Volume 11, No. 4 October 2019

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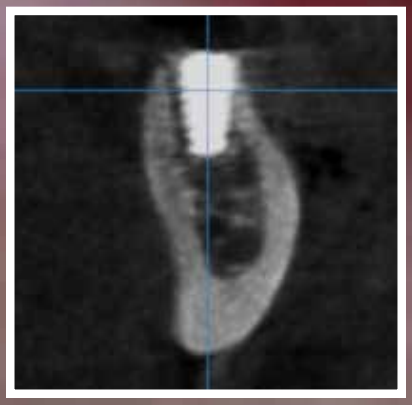
Vertical Bone Augmentation



Short Dental Implant Survival

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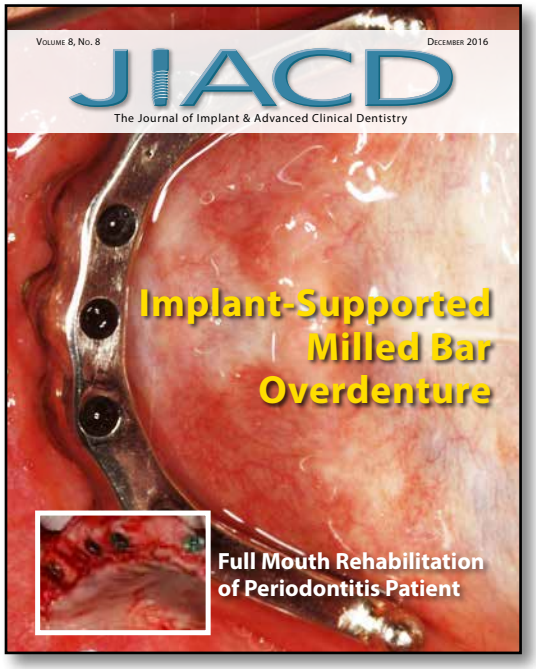

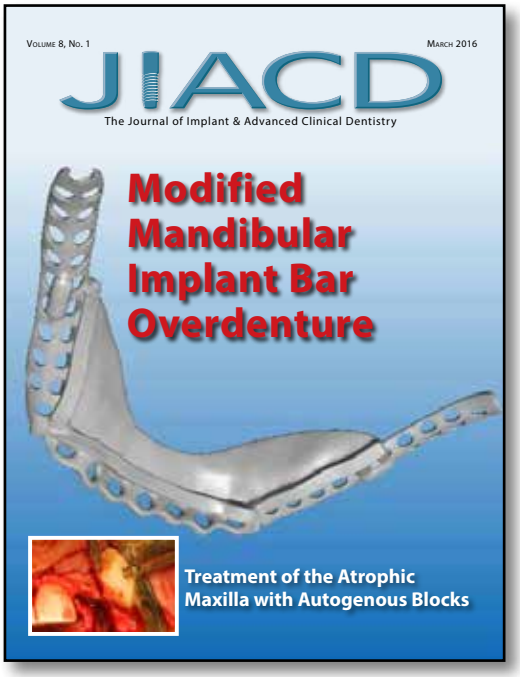

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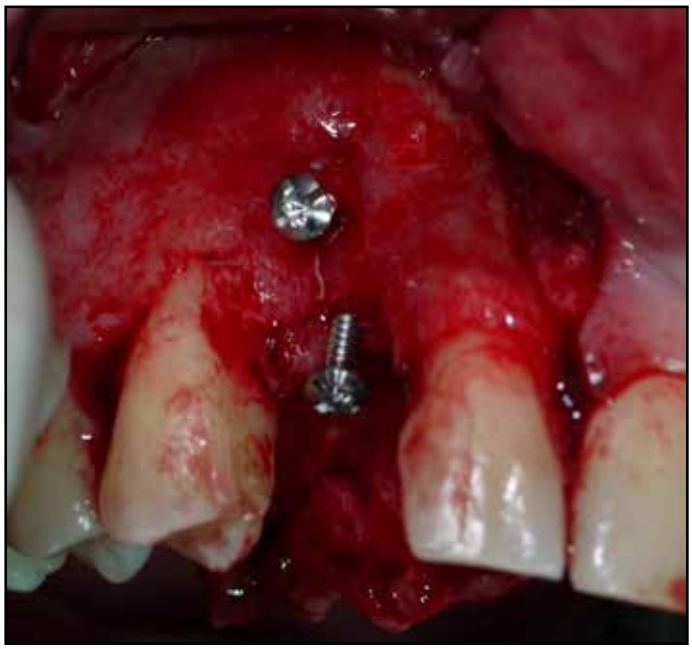

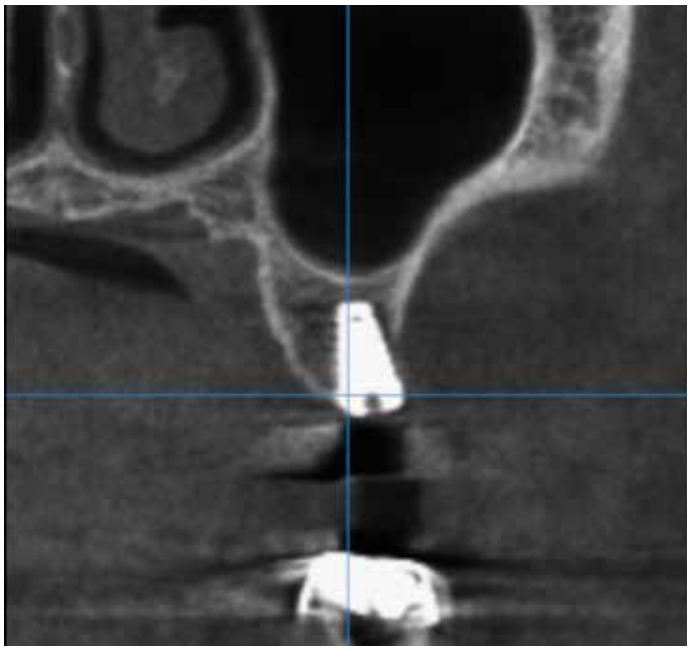

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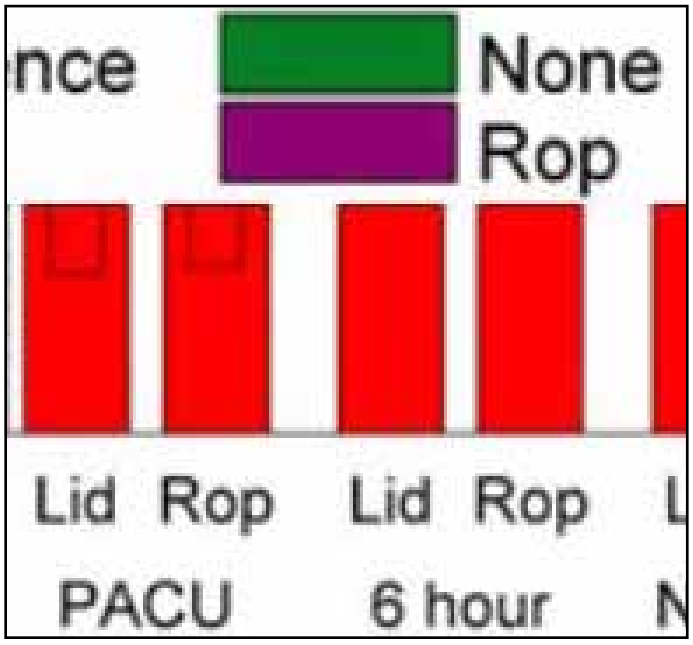

