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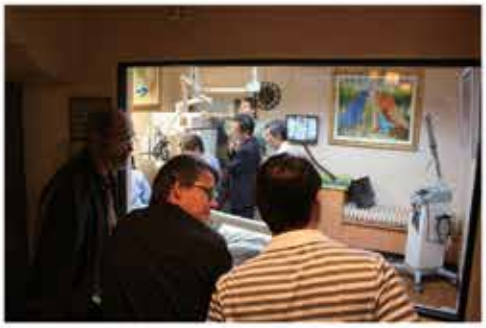

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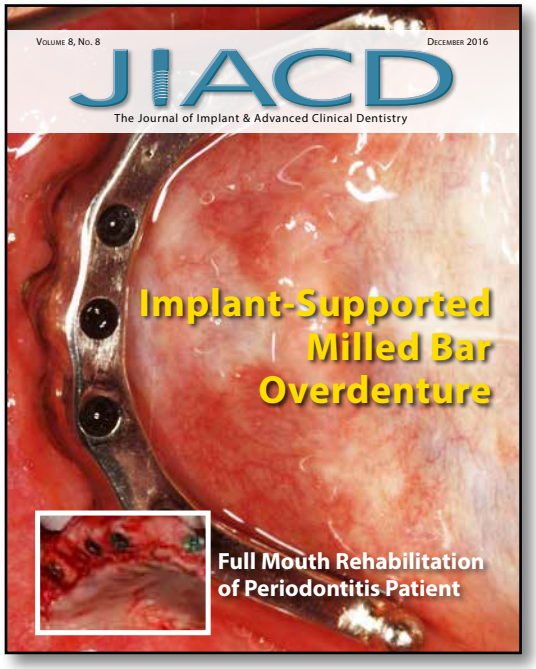

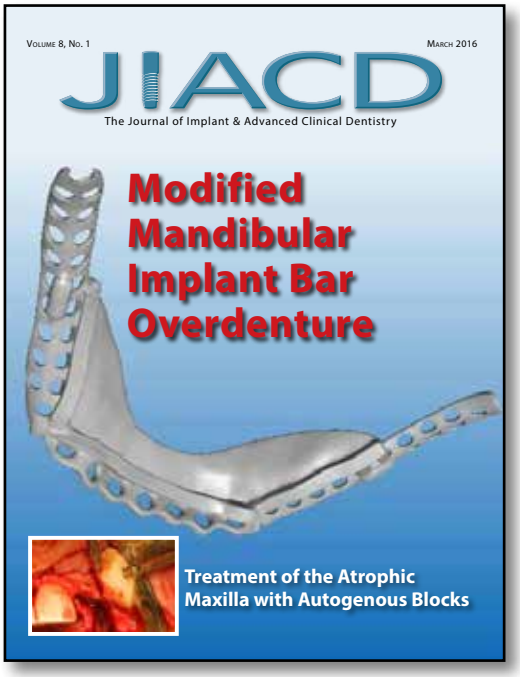

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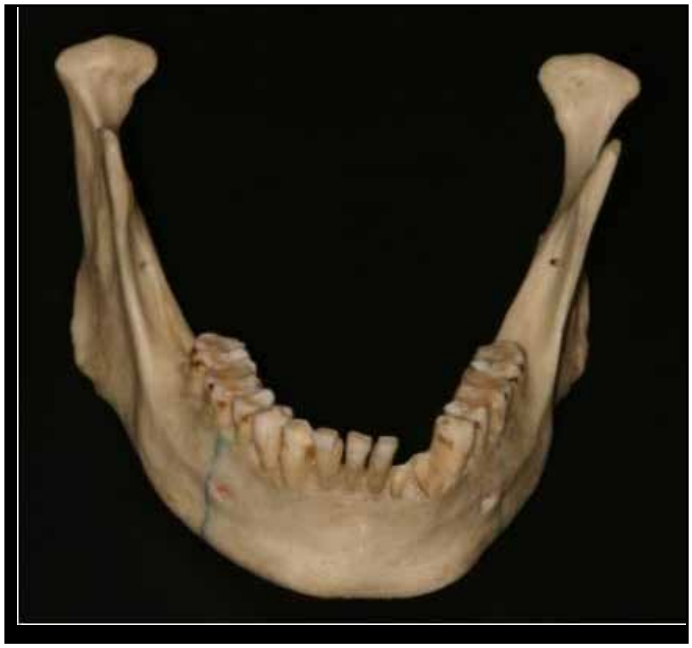

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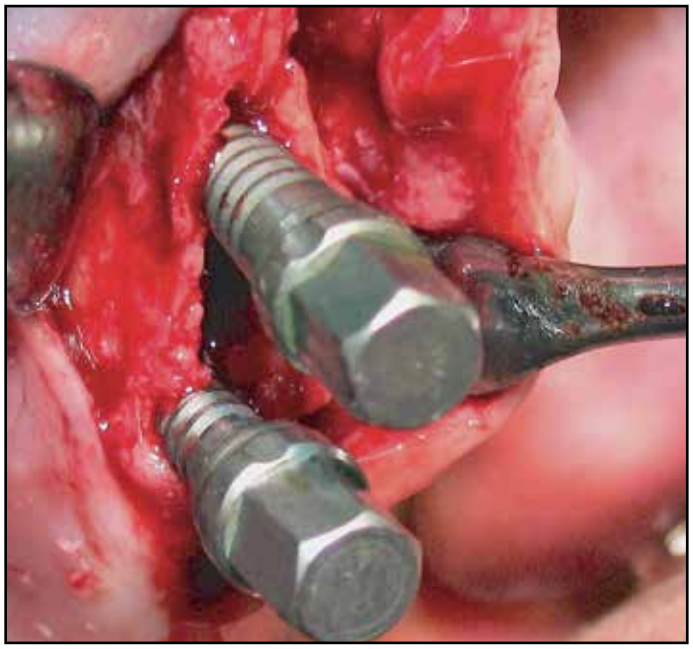

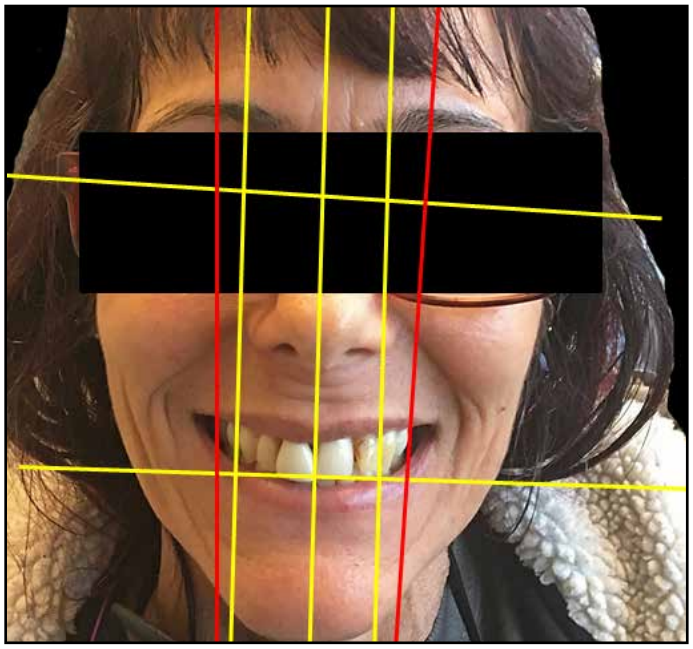

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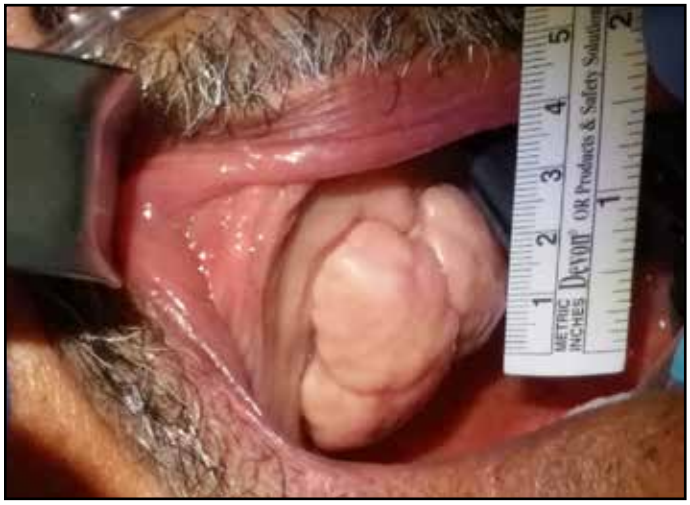
Torus Palatinus: A Brief Review of the Literature and Case Report of Removal

Juan Gonzalez, DMD, DABOMFS[1]
David Malave, DMD, DABOMFS[2] • Dan Holtzclaw, DDS, MS, DABP, DICOI[3]

Abstract



The Torus Palatinus is a specific type of exophytic bony protuberance that can have profound effects on certain patients. While typically slow growing and asymptomatic in most patients, Torus Palatinus can lead to chronic pain and frustration for patients with prosthetic devices such as complete dentures. The following article provides a brief review of the literature regarding Torus Palatinus and a Case Report in which this type of bony growth was removed to facilitate better maxillary complete denture comfort for a long suffering patient.

KEY WORDS: Torus Palatinus, prosthetics, surgery, maxilla

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BACKGROUND

In general, tori are benign bony protuberances composed of dense cortical bone and covered with a friable and poorly vascularized mucosa.[1,2] The *Torus Palatinus* (TP), specifically, most commonly occurs at the palatal midline at the union of the palatine apophysis of the maxillae.[3] Etiology of TP are poorly understood and a number of reasons for their development have been suggested. Genetics is a widely postulated theory for the development of TP[4-7] as these bony protuberances have shown higher prevalence in certain ethnic population groups.[5-12] Although findings of elevated TP prevalence in certain populations have been noted, little consistency has been found amongst these studies and, as such, genetics has been unable to be confirmed as a firm etiology. Another suggestion for the development of TP is an association with bruxism or heavy occlusal forces as these have also been somewhat linked to the etiology of mandibular tori.[13,14] This etiology, specifically in relation to TP, has been questioned as several studies have shown that the prevalence of TP may not necessarily correspond with parafunctional habits[14,15] or dentate status.[8] Other suggested causes of TP include trauma, vitamin deficiencies, diet, and use of certain medications.[16-19]

A number of studies have reported on the prevalence of TP in various populations. Sonnier et al.[8] found a 22.8% prevalence of TP in Caucasian North Americans and 12.2% prevalence in African American – North Americans. Studies of Norwegian populations found prevalence of TP to be 9.22-36.1%[9,10] while studies of Thais found TP prevalence of 23.1-58%.[6,11] In a study of Israeli Jews, Gorsky et al.[12] found TP prevalence of 21% while a study of Saudi Arabians found prevalence of only 7.79%[20] and a study of Germans found TP prevalence of 13.5%.[11] Concerning sex, most studies have shown a higher prevalence of TP in females.[4-12] A recent study by al Zarea et al.,[20] however, noted that men had higher prevalence of TP. Concerning age, the onset of TP seems to occur earlier in life compared to other types of oral exophytic bony protuberances such as mandibular tori.[5,11] However, due to their slow and asymptomatic growth, TP are not commonly noted until the third to sixth decades of life.[7,9-11] Concerning size, TP tend to be larger than other oral bony protuberances.[8] While most TP tend to be classified as "small" (less than 2mm)[9,11,18] some studies have shown TP to reach average sizes exceeding 20mm in length.[5,8] Concerning shape, TP have been classified as flat, spindle shaped, nodular, and lobular.[5,11,18,21] Very little consistency, however, has been found amongst studies concerning the shape of TP. In general, most TP are asymptomatic although exceptionally large TP interfere with speech, create food traps, or ulcerate/lacerate during mastication of particular foods.[3,8,20,21] The most common problem associated with TP is prosthetic interference leading to prosthetic instability.[20] These prosthetic issues, particularly in the case of complete maxillary dentures, is the most frequent impetus for TP removal.[3,8] In the present Case Report, surgical removal of a large TP is described for this reason in particular.

CASE REPORT

An 80 year old male with an unremarkable medical history presented with a chief complaint of being unable to comfortably wear his upper denture due to "the large bump on the roof of

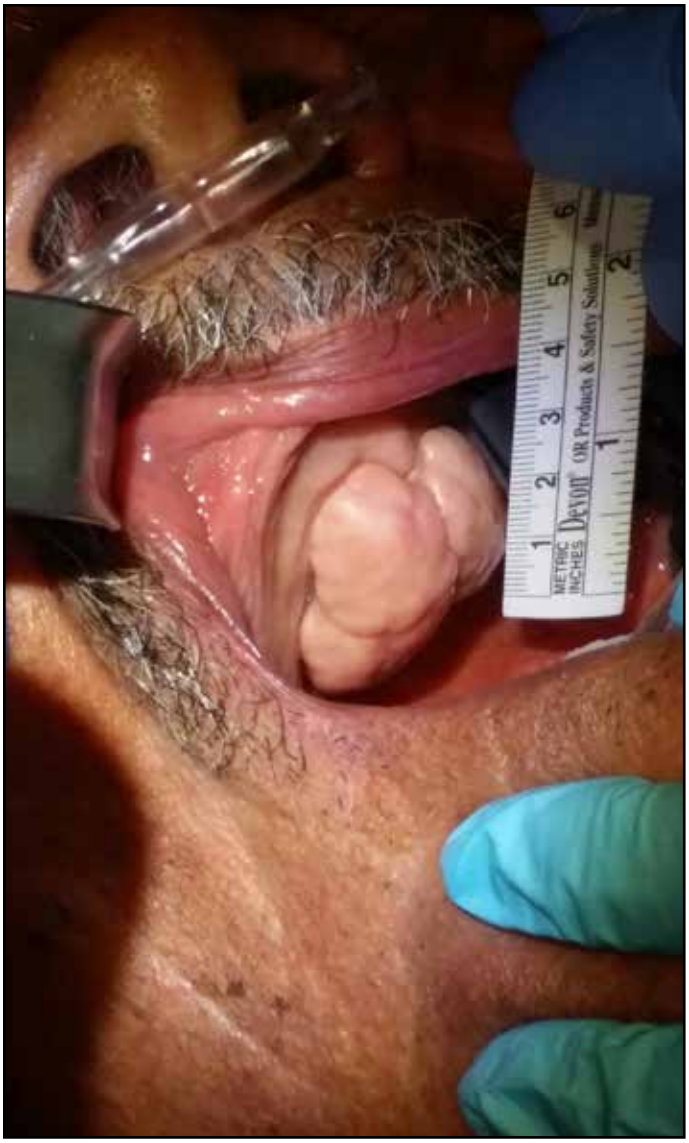

Figure 1: Pre-surgical examination showing extremely large Torus Palatinus that is interfering with the patient's maxillary complete denture.

