conclusion 2: Financial factors are perceived as a significant obstacle in subjects' choice of implant treatment.

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Disclosure
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