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JIACD
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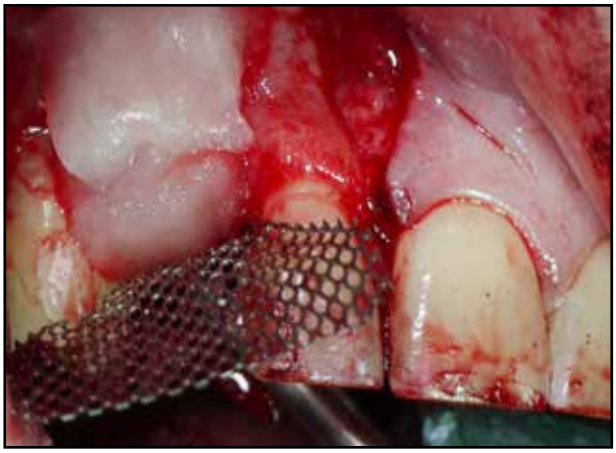
Vertical Bone Augmentation and Soft Tissue Management on the Anterior Maxilla, Before and After Implant Placement: A Case Report

Oscar Maldonado Molina, DDS[1]

Abstract



Background: Complex bone defects could be challenging and implant placement difficult after a complicated extraction. Treatment planning should include implant placement, bone augmentation and soft tissue grafting in horizontal vertical and transversal relationship. The aim of this study is to evaluate clinically the result of a staged -treatment planning for bone augmentation and soft tissue management before placing the implant and after implantation.

Methods: A case is report during a period of 5 years. Showing staged treatment planning.

Results: Clinical success was achieved with this protocol of bone augmentation and connective tissue grafting for soft tissue augmentation.

Conclusions: To restore the anatomy of the smile of a patient, and achieved an esthetically acceptable result is important to evaluate and planned for not only the implant placement but also for restoring the tissues supporting and surrounding the implant. Multiple procedures are necessary to obtain this result.

KEY WORDS: Dental implants, guided bone regeneration, GBR, Titanium mesh, rh-BMP2

1. Private practice

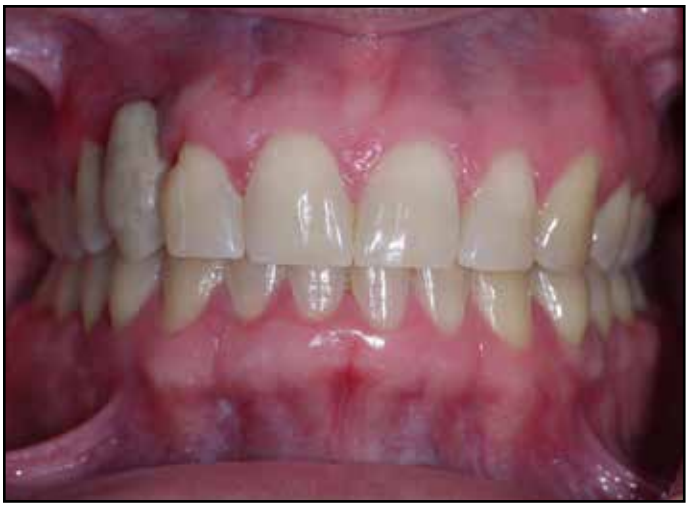


Figure 1a: Initial intraoral view. Acrylic temporary shows vertical and horizontal deficiency.

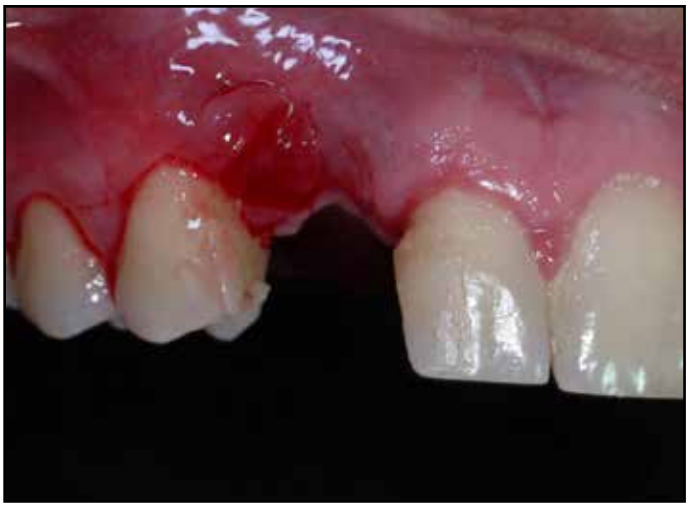


Figure 1b: Lateral view without temporary.

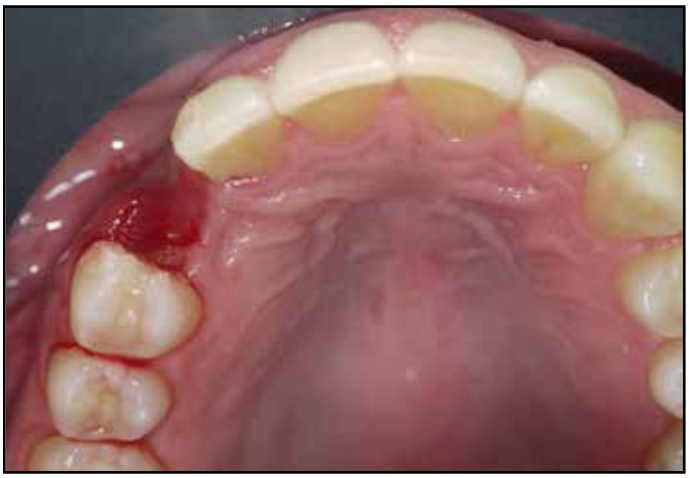


Figure 1c: Occlusal view showing horizontal deficiency.

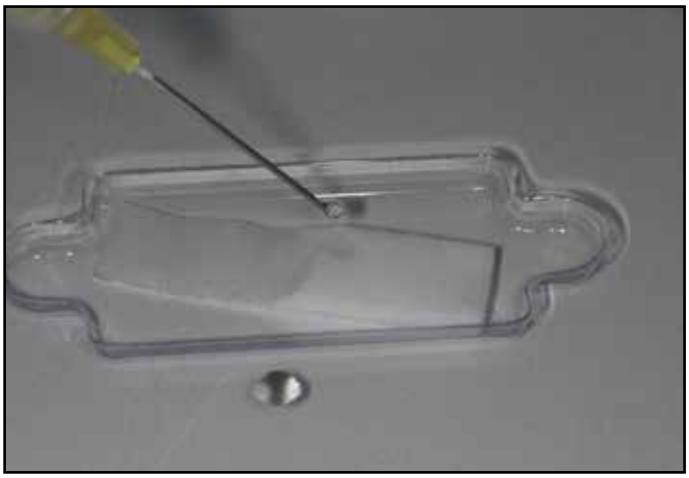


Figure 1d: rhBMP2-collagen preparation.