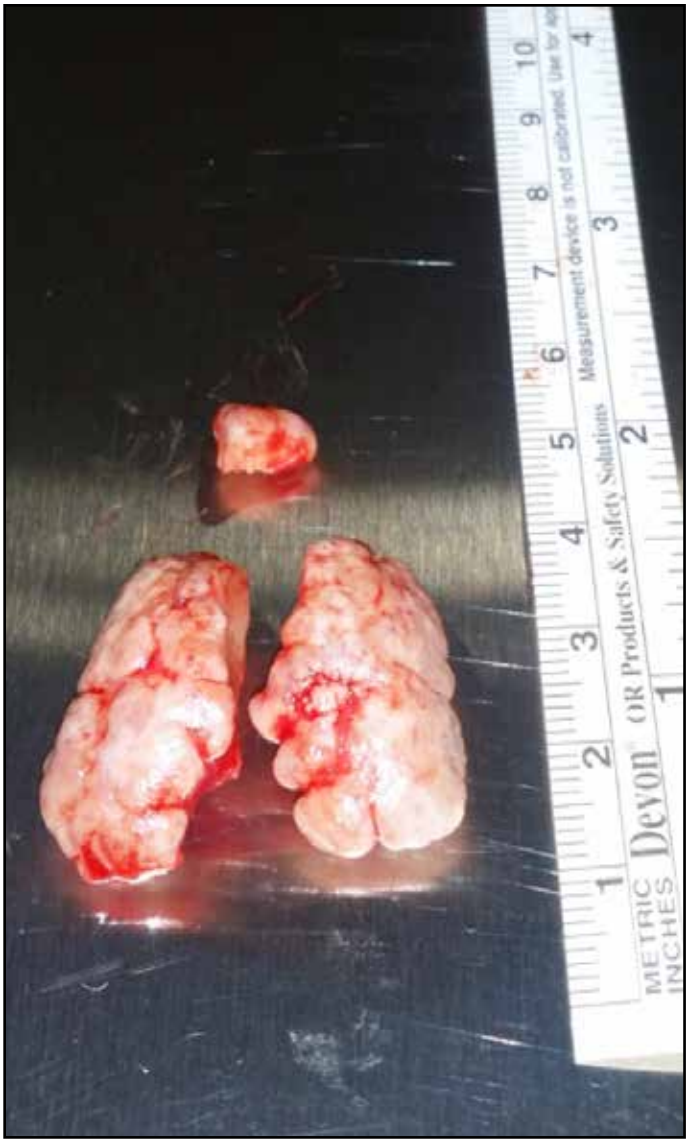

Figure 2: Excised Torus Palatinus following sectioning with a surgical high speed hand piece and mallet/chisel removal.

my mouth." The patient noted that the "bump" had been present for as long as he could remember and had not changed in size as far as he could tell. Furthermore, the patient stated that the bump was asymptomatic other than causing interference with being able to wear an upper denture. Intraoral examination revealed an edentulous maxilla with a large, non-mobile, lobular, exophytic protuberance of the mid-maxilla (Figure 1). Cone beam computed tomography (CBCT) scanning suggested the growth to be dense, radiopaque bone. The growth in question had characteristics consistent with a *Torus Palatinus* and measured approximately

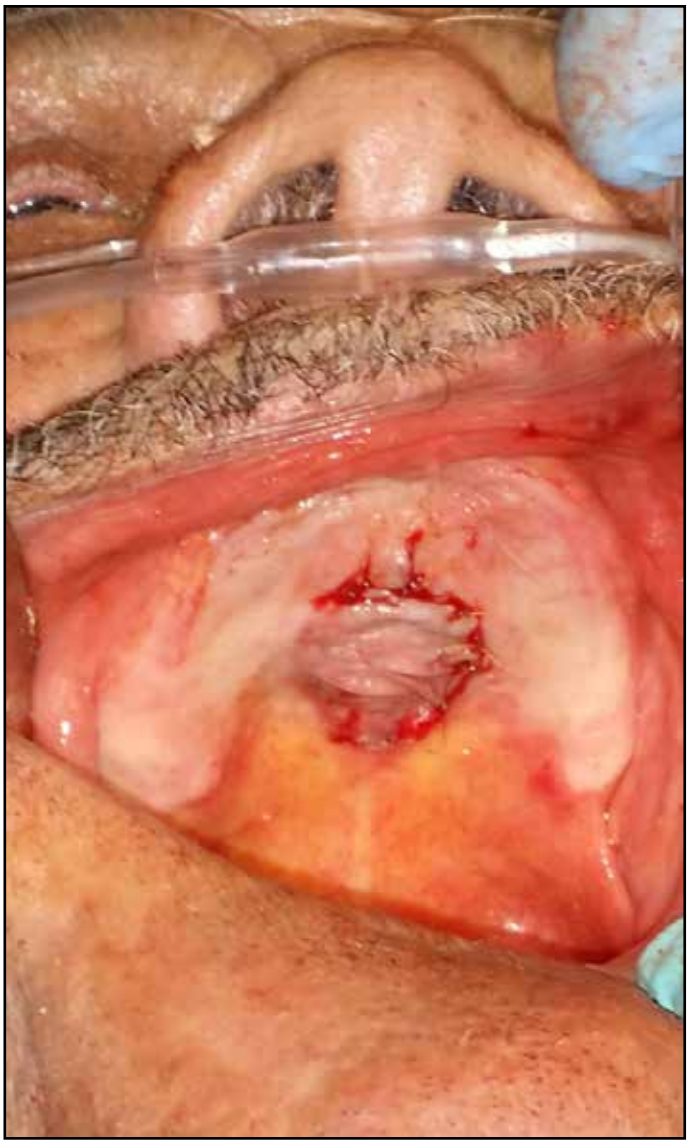

Figure 3: Sutured palate following removal of Torus Palatinus. Notice the immediate and dramatic change in palatal anatomy following the surgical procedure.

30x35mm in size. The patient was informed of the diagnosis of *Torus Palatinus* and surgical removal was recommended to facilitate better fit of a complete maxillary denture. The patient was consented for treatment and a complete history and physical was performed. With findings of an unremarkable medical history, the patient was prepped for surgery with intravenous and local anesthesia. A full thickness palatal flap was accomplished with an incision lateral to one side of the TP for exposure of the bony growth. The TP was sectioned in half with a surgical high speed hand piece and removed from the palate with a mallet and sharp chisel (Figure 2). The palate was carefully evaluated for any remaining sharp bony ledges which were subsequently removed and the surgical site was copiously irrigated with sterile saline. Closure was achieved with 4-0 chromic gut sutures (Figure 3). Post-operative pain medication and antibiotics were provided to the patient in the usual fashion. Healing was uneventful and the patient had his maxillary complete denture remade to accommodate the healed palate. The patient reported a dramatically improved fit of his new maxillary denture and no longer reported any discomfort with its use.

CONCLUSION

Although not a pathologically worrisome entity, the *Torus Palatinus* is a commonly seen condition that can negatively affect certain patients. The removal of TP is a relatively simple procedure for surgically trained dental providers and can significantly improve the quality of life for many patients, especially those with maxillary prosthetics.

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

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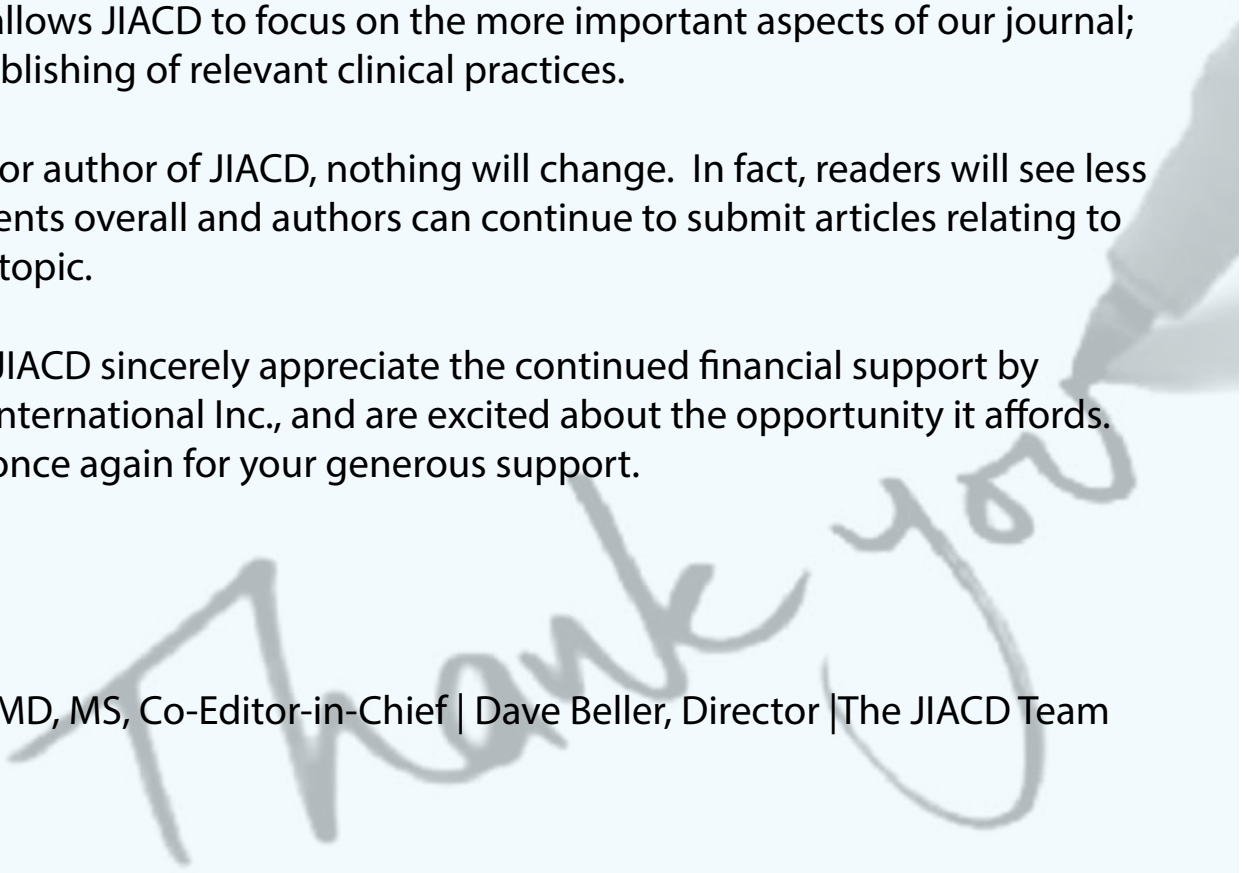

Comparison of the Linear Dimensional Accuracy and Detail Representation in Stereolithographic Models of a Human Mandible: An In-Vitro Pilot Study

Vahik Paul Meserkhani, DDS, MSD[1] • Tony Daher, DDS, MSEd[2]
Charles J. Goodacre, DDS, MSD[3]

Abstract

Statement of Problem: The accuracy of stereolithographic models produced by commercial biomedical laboratories using cone beam computed tomography (CBCT) data has not been investigated.

Purpose: The purpose of this study was to determine the accuracy of stereolithographic models of a human mandible produced by three commercial biomedical laboratories using data acquired from cone-beam technology. Materials and Methods: One adult dry human mandible served as the reference object, and was cut into three segments. Reference notches were placed in each segment to permit measurement and comparisons of linear dimensional accuracy and height of contour at 10 different sites. The sections were imaged using cone-beam technology. The acquired data were sent to three different medical modeling laboratories to produce one stereolithographic model for each segment. These models were then measured using the reference notches and the data were analyzed using an analysis of variance ANOVA and the LSD test at the significance level of α=0.05.

Results: Comparison of the linear measurements of the original human specimen and the three stereolithographic models at the 10 different sites at, revealed statistically significant differences when the reference notches were used for measurements at all 10 measurement points due to the poor surface detail reproduction of all the models. However, when the heights of contour of the same sites were used 6 out of ten sites with Protomed Laboratory, 4 out of ten sites with Biomedical Modeling laboratory and 3 out of ten sites with Medical modeling laboratory had no significant differences.

Conclusion: All three laboratories models exhibited significant differences when the measurement were at the reference notches, only thirteen out of 30 sites had no significant differences when height of contour were used for measurements. The result of this study indicates adequate dimensional accuracy and lack of surface details of stereolithographic models produced by different commercial laboratories.

Clinical Implications: The stereolithographic models produced in this study served as valuable aids in overall pre-surgical planning but lacked the surface detail that may be required for highly precise guided implant surgeries and immediate prosthetic placement.

KEY WORDS: Cone Beam, Stereolithographic models, linear dimensions, accuracy, guided surgery, immediate prosthetic placement.

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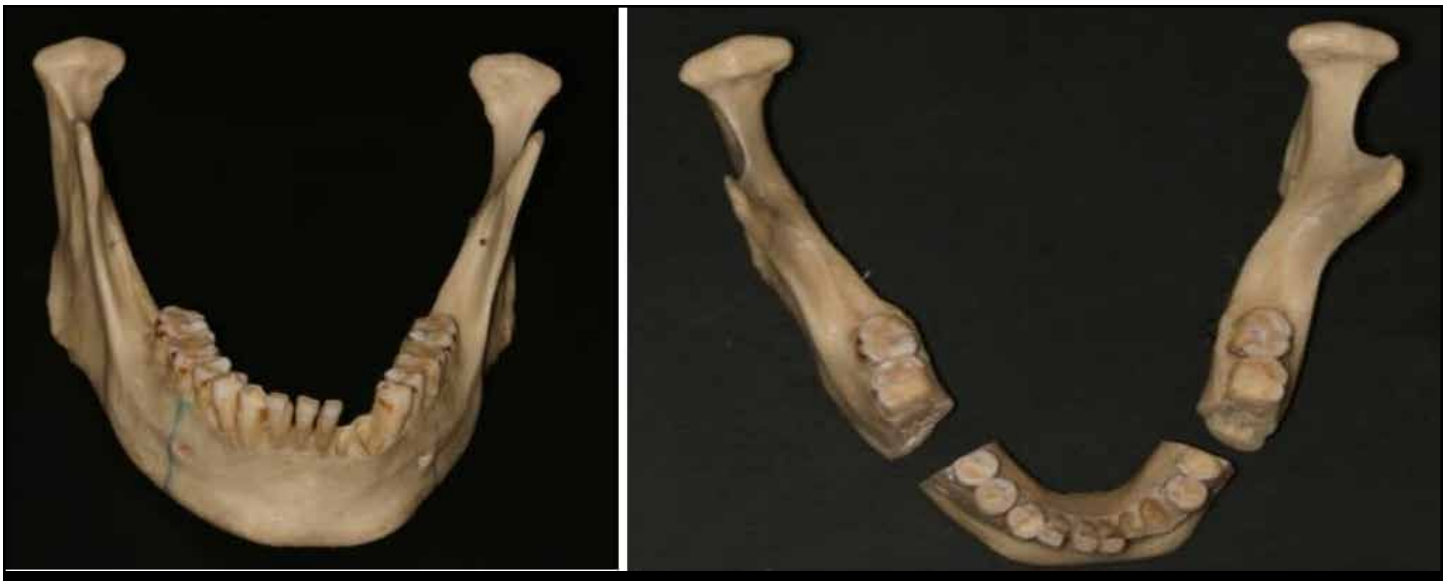

Figure 1: The dry human mandible specimen before and after sectioning.

INTRODUCTION

Although x-ray computed tomography (CT) was developed in the 1960s, it was not until 1972 that Godfrey Hounsfield introduced this technology for clinical studies.[1] CT was a chosen technique to diagnose the maxillofacial complex and to plan implant and bone graft placement. In fact radiological tomography went on to gain widespread use and quickly became one of the essential imaging techniques in medical and dental radiology.[1] Mozzo et al.[2] and Arai et al.[3] were the first to present CBCT machines to use in dentistry. Since then, many publications have described its applications and its characteristics.

A subsequent development of from CT technology, digital volume tomography or cone-beam volumetric imaging (CBVI) has emerged around 2001 and was introduced to dentistry in North America.[2] This technology is frequently a part of maxillofacial radiology, because of its characteristic low radiation dose, relatively high spatial resolution, less time spent during image acquisition and lower cost compared to computerized tomography.[3,4,8,] A typical CT scan of a potential maxillary implant site assessment can produce radiation exposure as high as 2,100μSV, or the dose equivalent to approximately 375 panoramic films or digital images. In contrast, CBCT machines produce much lower radiation doses, ranging from 40 to 500μSV or as little as the equivalence to approximately to six panoramic equivalents.[4,5,9] However, publications evaluating the accuracy of the CBCT images have appeared from 2003 onwards.[6] Accuracy of CBCT also has been investigated by Pinsky et al, and their result indicates that the technology is not only reliable but accurate.[7]

Of particular importance is the fact that data obtained from CT and cone beam technology can be used to generate medical models and reproductions of actual human anatomy by means of a process known as rapid prototyping (RP). Rapid prototyping is already in use to produce physical replicas (models) of human body parts to aid in medical and dental diagnosis and

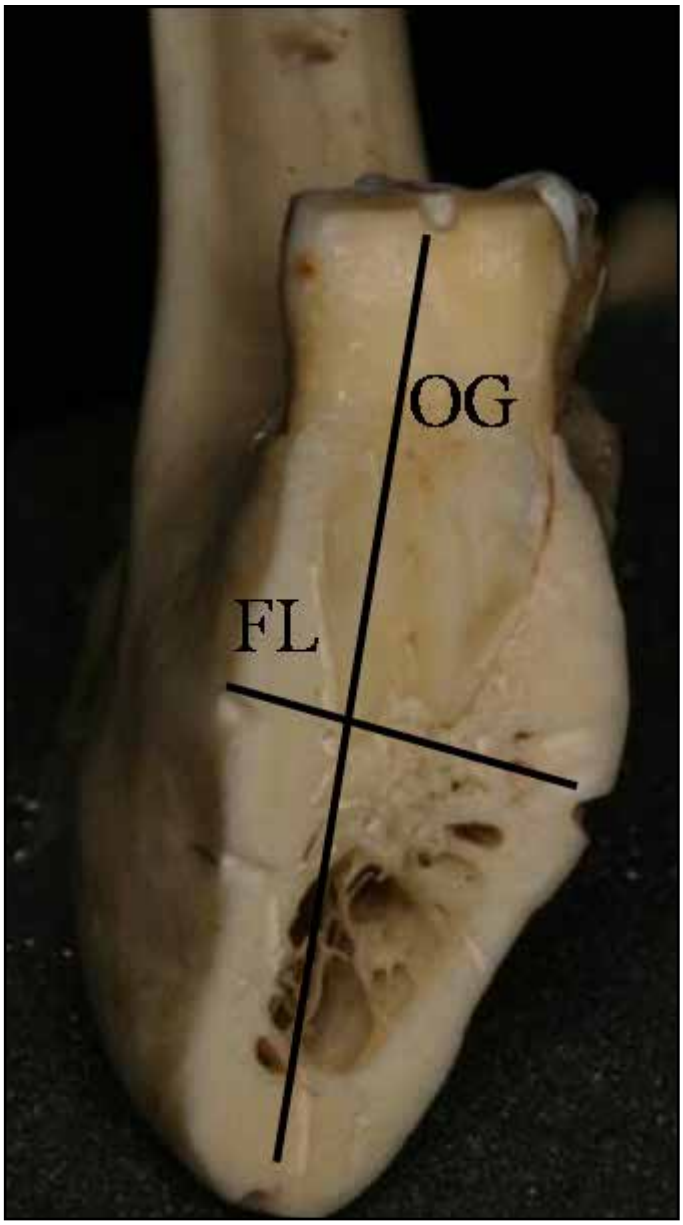

Figure 2a: Proposed measurement sites and reference notches.

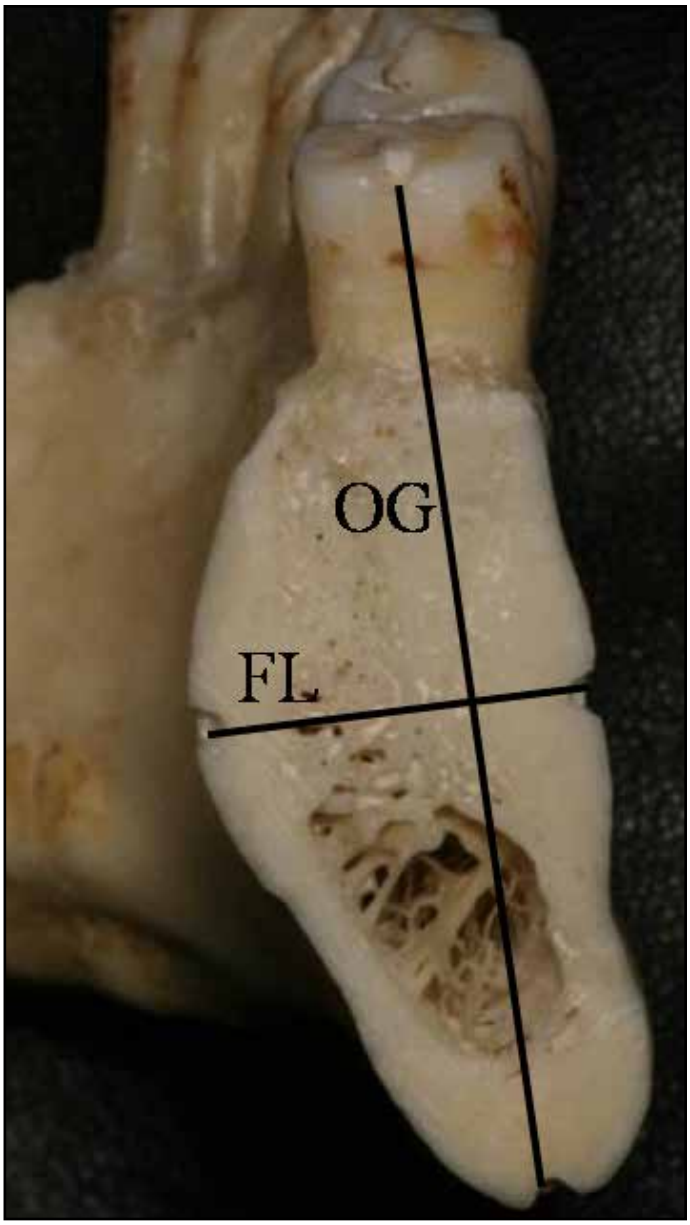

Figure 2b: Proposed measurement sites and reference notches.

treatment planning. In fact, with the first generation of rapid prototyping models, computer-aided design (CAD) was used to translate the 3-D data into physical models by milling solid blocks of Styrofoam or polyurethane. A leading technology for rapid prototyping in recent years has been Stereolithography or (SLA). Stereolithography creates 3-D models by selectively

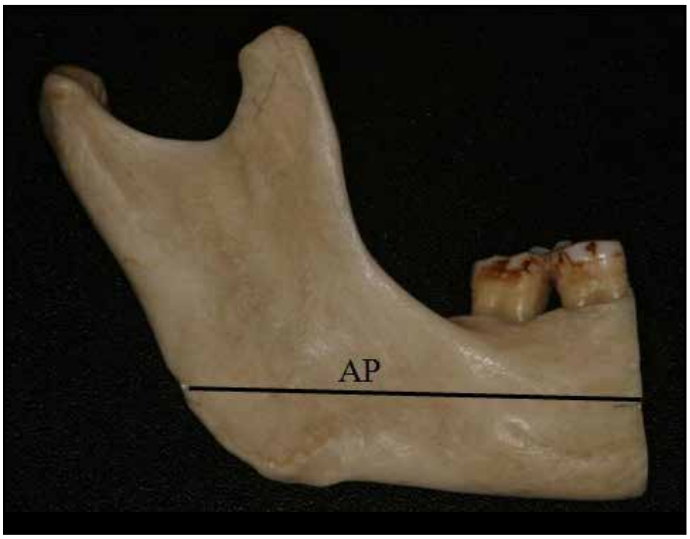

Figure 2c: Proposed measurement sites and reference notches.

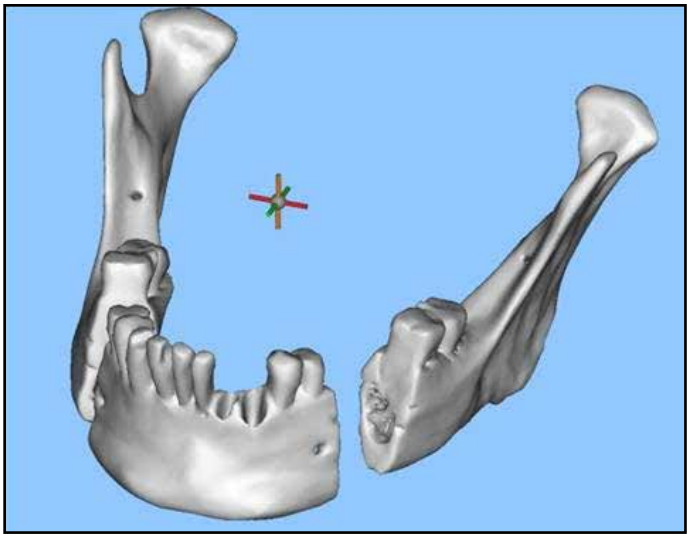

Figure 3: Virtual model of the three sections of the mandible by Biomedical Modeling Inc. laboratory.

Figure 4: ProtoMed Laboratory model (left) and the dry human specimen.

Figure 5: Biomedical Modeling Laboratory, model (left) and the dry human specimen.

solidifying UV-sensitive liquid acrylic resin using a laser beam.[10] The technology has gained a great amount of attention, particularly in oral and maxillofacial surgery.[11] An important and ongoing challenge in RP applications in this field is how to produce RP models that are complete and anatomically accurate for each patient.