BACKGROUND

Bone regeneration in vertical bone defects, after long-term extractions or trauma, are some of the most technique sensitive procedures in the dental implant field and bone regeneration. With so many materials available and different techniques, that proved successful, the clinician will perform the procedure that is most reliable in his/her own hands.[1-6] Growth factors and the simplification of the procedures to obtain those factors are providing that "extra-punch" needed ,in some cases, to achieve clinical success.[7-14] It is important to know that those factors are not a substitute for a clean and well performed procedure and a knowledge based in evidence of the expected results of bone regeneration.[6,15]

Resorption of the alveolar process following trauma may occur in spite of treatment to save

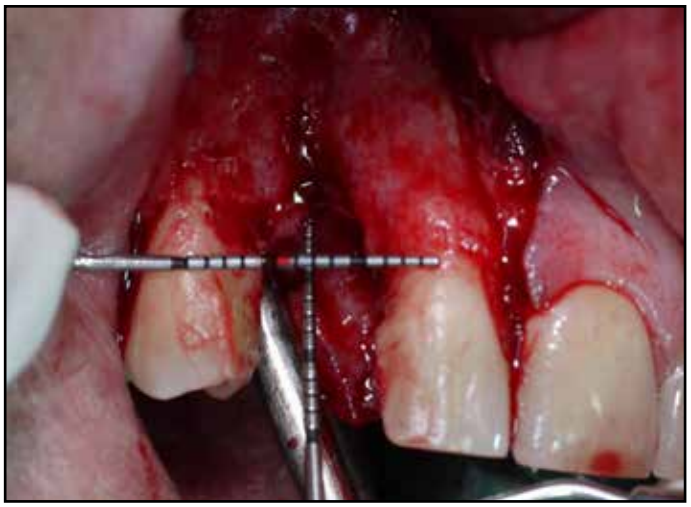


Figure 1e: Full thickness flap exposing bone defect.

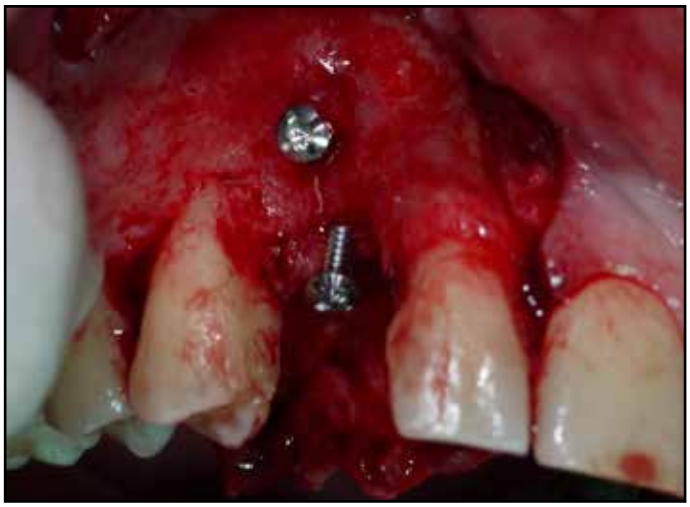


Figure 1f: Tenting screws for bone graft.

Figure 1g: Autogenous bone collected with bone scraper.

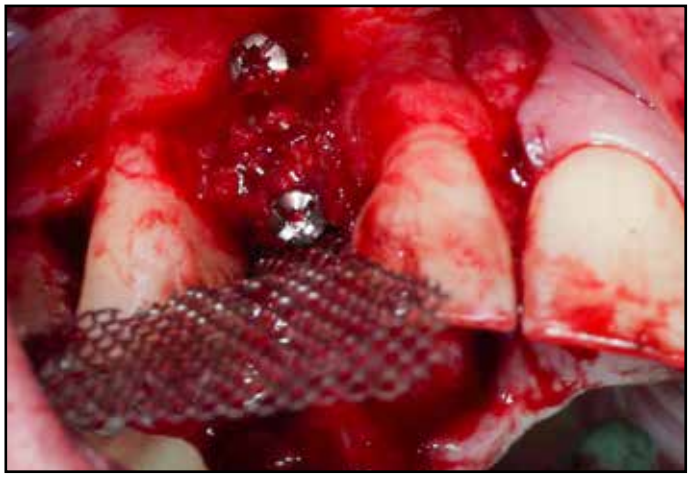


Figure 1h: Titanium mesh and autogenous bone grafting.

and retained the tooth. The resorption from a healing socket only exaggerate the tissue loss in the area, creating a ridge defect that is difficult to restore.[16] Vertical and horizontal augmentation using guided bone regeneration (GBR) has become a major treatment option to provide optimal bone support for osseointegrated dental implants.[17] Marx et al. reported on a novel surgical approach using dental implants as tent poles in combination with bone graft in the successful treatment of 64 resorbed mandibles, resulting in a mean bone height gain of 10.2mm. The novel strategy of this surgery was to allow bone graft to consolidate and maintain their volume with dental implants that create a tenting effect. Augmentation with titanium mesh can also be successful but has a high exposure rate of the mesh and subsequent partial graft loss.[3] In a separate literature review, several studies demonstrate the biological advan-

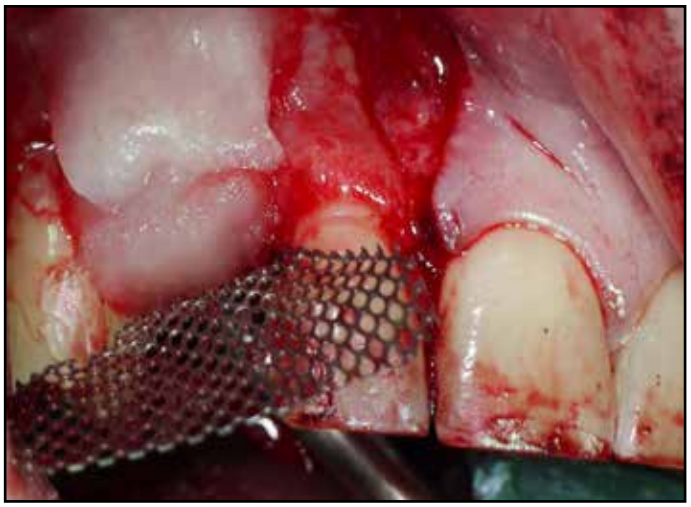


Figure 1i: BMP2 layered on top of graft.

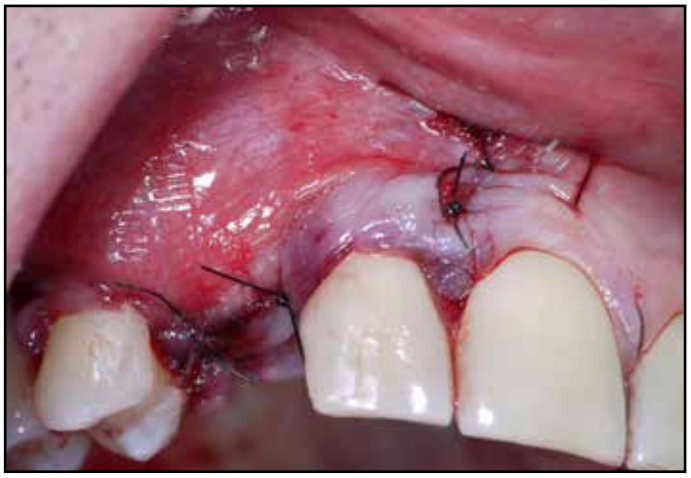


Figure 1k: Flap repositioned and tension free sutures. FCTG to prevent titanium mesh exposure.