In previously reported investigations on the

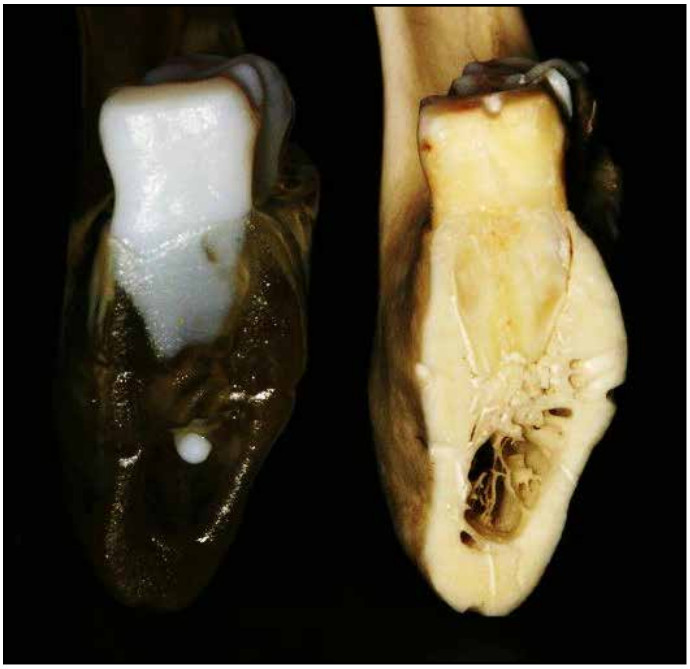

Figure 6: Medical Modeling Laboratory, model (left) and the dry human specimen. Cross-sectional comparisons of the right section of the human mandible specimen to the acrylic resin stereolithographic model produced by Medical Modeling Inc.

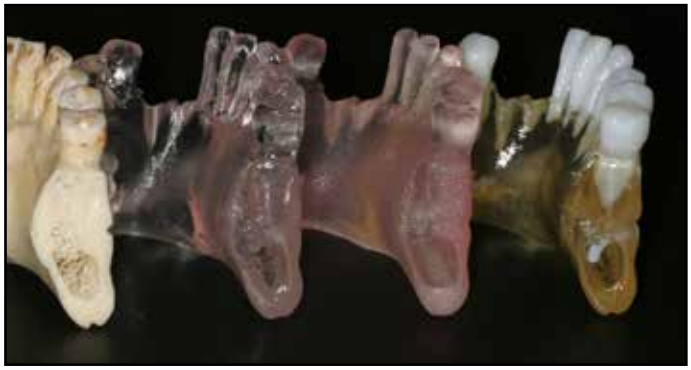

Figure 7: Anterior segment of the specimen and the three corresponding medical models in the following order: Protomed, Biomedical Modeling Laboratories, and Medical Modeling Laboratory. Cross-sectional view of the distal portion of the anterior mandible specimen compared to all three corresponding stereolithographic acrylic resin models.

accuracy of biomedical models and rapid prototyping by Barker et al.,[12] Choi et al.,[13] Robiony et al.,[14] and Bouyssie et al.,[15] computed tomography (CT) scans were used for data acquisition. However in recent years the use of Cone-Beam Volumetric Imaging (CBVI) is rapidly replacing the use of CT scans for dental applications.

There is a lack of published information on the accuracy of stereolithographic models of the same patient or subject produced by different commercial stereolithographic fabricators. Therefore, the aim of this study was to determine the linear dimensional accuracy and surface detail reproduction of stereolithographic models of a dry human mandible specimen from data acquired from one cone beam CT unit i-CAT™ (Imaging Sciences International, Hatfield, PA) produced by three commercial biomedical modeling laboratories. The null hypothesis for this study was that there are no differences in accuracy linear dimensions as well as surface detail reproduction between the mandible and stereolithographic models for any of the three commercial laboratories.

MATERIALS AND METHODS

One dry, adult human mandible served as the reference object for analysis. The mandible was sectioned distal to the mental foramen on each side (Figure 1) using diamond discs (946.104.220, Komet, Germany) and the W&H Osseo Set 100SI-95230 V surgi-

Table 1: Proposed Measurement Sites	
Mandible Right	
1-AP	**Anterior portion of segmented specimens to posterior border of**
2-OG	**Occlusal surface to inferior border of mandible**
3-FL	**Facial surface to lingual surface of mandible**
Mandible Left	
4-AP	**Anterior portion of segmented specimens to posterior border of**
5-OG	**Occlusal surface to inferior border of mandible**
6-FL	**Facial surface to lingual surface of mandible**
Anterior Right	
7-OG	**Occlusal surface to inferior border of mandible**
8-FL	**Facial surface to lingual surface of mandible**
Anterior Left	
9-OG	**Occlusal surface to inferior border of mandible**
10-FL	**Facial surface to lingual surface of mandible**

cal unit (Nobel Biocare USA, 22715 Savi Ranch Parkway, Yorba Linda, CA, USA).

This sectioning created three mandibular specimens: a right side, a left side, and a middle section. Four reference notches were cut into the superior, inferior, inner, and outer surfaces of the middle section of the mandible along each sectioned surface using diamond instruments round end (D835-31-010 and 6856 -31- 012, Komet, Germany). On the right and left segments, two additional reference notches were cut into the distal aspects of the ascending ramus. These sections provided four sites each where height and width were measured. The two additional reference notches were cut into the distal aspect of ascending ramus. These result in three segments with ten site for linear measurements, the middle segment will provide four sites for height and width measurements and left and right segments will provide three sites each on height, width and anterior-posterior measurements, these will provide a total of ten sites (Figure 2).

A glue gun (Model1200, Adhesive Tech-

nology Inc., 3 Merrill Industrial Drive Hampton NH, USA) was used to stabilize the three sections of the mandible on a foam base for the imaging process. Radiographic imaging were made with a cone-beam imaging technology i-CAT, (Imaging Sciences Int, 1910 N Penn Road Hatfield PA, USA) 120 KV and 5 mA, with the slice size of 0.4 mm and isotropic voxel size of 0.4 $(mm)^3$. The acquired data were stored in DICOM format.

The collected data were then used to order of 3-D stereolithographic models by three medical modeling laboratories, using rapid prototyping. Also a virtual model constructed through DICOM data by Biomedical Modeling Inc. (Boston, MA) is shown in Figure 3.

ProtoMed Laboratory (Westminister, Co, USA)

ProtoMed laboratory in Westminster Colorado used the SL-250 3D system with SL H-C9100R (Huntsman) resin and a layering thickness of 0.15mm and their stereolithographic model and the specimen are shown in Figure 4.

Biomedical Modeling Inc. (Boston, MA, USA)

The Biomedical Modeling Company used Viper Stereolithography 3D system and RenShape SLY-C 9300 photopolymer acrylic resin (Huntsman) with a layering thickness of 0.15 mm. That replica is shown in Figure 5.

Medical Modeling Inc. (Golden, CO, USA)

The stereolithographic model produced by Medical Modeling Inc. involved the use of Connex 500TM (Object Geometries Ltd) and two different acrylic resins. The bone structures were replicated with FullCure720 transparent and the teeth and nerve were made with Vero White acrylic resin with a layering thickness of just 30 micrometers or 0.03mm (Figures 6, 7).

MEASUREMENTS

Linear measurements were carried out using electronic digital calipers 3C301 (Storm electronic Kowloon, Hong Kong) with a dial-gauge display and viewed at a 4.5 magnification (Design for Vision, Ronkonkoma, NY) by one investigator (VPM). Table 1 lists the 10 measurements sites from which dimensions were measured on the mandible as well as the replicas.

Tables 2 and 3 include the actual mean linear measurements for those 10 different sites used in this study. The measurements were at the reference notches and at the height of contour of each site respectively. The dimensions of the dry mandible and the stereolithographic models were compared in occluso-gingival, bucco-lingual and anterior-posterior directions. Both absolute and relative differences were determined, and the relative differences were expressed as percentages and calculated using the following equation:

$$\text{Relative difference} = \frac{(\text{Original distance} - \text{Model distance})}{(\text{Original distance})} \times 100$$

The standard error of repeated measurement was determined to quantify any variable errors in the measurements. Each dimension was measured five times in succession by a single investigator (VPM). The selection of the order in which measurements were made, was randomized to ensure that the order did not influence the results obtained.

Table 2: The Mean of Absolute Measurements of Specimen and the Medical Models at Reference Notches

Mean Measurements of Proposed Sites at Reference Notches				
Proposed Measurement Sites	**Specimen**	**ProtoMED**	**Biomedical Modeling Boston**	**Medical Modeling Colorado**
Mandible Right				
1-AP	59.57	59.57	60.36	60.39
2-OG	32.84	33.86	33.73	34.06
3-FL	11.74	12.66	12.78	12.82
Mandible Left				
4-AP	56.18	57.07	57.17	57.22
5-OG	30.40	31.31	31.33	31.57
6-FL	12.00	12.80	12.66	12.88
Anterior Right				
7-OG	33.13	34.30	34.60	34.43
8-FL	11.53	12.30	12.28	12.40
Anterior Left				
9-OG	30.83	32.20	32.43	31.78
10-FL	11.86	12.62	12.66	12.72

The measurements were made in the following manner:

1. Each section of the mandibular specimens was measured followed by the same location on each of the three corresponding medical models.
2. Five successive measurement readings were collected in the occluso-gingival and facial-lingual dimensions at the sectioned surfaces.
3. Two additional measurements were made at the anterio-posterior aspects of the right and left segments for the mandible and the three stereolithographic replicas. These readings were recorded using the reference notches and at the height of contour of each proposed site.

STATISTICAL ANALYSIS

A one- way analysis of variance (ANOVA) was use with the stereolithographic models as a factor for comparison. The Least Squared Differences (LSD) tests were used for post hoc comparisons. All tests were considered to be significant at an alpha level of $p < 0.05$.

RESULTS

Comparisons of the three human mandible specimens, using the reference notches, with their corresponding medical models at the 10 different sites showed statistically significant differences between the specimens and medical models when the reference notches were used for measurement. Based on the F and P-value, at 5% level of significance ($\alpha = 0.05$), the null hypothesis was rejected, not all of the means were statistically equal.

However, when the heights of contour of the same sites were used 6 out of ten sites with Protomed Laboratory, 4 out of ten sites with Biomedical Modeling laboratory and 3 out of ten sites with Medical modeling laboratory had no significant differences. The heights of contour comparisons indicated that medical models were dimensionally accurate only in thirteen out of 30 sites measured.

Relative differences between the mandibular specimens and each the three corresponding medical models were calculated to determine the difference in mm and percentage errors. Table 4 includes the mean of absolute distances, the difference in mm and the relative differences by percentage for measurements at the reference notches. Table 5 lists the mean of absolute distances, the difference in mm and the relative differences by percentage for measurements at the height of contour.

DISCUSSION

The value of biomedical modeling in evaluating craniofacial anomalies and maxillofacial reconstructive surgeries have been extensively discussed by several authors.[16,17,18,19] In fact in recent years multiple articles have been published regarding implant placement using stereolithographic surgical guides.[20,21,22]

It is the opinion of the authors that both the dimensions of stereolithographic models and their detail reproduction are important characteristics that can affect the outcome of sensitive surgeries such as implant guided surgery and immediate placement of implant prostheses. A review of all three types of medical models revealed significant variations in the level of detail captured at the pre-determined reference notches as well as the natural anatomical landmarks found in a mandible.

Proper measurement of the models was a challenge, because the reference notches were missing or poorly reproduced on all the models.

Table 3: The Mean of Absolute Measurements of Specimen and Medical Models at the Height of Contour

Mean Measurements of Proposed Sites at Height of Contour				
Proposed Measurement Sites	**Specimen**	**ProtoMED**	**Biomedical Modeling Boston**	**Medical Modeling Colorado**
Mandible Right				
1-AP	60.96	61.19	61.28	61.46
2-OG	34.27	34.23	34.41	34.43
3-FL	13.83	13.90	13.61	14.16
Mandible Left				
4-AP	58.07	58.04	58.23	58.40
5-OG	32.24	32.60	32.16	32.61
6-FL	14.04	14.07	13.95	14.18
Anterior Right				
7-OG	34.93	35.50	35.23	35.23
8-FL	13.44	13.38	12.94	13.57
Anterior Left				
9-OG	32.59	33.24	32.95	32.78
10-FL	13.76	13.86	13.55	14.00

Table 4: Percent Difference Between Specimen				
			Measurements at Reference No	
			Distance (mm)	
Proposed Measurement Sites	Specimen	ProtoMED	Biomedical Modeling Boston	Medical Modeling Colorado
Mandible Right				
1-AP	56.57	59.97	60.36	60.39
2-OG	32.84	33.86	33.73	34.06
3-FL	11.74	12.66	12.78	12.82
Mandible Left				
4-AP	56.18	57.04	57.17	57.22
5-OG	30.40	31.31	31.57	31.57
6-FL	12.00	12.80	12.88	12.66
Anterior Right				
7-OG	33.13	34.30	34.60	34.43
8-FL	11.53	12.30	12.28	12.40
Anterior Left				
9-OG	30.83	32.20	32.43	31.80
10-FL	11.86	12.62	12.66	12.72

This poor surface reproduction was previously reported by Choi et al.[13] They explained that due to the nature of the voxel dimension the reconstruction of 3-D models from CT images involves the interpolation of slices. An inherent problem with this computation is that current technology smoothes out sharp corners or edges that exist between two slices in a process called the partial volume averaging effect or the inter-slice averaging effect. This effect makes it very difficult to replicate a 3-D volume precisely, because landmarks may have sharp or acute edges which

n and the Medical Models at Reference Notches

otches and Percent Differences

Difference (mm)			% Difference		
ProtoMED	Biomedical Modeling Boston	Medical Modeling Colorado	ProtoMED	Biomedical Modeling Boston	Medical Modeling Colorado
-0.40	-0.79	-0.82	-0.67	-1.33	-1.38
-1.02	-0.89	-1.22	-3.11	-2.71	-3.71
-0.92	-1.04	-1.08	-7.84	-8.86	-9.20
-0.86	-0.99	-1.04	-1.53	-1.77	-1.85
-0.91	-0.93	-1.17	-2.99	-3.06	-3.85
-0.80	-0.66	-0.88	-6.67	-5.50	-7.33
-1.17	-1.47	-1.30	-3.53	-4.44	-3.92
-0.77	-0.75	-0.87	-6.68	-6.50	-7.55
-1.37	-1.60	-0.97	-4.44	-5.19	-3.15
-0.76	-0.80	-0.86	-6.41	-6.75	-7.25

cannot be reproduced in 3-D stereolithographic models with current technology. This finding is similar to the challenges reported by Choi et al.[13]

Therefore the most significant challenge when making measurement in this study was the inability to return consistently to the same precise measuring point on the stereolithographic models and make measures with high degree of repeatability. The poor surface detail reproduction of the reference notches called into question the accuracy of the medical models we received. It can be readily noted that

Table 5: Percent Difference Between Specimen

		Measurements at Height of Co		
		Distance (mm)		
Proposed Measurement Sites	Specimen	ProtoMED	Biomedical Modeling Boston	Medical Modeling Colorado
Mandible Right				
1-AP	60.96	61.19	61.28	61.46
2-OG	34.27	34.23	34.41	34.43
3-FL	13.83	13.90	13.61	14.16
Mandible Left				
4-AP	58.07	58.04	58.23	58.40
5-OG	32.24	32.60	32.16	32.61
6-FL	14.04	14.07	13.95	14.18
Anterior Right				
7-OG	34.93	35.50	35.23	35.32
8-FL	13.44	13.38	12.94	13.57
Anterior Left				
9-OG	32.59	33.24	32.95	32.78
10-FL	13.76	13.85	13.55	14.00

detail representation of critical landmark such as the mental foramina, was absent on all three

The height of contour linear measurements were made to determine dimensional accuracy since the reference notches were not accurate reproductions of the dry mandible using the heights of contour data produced more accurate measurements but four sites still had statistically significant differences.