tage of rhBMP2 on bone regeneration of the jaws. In recent years, morphogenetic protein has presented a large clinical use.[7] Many clinical reports have demonstrated predictable and controllable bone augmentation using a titanium mesh in combination with autogenous bone or a combination with a xenograft in vertical bone defects. However a titanium mesh has some inherent drawbacks when used in a local ridge augmentation procedure, resulting in wound

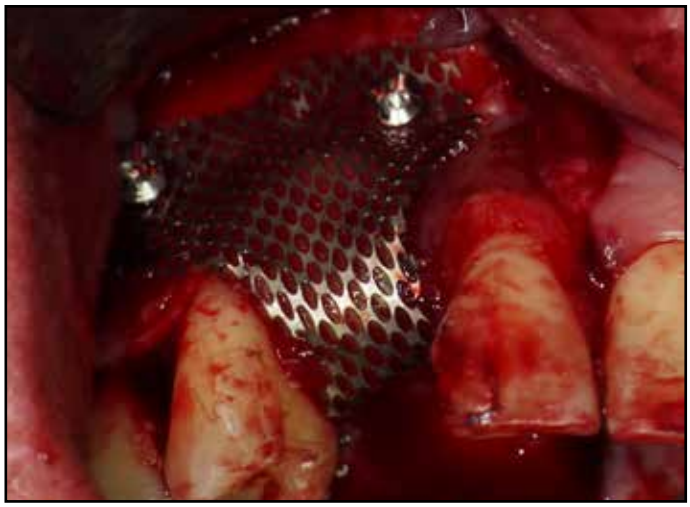


Figure 1j: Titanium mesh secure with fixation screws.

dehiscence and mesh exposure.[2] Recombinant human bone morphogenetic protein 2 (rhBMP-2) has been actively studied as an alternative to harvesting autogenous bone grafts. One of the optimal rhBMP-2 carriers that has been identified is type I bovine absorbable collagen sponge (ACS). However collagen sponge has poor scaffolding properties to resist flap compression when used for onlay ridge augmentation. Titanium mesh has been proposed as a method to provide support and protection of the rhBMP-2/ACS for bone augmentation.[18]

CASE REPORT

A 35 year old male patient with a non-contributory medical history presented with a dental history of extraction of the right upper cuspid, and immediate implant placement and grafting attempt without success. Treatment alternatives were discussed with the patient including autogenous grafting and thin cortical plates as first choice, considering autogenous bone as a gold standard for reconstructive surgery.[16, 19] A second alternative discussed was rhBMP-2

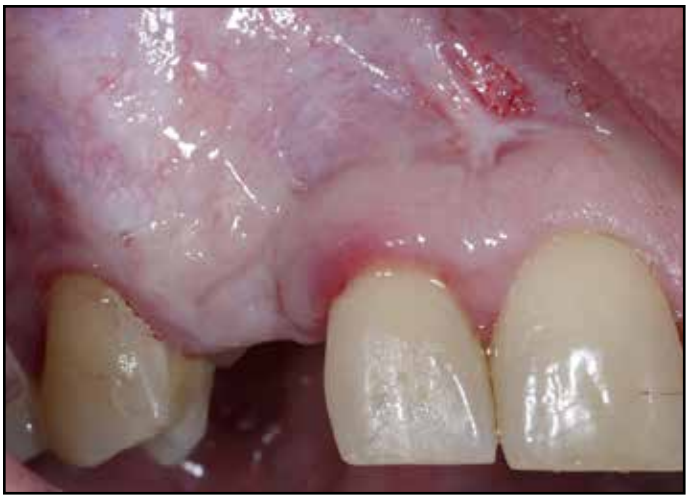


Figure 2a: 10 month post-op lateral view.

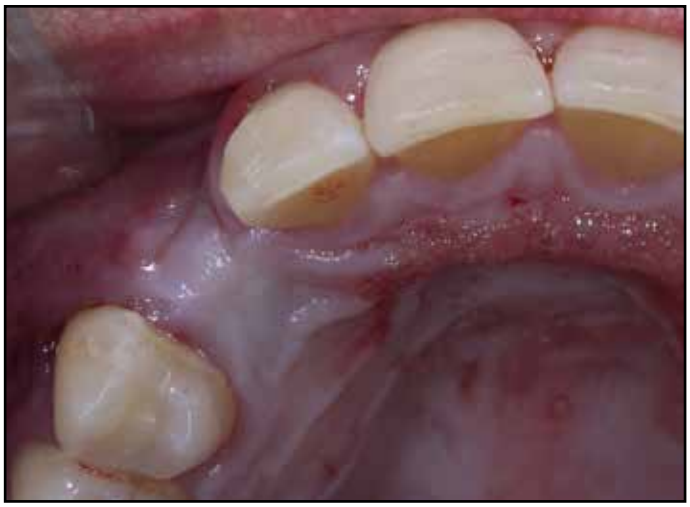


Figure 2b: Occlusal view at re-entry.

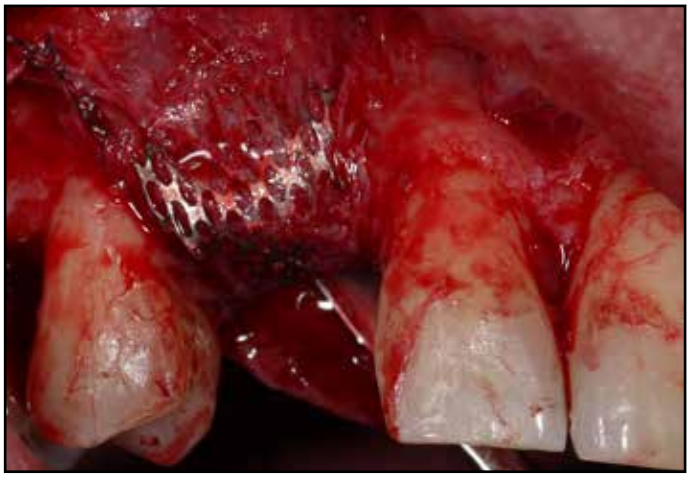


Figure 2c: Full Thickness Flap to remove ti-mesh.

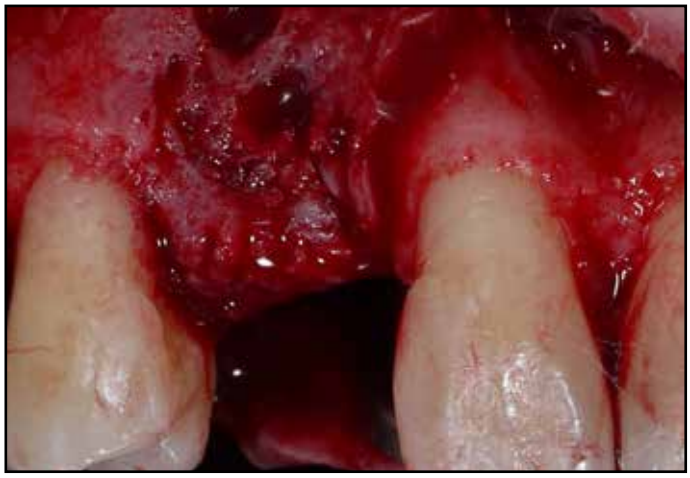


Figure 2d: New bone formation observed and tenting-screws removed.

and titanium mesh as an alternative with no need for a donor site for grafting. After evaluating benefits and risks, and based on previous grafting history, the clinician and patient elected to perform rhBMP-2 with autogenous grafting.