The results also indicated that the use of reference notches is not recommended, because the technology used by companies

and the Medical Models at the Height of Contour

ntour and Percent Differences

Difference (mm)			% Difference		
ProtoMED	Biomedical Modeling Boston	Medical Modeling Colorado	ProtoMED	Biomedical Modeling Boston	Medical Modeling Colorado
-0.23	-0.32	-0.50	-0.38	-0.52	-0.82
-0.04	-0.14	-0.16	0.12	-0.41	-0.47
-0.07	0.22	-0.33	-0.51	1.59	-2.39
0.03	-0.16	-0.33	0.05	-0.28	-0.57
-0.36	0.08	-0.37	-1.12	0.25	-1.15
-0.03	0.09	-0.14	-0.21	0.64	-1.00
-0.57	-0.30	-0.39	-1.63	-0.86	-1.12
-0.06	0.50	-0.13	0.45	3.72	-0.97
-0.65	-0.36	-0.19	-1.99	-1.10	-0.58
-0.10	0.21	-0.24	-0.73	1.53	-1.74

in this study cannot replicate these features in the stereolithographic models they produce.

Previous investigations such as Baker et al.[12] and Choi et al.[13] used CT imaging rather than cone beam technology. Because more dental clinicians are incorporating cone beam technology into their practices, additional research is needed into the use of CBCT data in the fabrication of stereolithographic models. Additionally, future studies should compare the accuracy of different cone beam units.

CONCLUSION

Stereolithographic models fabricated using data from one cone beam unit were dimensionally accurate in thirteen out of 30 sites when heights of contour measurements were made. However, surface details were not recorded at a level that permitted accurate replication of the reference notches. Consequently, none of the stereolithographic models manufactured by the three companies included in this pilot study could be used to make accurate linear measurements to assess dimensional accuracy. The accuracy of stereolithographic models might not be so significant in pre-surgical assessments of surgical site but the accuracy of biomedical models could be very critical in procedures such as guided implant surgeries and the assessment of the prosthesis in immediate loading techniques.

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Disclosure
The authors report no conflicts of interest with anything in this paper.

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Ridge Splitting Crest Technique and Simultaneous Implant Placement in a Patient with Severe Maxillary Ridge Atrophy and Palatal Torus: A Case Report

Dr. Ezequiel Bolli[1] • Dr. Guillermo Schinini[1] • Dr. Hugo Romanelli[1]

Abstract

Background: Severe maxillary atrophy frequently limits dental implant placement. In the presence of a protruding palatal torus, such a situation may further condition the final prosthetic reconstruction.

Methods: An edentulous patient with a severely resorbed alveolar ridge and a big palatal torus was treated. A ridge splitting crest technique was used and four 3.3 mm wide by 10 mm long implants (Lance, MIS®) were immediately inserted. The space between the implants and the bone disjunction was filled with particles of autogenous bone and bovine bone without membrane.

Results: The width of the average preoperative alveolar ridge measured in the CBCT was 2.8 mm and increased to 5.2 mm 5 years after surgery.

Conclusions: This technique allows the volume to be increased horizontally and the simultaneous placement of the implants, being highly predictable, safe and comfortable for the patient, with no need for a donor site which may cause greater morbidity or postoperative complications

KEY WORDS: Dental implant, ridge split, bone augmentation, palatal torus

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INTRODUCTION

Over the last few decades, implant placement in partially or fully edentulous patients has become a reliable technique with successful long-term outcomes. However, in fully edentulous patients with a severely resorbed alveolar ridge and a protruding palatal torus, it may pose certain limitations and a major challenge for the future prosthetic rehabilitation.[1]

Palatal tori in dentate patients do not produce any functional modifications. Nevertheless, due to the loss of the teeth over the years and without early treatment with implants, problems begin in the use of removable partial appliances, since their design must avoid contact with the palatal torus.[2] When the loss of bone exceeds the retention that the appliances may exert, it will be necessary to make mucosal abutments that will eventually determine greater resorption of the bony pre-maxilla by compression since there is no palatal abutment, which is responsible for withstanding the compression and distributing the strengths.[2] As a result, patients will become fully edentulous with atrophic maxillae both vertically and horizontally, making it difficult or impossible to place dental implants.[3] In these cases, Guided Bone Regeneration (GBR) or block bone grafts become relevant.[4,5]

Both methods present numerous limitations or drawbacks to increase the maxilla ridge width, such as: secondary donor site, higher morbidity, resorption of the grafted material, and membrane collapse/exposure which increases the chances of infection. These techniques are more invasive and require a longer waiting time for the grafted material to integrate, which will delay implant placement and treatment will therefore be longer.[6] In order to avoid such limitations, an alternative might be the maxilla bone disjunction, expansion of the alveolar bone plates and simultaneous implant placement. In 1992 Simion et al. and in 1994 Scipioni et al. proposed a surgical technique that split the alveolar ridge longitudinally into two parts, creating a greenstick fracture where to place the implants.[7,8] Nevertheless, this procedure does not come without postoperative complications, such as buccal wall fracture and ridge resorption, among the most typical ones. The following article describes implant placement in atrophic upper maxilla with a severe palatal torus using the split-crest technique by means of piezoelectric scalpel (Piezosurgery).

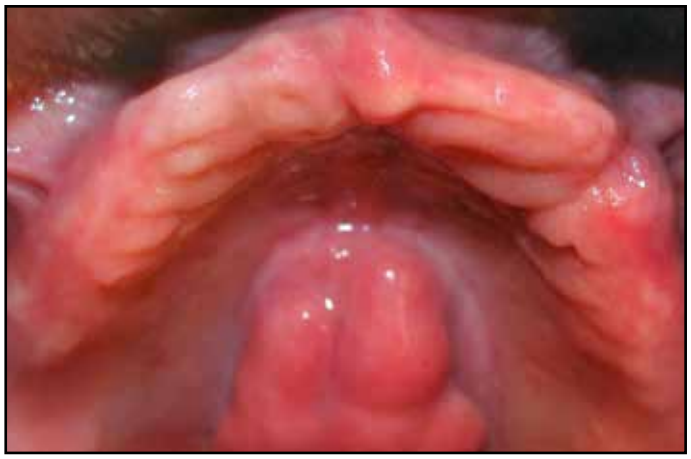

Figure 1: Preoperative view. Note big palatal torus and severe maxillary ridge atrophy.

CASE REPORT

A 60 year-old female patient who was edentulous for over 20 years presented for consultation to solve the problems caused by a palatal torus which did not allow her to use a complete conventional prosthesis. During the clinical diagnosis, a large palatal torus was observed together with ridge alteration due to a badly adapted prosthesis associated with severe horizontal resorption of the upper jaw (Fig.1).

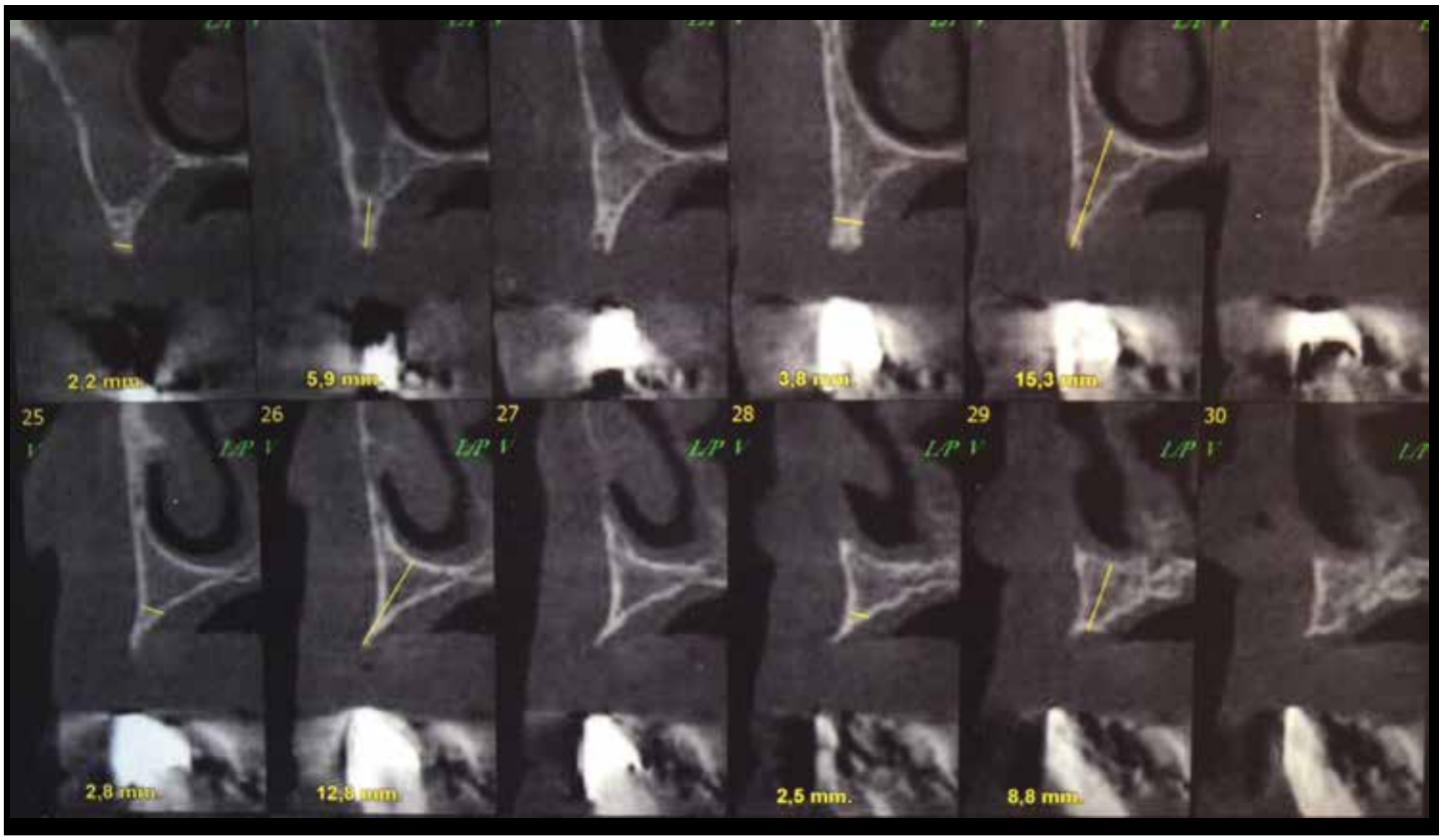

Figure 2: CBCT shows insufficient alveolar ridge width.

METHODS

Computed tomography scan (CBCT) confirmed an insufficient alveolar ridge width which averages 2.8 mm and made it difficult to place the implants conventionally. Therefore, bone splitting technique by Piezosurgery with immediate implant placement together with particulate autologous bone with xenograft mixture was decided.[9] CBCT allowed the identification of a minimum amount of marrow bone tissue (>1 mm) interposed between the vestibular and palatine cortical layers in order to exercise such technique. In turn, it also shows the necessary bone height for simultaneous implant placement (Fig. 2).

SURGICAL PROCEDURES

A crestal incision on each side of the premolar region was performed and a mucoperiosteal flap was raised in the first 10 mm of the alveolar ridge, followed by partial thickness towards the apical region in order to preserve periosteal blood supply and minimize bone resorption risk. Once access was achieved, the knife-shaped ridge was smoothed out by means of crest osteotomy performed with a piezoelectric scalpel (Mectron®, Genoa, Italy), preserving the extracted bone for future filling between implants. (Figs. 3, 4) Subsequently, the cortical layers of the bone tissue were split over the ridge top at a depth of 10 mm and then two vertical lines (mesial and dis-

Figure 3: Knife-shaped ridge osteotomy after full-thickness flap elevation.