After curettage and root planing to remove plaque and irritants, a full thickness flap of the recipient site was raised on buccal and palatal, cleaned and prepare for grafting. Cortical bone perforations were drilled in the buccal side for vascularity with a small carbide bur. Rh-BMP2 were prepared following the instructions from manufacturer. Autogenous bone was obtained with a micrografter from the apical and distal part of the recipient site. Tenting screws were placed to prevent compression of the graft and to help to keep autogenous bone as the primary grafting material at the core of the recipient site to correct the vertical defect.[3] rhBMP-2 collagen were placed on top of the graft to act as a booster

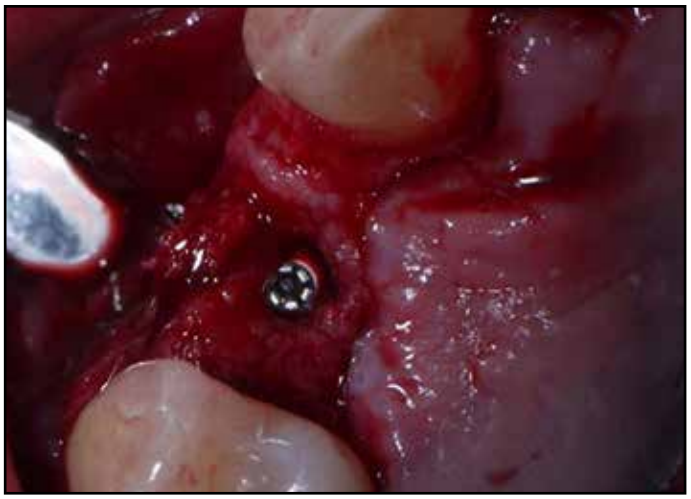


Figure 2e: Implant placement.

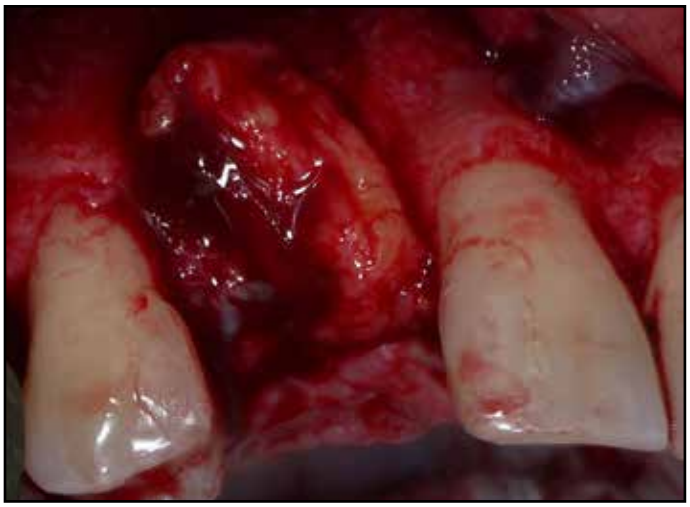


Figure 2f: Pedicle connective tissue graft.

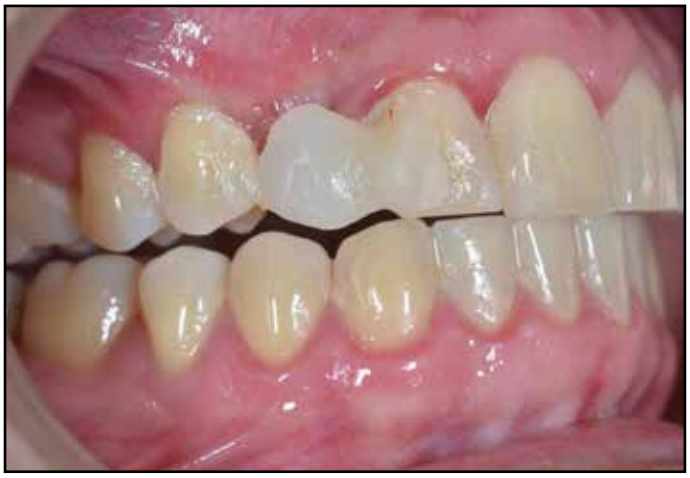


Figure 3a1: 6 month after implantation, bonded acrylic temporary while osseointegration period.

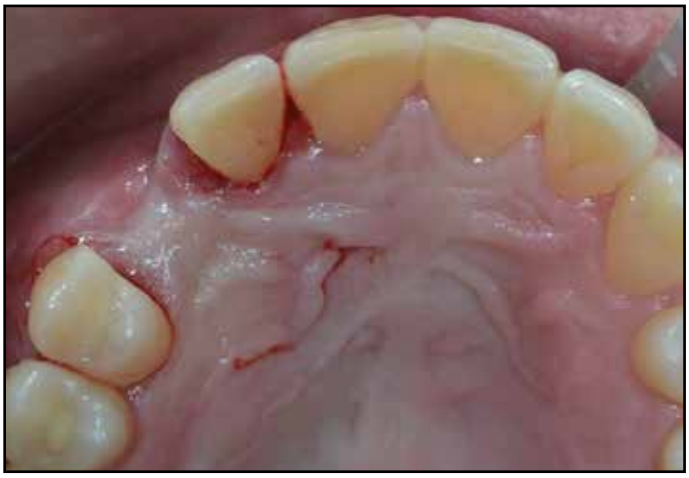


Figure 3a2: Occlusal view after removing temporary.

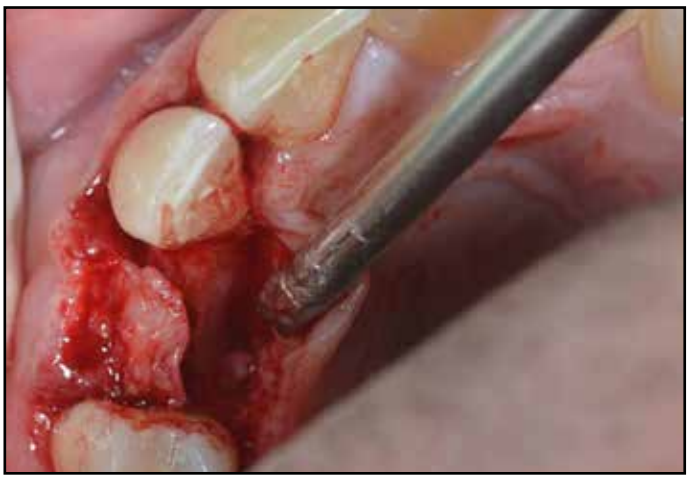


Figure 3b: Connective tissue roll flap from palatal to buccal.

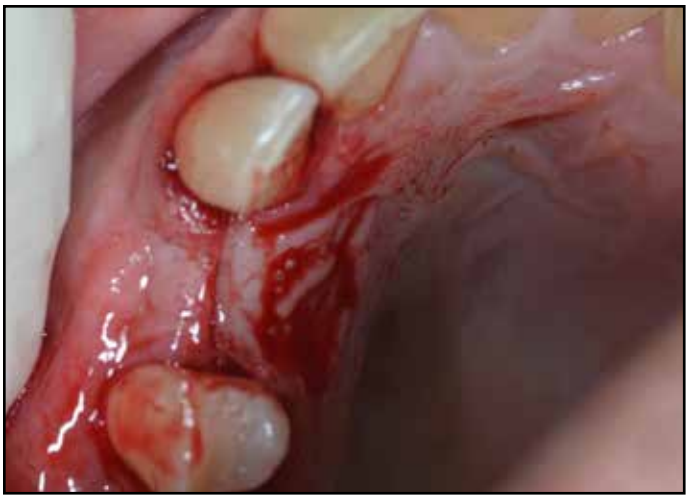


Figure 3c: CTG (roll flap) showing horizontal volume.

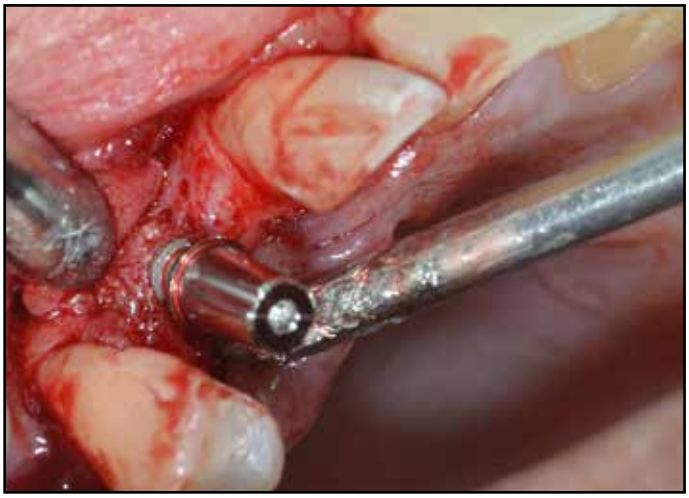


Figure 3d: Conical connection titanium abutment for temporary fabrication.

Figure 3e: Acrylic temporary and nylon sutures.

Figure 3f: Suspensory sutures to prevent soft tissue collapse.

with growth factors and chemotactic effect for bone bone formation. Titanium mesh was placed with fixation screws for space maintaining and scaffold. Periosteal incisions were made at the flap base to accomplish a tension free flap repositioning. Free connective tissue graft were obtained from the palate and placed on top of the mesh to augment soft tissue volume and prevent mesh exposure. Sutures were removed 21 days after surgical procedure, healing without any complications were observed. Re-entry and mesh removal were schedule 10 months after grafting. No complications or mesh exposure during the healing period were observed.

Ten Months after grafting, full thickness flaps were raised to uncover and remove the Ti-mesh and tenting screws. New bone formation was observed, with vascularity and bleeding pres-

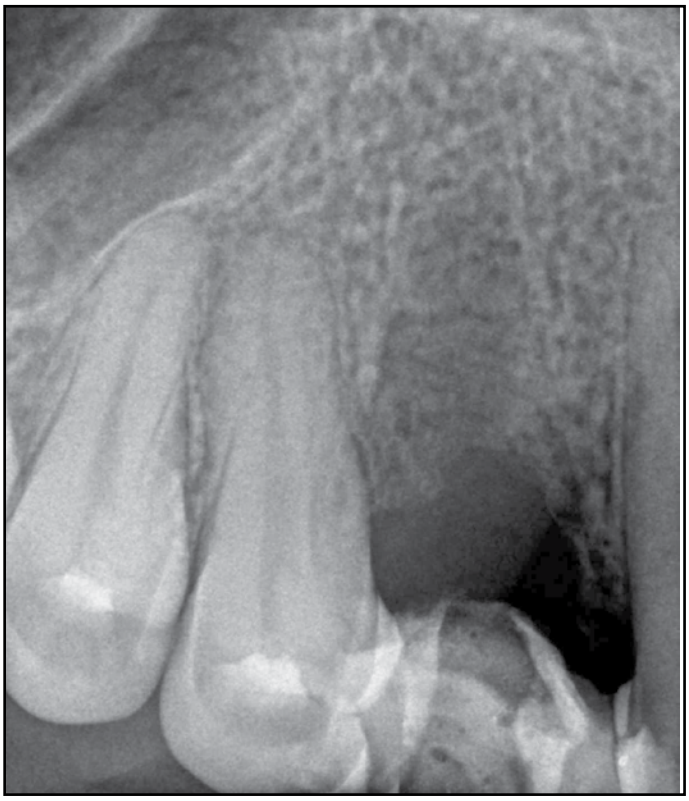


Figure 4a: Initial x-ray.

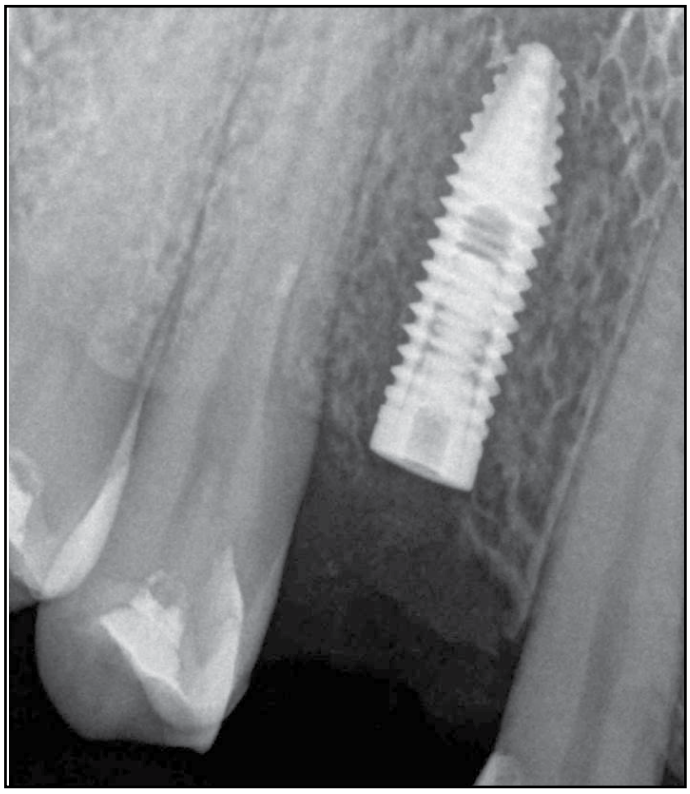


Figure 4b: implant placement.