Figure 4: Preserved extracted bone for future filling.

tal) were cut in the bone (Fig. 5). The decision to place 4 implants in the premolar region was made at that moment, since the maxillary anterior region presented such a strong resorption that the performance of this technique was impossible. Subsequently, a greenstick fracture was gently created by means of a chisel. Next, the implant bed was prepared, using a 2-mm diameter bur. Expanders of increasing diameter made room for proper implant placement, so two 3.3-mm diameter and 10-mm long (LANCE® MIS) implants were manually placed on each side of the maxilla. The autogenous bone tissue obtained from the ridge was mixed with 0.5 g of bovine inorganic bone filler (Bio-Oss®, Wolhusen, GeistlichPharma, Switzerland) and placed in the defect without using membrane (Figs. 6-11). The primary wound closure was sutured with simple stitches (Ethicon® 4-0) and Amoxicillin of 500 mg, one every 8 hours for 5 days was prescribed, as well as Ibuprofen 400 mg every 8 hours for the first 3 days, and mouthwash with Chlorhexidine Digluconate (Plac-out®) 0.12% twice a day for 15 days. Sutures were removed 10 days after surgery. Post-surgery, the

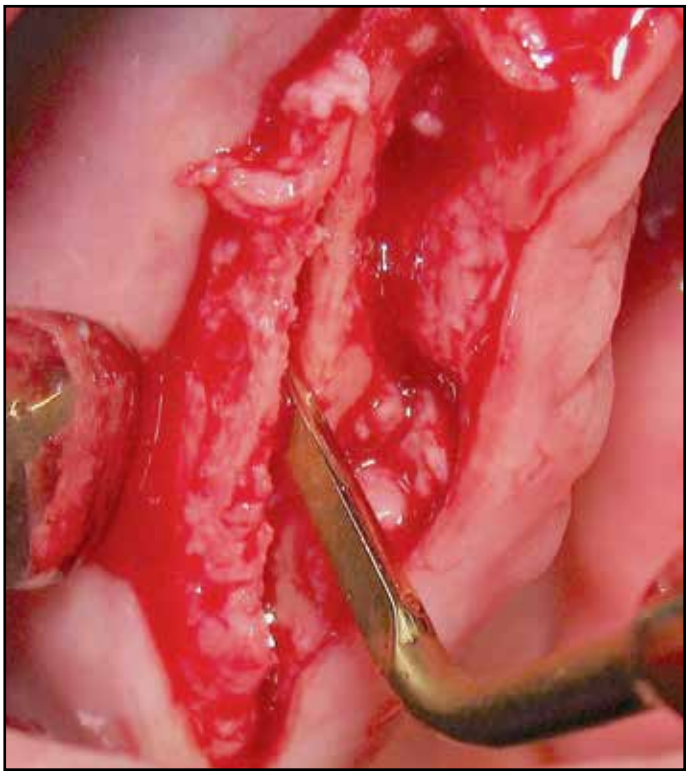

Figure 5: Splitting the narrow ridge with a piezoelectric scalpel.

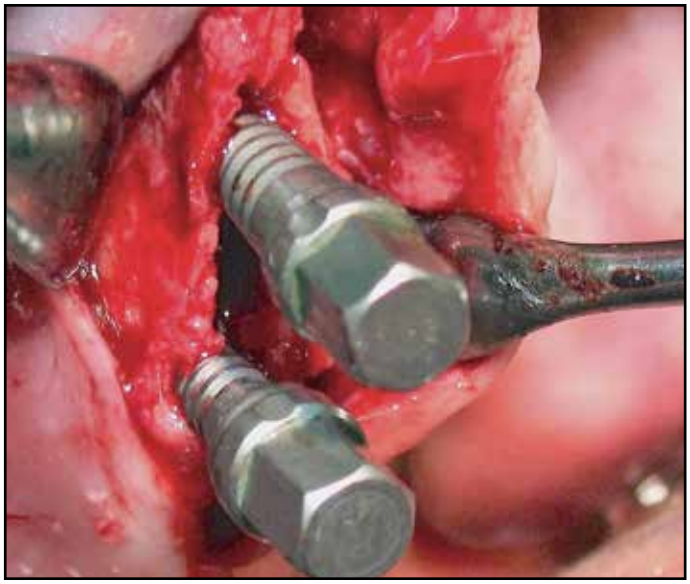

Figure 6: Ridge splitting after using mechanized expanders.

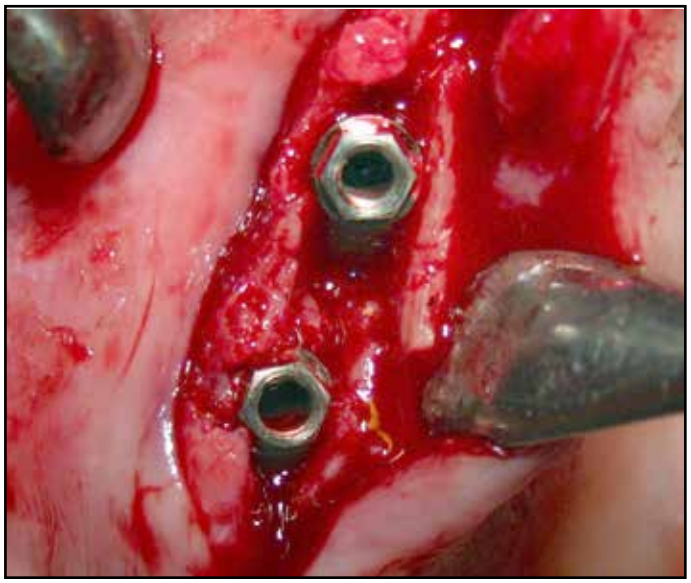

Figure 7: Placement of 2 implants at the expanded ridge.

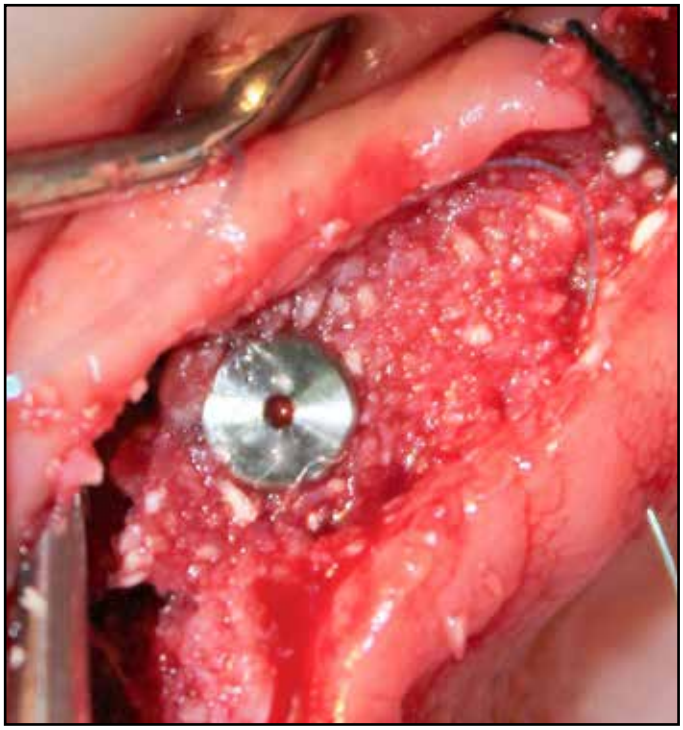

Figure 8: Filling the gap between implants using autologous bone and bovine inorganic bone filler.

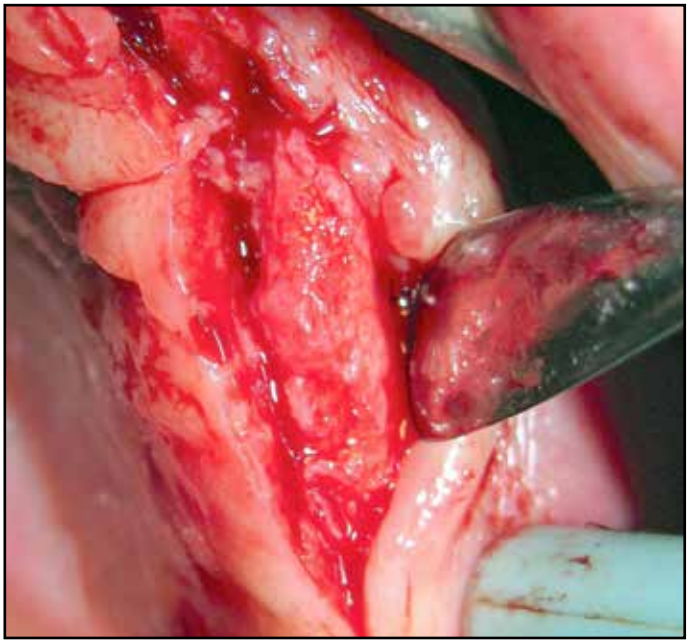

Figure 9: Narrow ridge before crest splitting on the left side.

Figure 10: Implant placement.

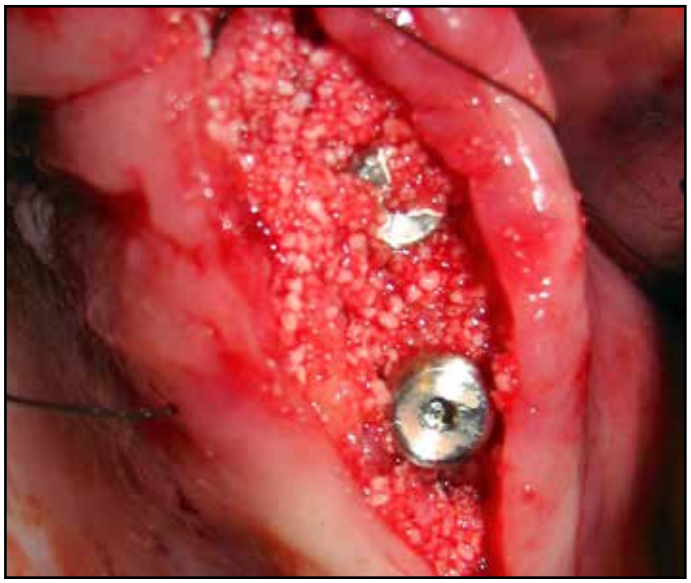

Figure 11: Implant placement and bone graft.

patient was instructed not to use any prosthesis that might exercise pressure on the wound until the second phase of implant opening in the following 6 months. The healing process was uneventful.

RESULTS

The pre-surgical alveolar ridge average width was 2.8 mm. However, it was possible to place two 3.3-mm diameter and 10-mm long implants on each side of the upper maxilla by means of ridge splitting with a piezoelectric scalpel (Piezosurgery) and mechanized expanders. Six months after surgery, an acrylic prosthesis was made with a chrome cobalt frame and two separate bars with ball-attach retention system on each side of the maxilla. (Figs. 12, 13). The post-surgical ridge width was an average of 5.2 mm measured in the postoperative CBTC after 5 years of follow-up. Therefore, the average width gain was 2.4 mm (Fig.14). There were no functional disorders during a 5-year follow-up period.

DISCUSSION

Many patients find it difficult to use complete removable prostheses or implant rehabilitation when basal bone loss is too severe.[10] Furthermore, the presence of a big palatal torus in a fully edentulous patient poses a challenge to the clinician when designing properly-fitting prosthesis. However, there are alternatives to the traditional techniques of bone volume augmentation for future implant placement.[11] The ridge splitting crest technique is a valid and predictable alternative in situations in which the amount and thickness of bone tissue are limited for the use of a conventional technique without resorting to a block autologous or heterologous graft and Guided Bone Regeneration. Nevertheless, the existence of at least a minimum amount of cortical bone (>1 mm) on both sides with spongy tissue interposed between both cortical tissues to minimize the fracture risk of the cortical tissue has been suggested.[12] The Split-ridge technique permits shortening treatment times in compari-

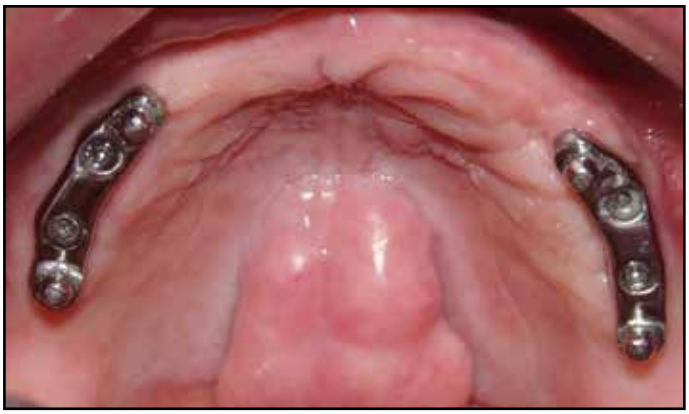

Figure 12: Clinical aspect after treatment. Two separate bars with ball-attach retention system were installed on each side of the maxilla.

Figure 13: Final prosthesis.

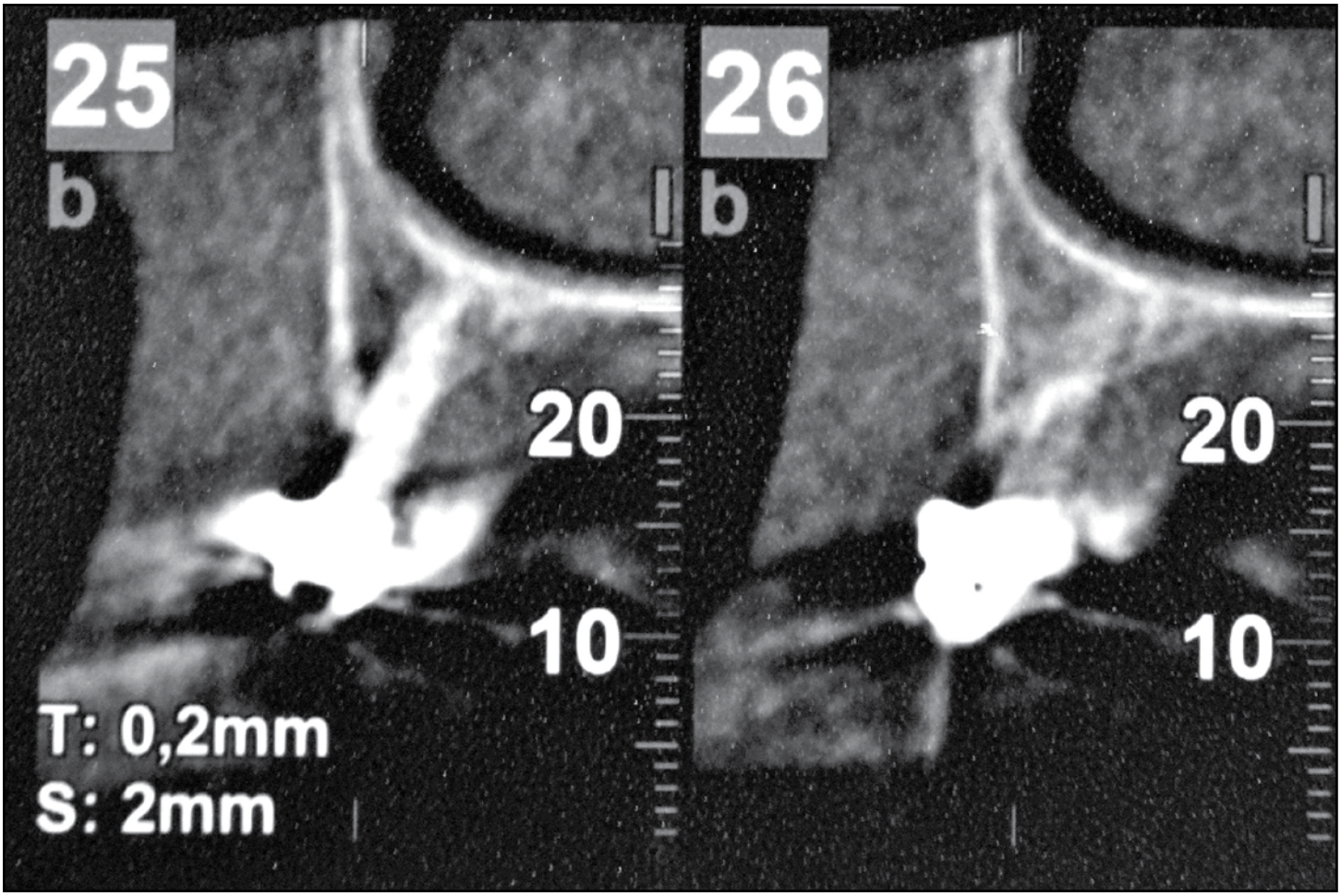

Figure 14: Postoperative CBCT after 5 years.

son with the traditional techniques (GBR), since it does not require the maturation of the new regenerated bone for implant placement, thus decreasing morbidity by avoiding a second donor site. However, it can augment only the buccolingual dimension of the alveolar ridge and it may not be a suitable option if ridge vertical augmentation was necessary. Moreover, various studies have shown that immediate implant placement after ridge splitting crest technique in atrophic maxillary ridges present a survival rate similar to the implants placed in the native bone and good results in the long term.[13,14] Numerous reports have shown ridge width augmentation by means of bone disjunction in atrophic jaws using Piezosurgery, osteotomes, chisels or screw expanders or tapered implants.[14-21] Chiapasco et al.[18] reported an average augmentation of 4 mm (ranging 2 to 5) in edentulous ridges after 20 months; Zahran et al.[19] reported an augmentation of 2.93 mm after 6 months; and Bassetti et al.[20] described a gain of 4.7 mm after 27 months. In this clinical report, the alveolar ridge average width augmented 2.4 mm. A recent systematic review indicated an implant survival rate of over 96% using this surgical technique and an increase in average bone width of 3.19 ± 1.19 mm.[22]

CONCLUSIONS

Finally, the *Split-crest technique* with immediate implant placement in severely resorbed upper maxilla may be considered a reliable option, and a one-stage alternative that is safe and less invasive than the conventional methods of horizontal bone regeneration for atrophic maxilla with palatal torus presence. ●

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Disclosure
The author reports no conflicts of interest with anything in this article.

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The DIAsmile™ Smile Analysis and Design Protocol for Full Arch Immediately Loaded Implant Dentistry

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David Malave, DMD, DABOMS[2]

Abstract

Background: While smile analysis and design has been routinely used by cosmetic dentists, prosthodontists, and orthodontists to help plan and execute treatment, they are not typically utilized by dental implant surgeons. Because of this, a breakdown in communications between the lab, surgeon, and restorative dentist can sometimes lead to less than optimal final results for full arch immediately loaded dental implant cases. Utilization of a standardized and systematic means of smile analysis and design may eliminate many of these issues as all members of the treatment team will be utilizing the same thought process. The current article describes the DIAsmile™ smile analysis and design protocol which was developed by the authors over the course of treating and restoring 1,000+ full arch immediately loaded dental implant cases.

Methods: The DIAsmile™ smile analysis and design process was developed over many years using a variety of information including a number of articles from PUBMED and Google Scholar searches, facial analysis of 200 celebrity photos, and the authors' personal experiences with full arch dental implant treatment and restoration. The authors now routinely employ the DIAsmile™ protocol on all full arch immediately loaded dental implant cases and present a Case Report to show a sample of the process.

Results: Articles regarding smile analysis and design are generally consistent in their recommendations, although some minor variations do exist. In utilizing this information to analyze 200 celebrity smiles, patterns were identified for what is considered by many to be an "ideal" smile. These patterns are discussed in this paper and were used in the establishment of the DIAsmile™ smile analysis and design protocol. The Case Report in this paper documents use of the DIAsmile™ protocol and shows an aesthetically pleasing final outcome that retains solid function.

Conclusion: The DIAsmile™ smile analysis and design protocol provides a systematic and standardized manner in which the smile of a patient can be analyzed pre-surgically and an aesthetic restoration planned. This process helps to ensure consistent thought processes amongst all members of the full arch treatment team and improves the chances for predictably aesthetic final outcomes.

KEY WORDS: Dental implants, smile analysis, smile design, prosthetics

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INTRODUCTION

Smile analysis and design has long been used by prosthodontists and cosmetic dentists for the aesthetic fabrication of full mouth rehabilitations.[1-14] Orthodontists have also used smile analysis and design to plan and finalize orthodontic tooth movement.[15-17] Recently, full arch immediately loaded implant dentistry has become a widely accepted protocol[18-40] and this treatment heavily relies on pre-surgical smile analysis and design for the fabrication of both the transitional and final restorations. Typically, full arch immediately loaded dental implant treatment such as the All-On-4™, NeoArch™, ProArch™, and TeethXpress™ protocols have relied on a team approach with a surgical provider performing the placement of dental implants/abutments while a separate restorative provider performs the restorative phase. In some cases, a lack of communication between the laboratory, the surgical provider, and the restorative provider results in implant/abutment positioning that may not always be conducive to a harmonious aesthetic restorative result. Considering this, a better understanding of smile analysis and design principles on the part of the surgical team would allow for improved dental implant/abutment placement when performing non-computer-guided procedures. The authors of this paper have both performed and restored more than 1,000 cases of full arch immediately loaded implant dentistry. By performing both the surgery and the commensurate accompanying restorations, valuable insight has been gained regarding dental implant/abutment positioning and how they affect both the form and function of the restorative phase. In the current paper, the authors discuss the smile analysis and design principles they use for the planning of the restorative phase of full arch immediately loaded dental implant procedures. Collectively, these analysis and design principles have been bundled into a process the authors call DIAsmile™.

MATERIALS AND METHODS

The DIAsmile™ analysis and design process was developed over many years using a variety of information. First, a PUBMED database and a subsequent Google Scholar search were performed using the following keywords: smile design, smile analysis, dental prosthetic design, and orthodontic smile analysis. Of the results returned from this search, only those articles which pertained to external smile characteristics in adults were selected. Second, publicly available photos for 200 celebrities were obtained from Google searches on the internet. Acceptable celebrity photos included only those in which the celebrity was smiling and directly facing the camera. A total of 100 male and 100 female celebrities were obtained. Each photo was then inserted into a computer application (Microsoft Powerpoint) and applied to a grid with 0.042 inch gridline spacing. The following parameters were then evaluated by tracing analysis: maxillary incisal plane parallelism to the interpupillary plane; maxillary central incisor midline plane relationship to the chin midline, maxillary central incisor midline plane relationship to the nasal midline, maxillary canine-to-canine width relationship to the width of the nose, buccal corridor relationship to the pupils of the eye, maxillary incisal plane relationship to the body of the lower lip. Celebrity photos were analyzed for smile characteristics (Figures 1, 2) because, in the authors' experience, most patients tend to request smiles that mimic those of particular celebrities. This information was then combined with the authors'

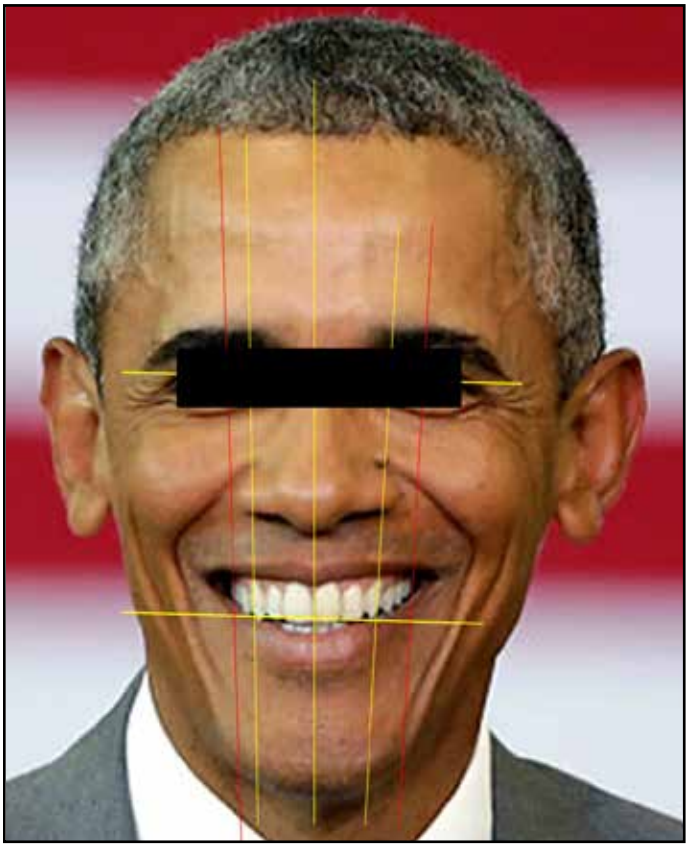

Figure 1: DIAsmile™ analysis of male celebrity smile.

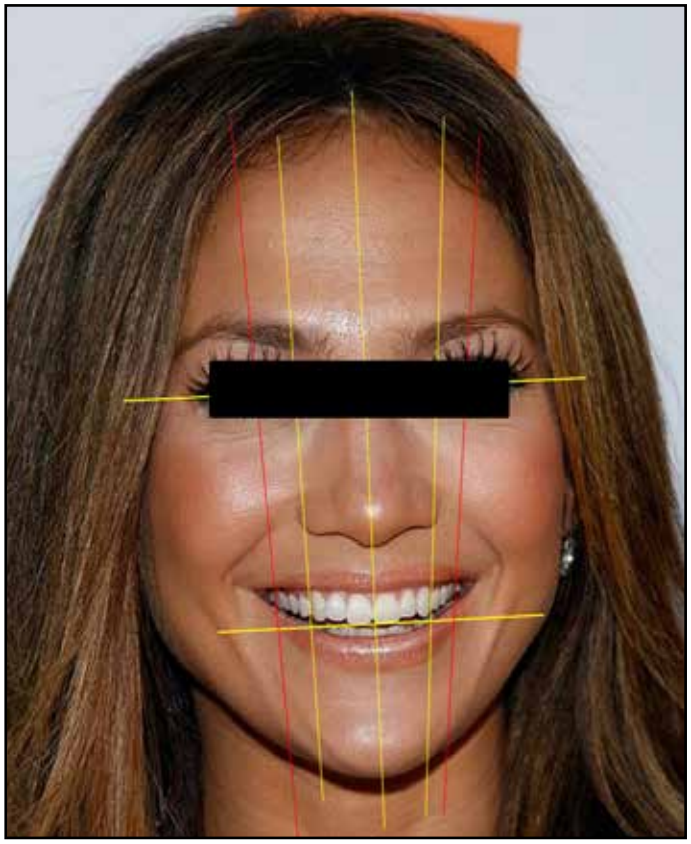

Figure 2: DIAsmile™ analysis of female celebrity smile.

clinical experience of treating more than 1,000 full arch dental implant cases to create parameters for the DIAsmile™ analysis and design process. The DIAsmile™ analysis and design process is demonstrated in a Case Report within this paper.

RESULTS

A total of X articles met the inclusion criteria for this paper. Commonalities of these articles produced the following suggestions for acceptable smiles by the general public: in the relaxed lip position, maxillary central incisors display 3-4mm; the average height of maxillary central incisors ranges from 9.5-12mm, greater maxillary incisor exposure is associated with a youthful appearance, maxillary incisal plane should parallel the interpupillary plane, maxillary incisal plane should approximate the lower lip and should be no more than 2mm away from the lower lip during a normal smile, incisal edges of the maxillary teeth should approximate the wet-dry junction of the lower lip during "F" and "V" phonetics, the midline for the maxillary central incisors should be within 4mm of the facial midline and should remain as vertical as possible, rotation of the maxillary central incisor midline should be < 1mm as it is one of the most notable smile characteristics observed by the layperson, the edges of the lateral incisors should be offset apically from the central incisors by 1-1.5mm in women and 0.5-1mm in men, incisal embrasures should get progressively larger from central incisors to canines, contact areas

Table 1: DIAsmile™ Analysis of 100 Celebrity Smiles		
Characteristic Evaluated	**Male**	**Female**
Lateral Incisors 1mm+ shorter than central incisors	**98%**	**84%**
Dental arch midline equal to chin midline	**100%**	**100%**
Dental arch midline equal to nasal midline	**96%**	**86%**
Canine to canine spread equal to width of the nose	**76%**	**100%**
Arch width terminates at or inside of the pupils	**98%**	**100%**
Gingiva other than papillae shows in smile	**26%**	**12%**
Excessive or indadquate buccal corridor space	**2%**	**0%**

between central incisors should approximate 50% the length of the central incisors, contact area between the central incisor and lateral incisor should be 40% of the length of the central incisor, contact area between the lateral incisor and the canine should be 30% of the length of the maxillary central incisor, axial inclination of the maxillary teeth should be medially directed, diastemas should be avoided, gingival display during smiling should range from 0-3mm, if gingival tissue is displayed, the gingival margins of the maxillary central incisors, lateral incisors, and canines should either be equal or within 1mm of each other (lateral incisors being 1mm shorter than the central incisor and canine if chosen to be offset), buccal corridor space should be moderate as too much buccal corridor space gives the appearance of an "empty" smile and too little or no buccal corridor space gives the appearance of a "toothy" or "full" smile, teeth forming the buccal corridor should have a slight medially directed axial inclination and should avoid a flared appearance. In general, the articles included in this paper agreed upon the aforementioned characteristics of an ideal smile. Regarding tooth proportion, the articles did have variations on agreement with all based in some form or fashion on the principle of "golden proportion". The rule of golden proportion regarding smile analysis and design is an extensive subject worthy of its own entire paper and is beyond the scope of this article other than noting that most articles reviewed utilized some variation thereof.