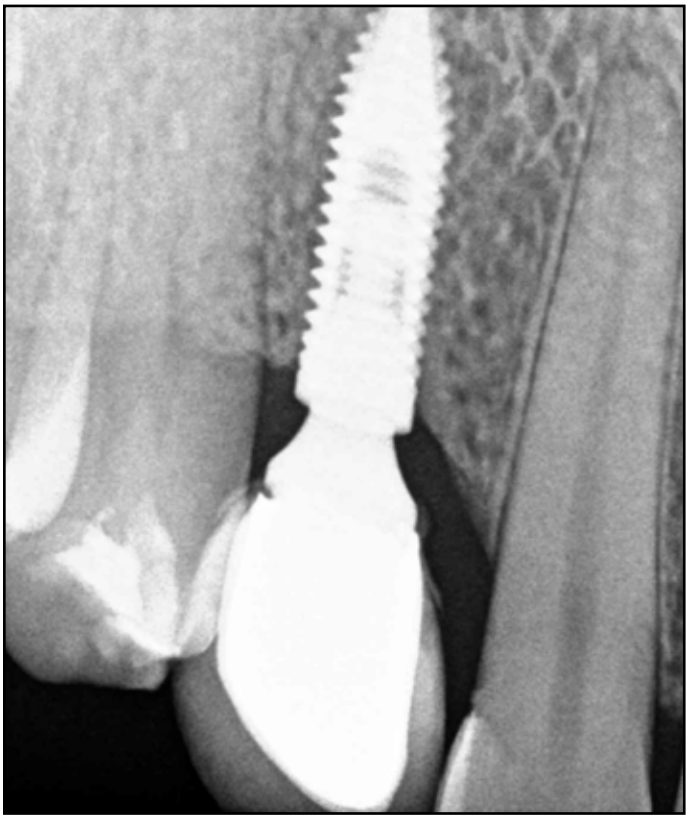


Figure 4c: PFM placement 2012

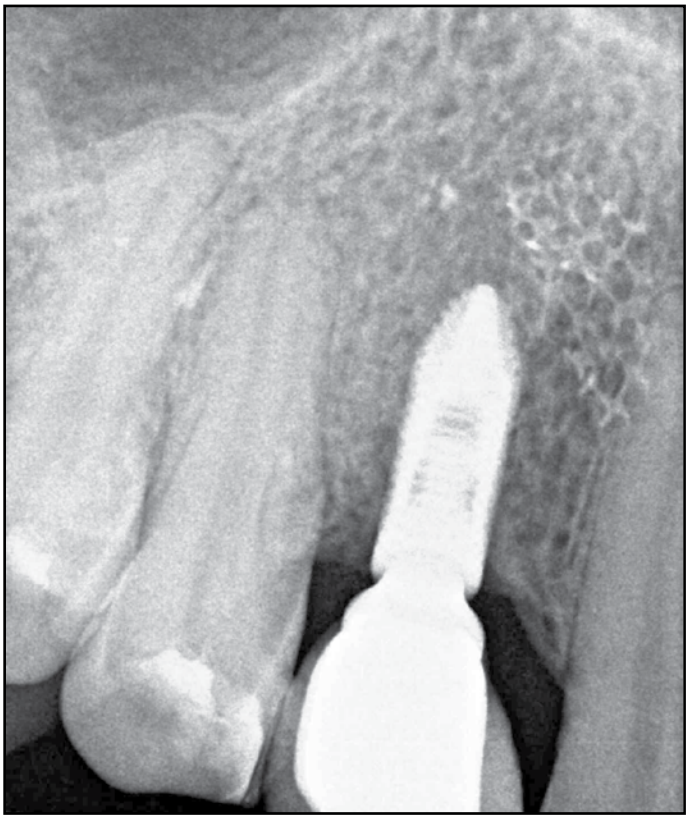


Figure 4d: 5 year post-op 2017.

ent at drilling. Type II bone density was found. Dental implant and cover screw were placed with more than 25 nw/cm2 of primary stability. A pedicle connective tissue graft from the palate was placed on top of the implant to augment soft tissue volume. Six months later, after dental implant osseointegration and healing with no complication, a partial thickness flap from the palate and full thickness flap from the buccal were performed. An additional roll flap from palate to buccal, to augment soft connective tissue was performed. A Titanium abutment and acrylic temporary were placed and suspensory sutures were placed at tooth contact to aid in vertical coronally flap re-position and prevent flap collapse and black triangles.

DISCUSSION

Severe vertical alveolar ridge defects are usually three dimensional and present a difficult challenge to the implant surgeon.[3, 20] Achieving an esthetic outcome in tooth replacement and implant treatment requires a proper tooth shape and stable surrounding soft tissue profiles. Bone augmentation is considered vital to support the esthetic profile around definitive restorations. Drawing an imaginary horizontal line spanning the space between the remaining healthy interproximal bone peaks is the most reliable vertical augmentation target to create esthetic papillae around an implant prosthesis.[20] Autogenous bone graft has long been considered the gold standard for grafting hard tissue defects. The use of titanium mesh for alveolar ridge reconstruction has shown a 97% success rate, although exposure of the titanium mesh was reported to be 52%.[3] rhBMP-2 induces bone formation at the site of application, the growth factor is chemotactic for mesenchimal stem cells, osteoprogenitor cells, and osteoblasts. Preparation of the osseous recipient site is important since these cells are found in bone marrow, cortical bone of the recipient site should be perforated to allow access to the marrow.[18] Primary tension free closure of the soft tissue flaps over the grafted site is necessary to prevent wound dehiscence and early exposure of the mesh.[3,18] The addition of free connective tissue graft from the palate, like a poncho, covering the mesh will augment the thickness of the soft tissue and prevent the titanium mesh exposure. Therefore, soft tissue augmentation is advisable after bone augmentation, not only because of the gain in keratinized tissue and soft tissue thickness, but also to maintain the regenerated bone and tissue color for optimal esthetics.[20] To get the optimal results in esthetics, multiple procedures for vertical bone augmentation could be needed for the same site and also connective tissue grafts for soft tissue thickness and height. Connective tissue grafts can compensate for a small bone deficiency not accomplished during bone augmentation procedures.

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

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Clinical and Radiographic Evaluation of Short Dental Implants in Posterior Atrophic Ridges with a Follow-up Period of 1 year After Loading: A Controlled Clinical Trial

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Abstract

Objective: To evaluate clinically and radiographically the performance of short dental implants in the posterior atrophic ridges (maxilla and mandible) with deficient vertical bone height as an alternative treatment modality to other more invasive procedures .

Methods: 30 patients, with residual bone height 7-9 mm in the mandibular or the maxillary posterior regions, were selected to receive 6.5 mm short dental implants (Maxi Z Flat-End, Osteo-Care™ Implant System, London, UK). Implants were loaded 4 months (T2) after placement and Patients were followed up 1 year after loading (T3). 32 implants were inserted, 15 implants in the posterior maxilla and 17 implants in the posterior mandible. Outcomes measured included: Implant stability measured by Periotest®M mean values (PTMVs), Implant failure rate, marginal bone loss (MBL) and other complications.

Results: - 30 patients were evaluated at 1 year after loading. The PTMVs were -1.23 ± 0.31 in maxilla, and 2 ± 0.23 in mandible. Marginal bone loss in the maxilla recorded -1.55 ± 0.29 mm and in the mandible -1.10 ± 0.12 mm after1 year of loading. The difference between the two groups showed no statistical significance (difference = -0.44 mm; 95% CI: -0.18 to 1.06; $P = 0.1549$). Two implants failed in the maxilla with a failure rate of 13.3% while there were no failures in the mandible. Statistical analysis showed no significant difference between the studied groups (P=0.4828).

Conclusion: Short dental implants seem to be an effective alternative treatment for atrophic ridges with a very high success rate in the mandible. They minimize the need for bone grafting procedures and increase the patients` acceptance, as well as, maximizing dental implant placement possibilities.