Utilizing the data gathered from the PUBMED and Google Scholar search in combination with our celebrity smile analysis (Table 1), we created the following parameters for our DIAsmile™ smile analysis and design protocol (Figure 3). We then applied the principles of smile design in a case report presented in the next section of this paper.

DIAsmile™ Smile Analysis and Design Case Report

A 54 year old female patient (Figures 4, 5) presented with a chief complaint of "I am not happy

Figure 3: DIAsmile™ principles

- Dental midline equal to or close to chin midline
- Dental midline equal to or close to nasal midline
- Dental midline non-canted (non-rotated)
- Maxillary central incisors 3-4mm display at rest
- Maxillary central incisal plane parallel to interpupillary plane
- Maxillary central incisal edges equal to incisal edges of canines
- Maxillary incisal plane at approximates lower lip "body" during smile
- Maxillary central incisal edges touch wet-dry junction of lip during "F" and "V" sounds
- Maxillary lateral incisal edges at least 1mm apical to maxillary central incisors
- Maxillary canine-canine width equal to or close to width of nose
- Maxillary anterior teeth axially incline medially
- Maxillary teeth bordering buccal corridor space terminate at or inside of pupils
- Maxillary teeth bordering buccal corridor space have slight axial inclination medially
- No showing of prosthetic transition zone during maximum smile

with my upper teeth." The patient had a history of orthodontic treatment during which teeth 1, 5, 12, 16, 17, 21, 28, and 32 were removed. Specifically concerning the maxilla, teeth 8, 14, and 15 were also missing. Carious lesions were noted on teeth 2, 3, 7, 8, 10, and 12. Teeth 3 and 8 displayed apical radiolucencies and were tender to palpation. Probing depths in the maxilla ranged from 2-6mm with localized bleeding upon probing. A class 2 furcation was noted at the distal of tooth #3, grade 2 mobility was noted on teeth 2, 3, 4, 7, 8, 11, and 12, while class 3 mobility was noted on tooth 10. The patient wore a temporary removable prosthesis to replace missing tooth #9. The mandibular teeth displayed probing depths of 2-4mm with localized bleeding upon probing and generalized mobility of 0-1 on all teeth. Multiple treatment options regarding the maxilla were presented to the patient with the patient ultimately electing to proceed with immediately loaded full arch dental implant treatment of the maxillary arch. DIAsmile™ analysis of the patient's existing smile was performed (Figure 6) and the results were discussed with the patient. The patient expressed desire for a "fuller" smile, different tooth shape, whiter teeth, and a final smile that did not appear "fake". The surgical process was carried out in the standard fashion and a total of 5 dental implants (Neodent CM Drive, Neodent) were used to support an immediately loaded fixed transitional prosthesis. After 4 months of healing, the transitional prosthesis was removed and

Figure 4: Pre-surgical photograph of Case Report Patient.

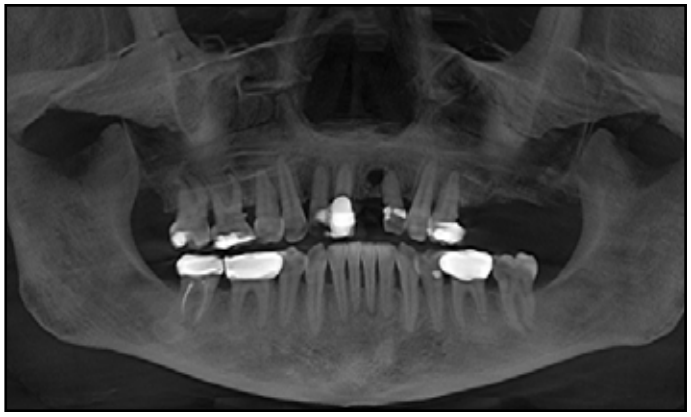

Figure 5: Pre-surgical radiograph of Case Report Patient.

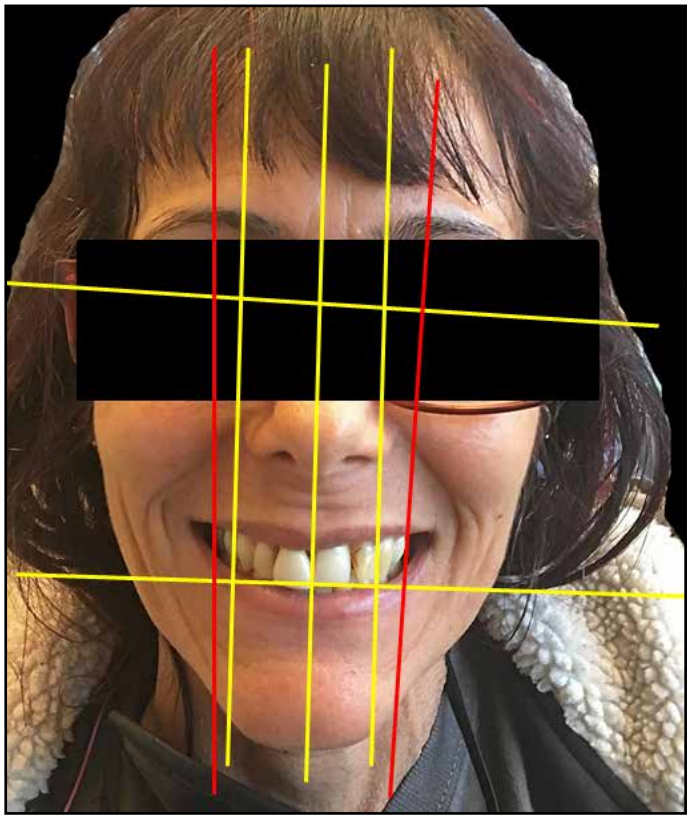

Figure 6: Pre-surgical DIAsmile™ analysis of Case Report Patient.

a try-in of a waxed prosthesis was performed to verify the patient's smile aesthetics and occlusion. After approval by the patient, the waxed prosthesis was processed into a final screw retained monolithic zirconia prosthesis (Figures 7-9). The patient was very pleased with the final result.

DISCUSSION

The principles of smile analysis and design can be effective tools in planning and executing a functional and aesthetic prosthesis for immediately loaded full arch implant dentistry. All too often, a breakdown in communication between the lab, surgeon, and restorative dentist leads to less than optimal final results for full arch immediately loaded dental implant cases. For example, if the restorative dentist fails to communicate to the surgeon that the patient has an extremely mobile lip resulting in a high smile line (or if the surgeon fails to notice this on their own), inad-

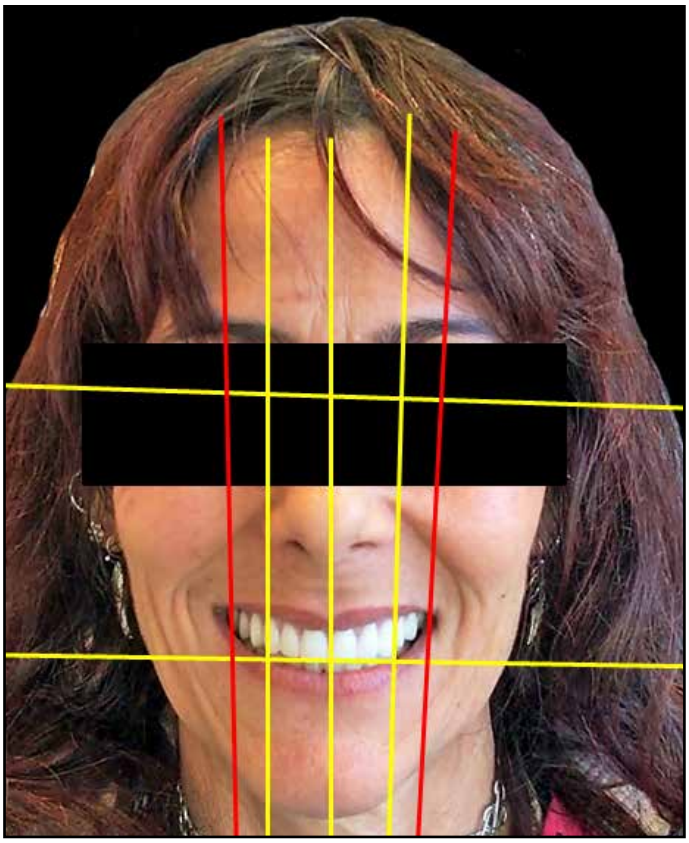

Figure 7: DIAsmile™ analysis of final restoration for Case Report Patient.

Figure 8: Monolithic zirconia final restoration of Case Report Patient.

equate bone reduction may occur. This would lead to disastrous final aesthetics in which either the transition line between the prosthesis and gingiva is visible or a bulky ridge lapped restoration is fabricated to hide the transition line. Another restorative complication that occasionally arises in full arch immediately loaded implant treatment secondary to inadequate communication is improper abutment placement. With a poorly placed implant or multi-unit abutment, screw access holes can ruin aesthetics by exiting facially through the prosthesis. With proper planning and smile design, complications such as this can be easily avoided. By knowing the principles of smile design such as the DIAsmile™ protocol, surgeons can systematically and easily plan for better outcomes when placing dental implants for immediately loaded full arch cases.

After going through a challenging surgical process such as immediately loaded full arch implant dentistry, there is nothing more disappointing to a patient than to be unhappy with the aesthetics of their restoration. It is very easy to find poorly finished final restorations for immediately loaded full arch implant dentistry. A simple internet search for photos of these restorations show cases with offset midlines, canted incisal planes, excess buccal corridor fill, inadequate incisal length, etc. How can one avoid these less than desirable outcomes? The DIAsmile™ smile

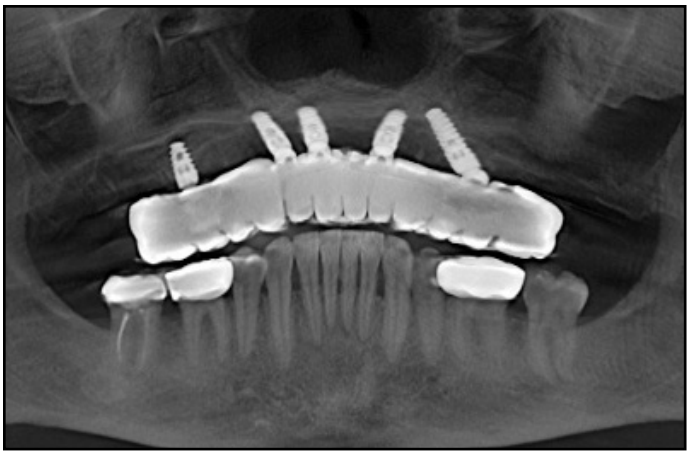

Figure 9: Radiograph of final restoration for Case Report Patient.

analysis and design protocol provides an easy to follow and systematic protocol that helps to eliminate undesirable final aesthetic outcomes for full arch implant dentistry. Principles of the DIAsmile™ smile analysis and design protocol are outlined in Figure 3. By following a standardized protocol such as DIAsmile™, the lab, surgeon, and restorative dentist will always be thinking along the same lines. As such, even in the event of a communication breakdown, consistent final outcomes are more likely to be achieved as everyone is following the same thought process. With that being said, it is important for all members of the treatment team to be familiar with the protocol. Dental implant surgeons no longer have the luxury of simply being responsible for placing implants without considering both form and function. Dental implants must be placed with the final outcomes in mind and DIAsmile™ helps to simplify this process. On the restorative end, following a systematic and standardized process helps both the lab and the restorative dentist work with the patient to achieve the most desirable aesthetic final outcomes while still preserving function.

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Disclosure
DIAsmile™ is a registered trademark of DIA Dental Implant Centers, LTD.

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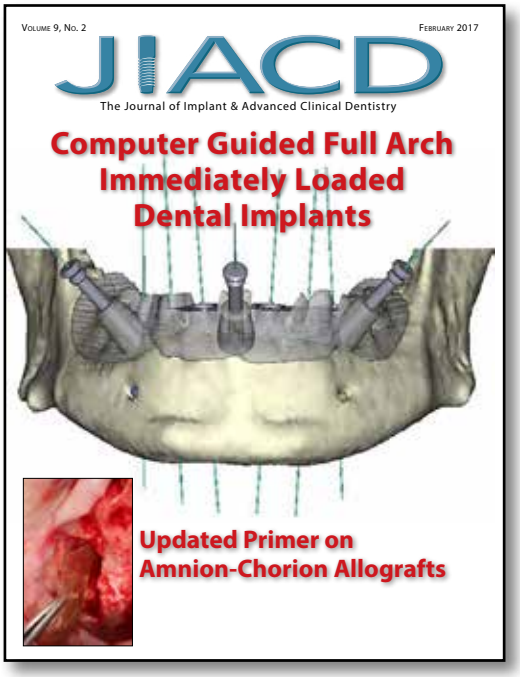

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