KEY WORDS: Short dental implants, bone loss, PerioTest®

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INTRODUCTION

Implant dentistry is becoming more popular as a treatment modality especially with the emergence of newer and improved implantation technologies. Much of these improvements can be attributed to the relatively high success rates of implants in both partially and completely edentulous patients.[1] In patients with long-standing edentulous arches, alveolar bone resorption (Both vertical and horizontal or combined defects) is frequently observed. The insertion of dental implants in patients with reduced alveolar bone height is challenging and may require additional invasive bone augmentation procedures.[2]

The use of short dental implants could fulfill various indications where there is insufficient bone volume to avoid complicated bone augmentation or maxillary sinus floor elevation procedures. Owing to the need for rehabilitation of such an increasing number of atrophic jaws, the 7-mm standard implant was introduced in 1979. The survival rates of implants shorter than 10 mm seem to be comparable to that of longer implants. The success rate of short implants is proposed to be higher in the mandible than the maxilla due to the nature of softer bone in the maxilla.[3-6] The possibility of restoring the dentition without the need for significant surgical augmentation has widened the scope for treatment options which, in turn, can lead to simplified implant rehabilitation procedures. These factors may increase patients` acceptance, making the treatment option available to more people, further contributing towards improved oral function and general health.[7] A broad number of cases series[8,9,10] and reviews[11,12] have reported favorable outcome in terms of survival rate for short implants placed in posterior areas. Nevertheless, there are still controversies regarding the long-term consequences of peri-implant bone loss around short implants and its impact on the long-term implant success rate. As a consequence, the borderline scenario with 5–8 mm of available bone still constitutes a challenging therapeutic dilemma for clinicians.[13] However, the development of implant design, surface structure and improved surgical techniques have given a reason to re-evaluate previous results, and recent randomized clinical studies with 3 to 5 years follow-up indicated that short implants survival and success rates were similar to long implants and may support most prosthetic restorations adequately.[14,15,16]

Recently, a number of systematic reviews evaluated the survival rate of short dental implants, overall concluding that the survival rates are similar to that of long implants.[11,6,5,13,17] Nevertheless, limitations such as a slightly lower survival rate in soft bone or in the posterior maxilla were reported.[5,18] Scientific evidence is scarce on short dental implants placed in the posterior maxilla. In addition, in most clinical studies short implants were splinted to longer ones.[9,19] Sinus floor elevation procedures with long implants or complicated bone augmentation procedures have been reported to suffer many drawbacks in terms of complications faced and patients` acceptance, besides other considerations including cost, treatment time and morbidity associated with aforementioned procedures.[18,19]

The aim of the present study was to evaluate, clinically and radiographically short dental implants placed in the posterior maxilla and mandible.

SUBJECTS AND METHODS

Patient Selection

Patients were selected, from the out-patient clinic

of the Faculty of Oral and Dental Medicine (Cairo University), according to pre-set eligibility criteria. Any partially edentulous patient missing teeth in the premolar and molar area requiring one to three dental implants, aged 18 years old or older, and able to sign an informed consent form, was considered eligible for inclusion in this trial. Vertical bone heights at implant sites had to be at least 8 - 9 mm above the mandibular canals and 7 - 8 mm below the maxillary sinuses, with bone width of at least 6.0 mm as measured on cone beam computed tomography (CBCT) scans. Exclusion criteria were as follows: (1) severe systemic diseases that might contraindicate surgical intervention; (2) uncontrolled diabetes mellitus; (3) immune-compromised status; (4) coagulation disorders; (5) radiotherapy; (6) chemotherapy; (7) alcohol or drug abuse; (8) pregnancy or lactation; (9) use of oral and/or intravenous amino-bisphosphonates; (10) untreated active periodontal infections; (11) active infection in the site of implant placement (13) heavy smokers and (12) bruxism. The study protocol was reviewed by the Ethical Committee for Human clinical trials at the Faculty of Dentistry, Cairo University. The protocol of this study was also registered at the Pan African Clinical Trial Registry (PACTR) in 2015/07/11 and the registration no. is PACTR201610001197438.

Surgical Procedures

All procedures were done under completely aseptic conditions. Patients were anesthetized at the surgical site by infiltration, using Articaine Hydrochloride 4% (Septocaine® 1.8 ml. Articaine Hydrochloride 4% and epinephrine 1:100000. Septodont, USA). Bone width was assessed using a bone caliper. Using a Bard Parker blade no.15, a palatal or lingual sub-crestal incision was created in the surgical site, extending the entire length of the edentulous area. Two oblique releasing incisions were then created on the buccal aspect. A full thickness flap was then elevated to expose the underneath buccal alveolar bone. Under copious saline irrigation, the osteotomy was prepared by sequential drilling. The Maxi Z Flat-End implant 4.5 x 6.5mm (Osteo-Care™ Implant System, London, UK) was inserted into the osteotomy using its peek carrier. Then the full seating of the implant was done using the 2.2mm hex-driver until implant platform was flush with the bone level and torqued to 30NCm to check the initial stability. A periapical radiograph was taken to check the final implant position and to estimate the initial bone level around the implant. The recipient site area was then sutured with 4-0 silk (Hu-Friedy, USA) interrupted sutures which were removed after 2 weeks.

Post-operative Care

Post-surgically patients were prescribed 875mg of Amoxicillin and 125mg of Clavulanic acid tablet (1gm Augmentin, Glaxosmith Kline, England) twice daily for 7 days, anti-inflammatory tablets (Brufen 200 mg, Abbott, India ltd.) twice per day for three days. A CBVT (Scanora 3D Soredex, Helsinki, Finland) scan was done within 24 hours post-surgically (T1) to assess marginal bone level (Figure 1 , Figure 3). Four months after implant placement (T2), re-entry using a tissue punch was done to fit a healing collar. A periapical radiograph was taken to check the proper fixation of the healing collar. Seven to 10 days later, impressions were made using impression transfers and implant replicas and the final ceramo-metallic restorations were delivered and cemented after being checked for shade matching, marginal fit-

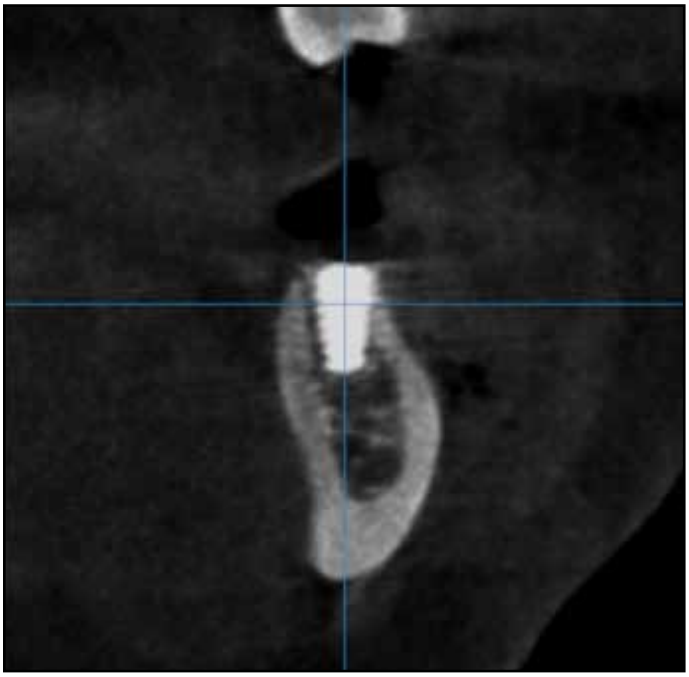

Figure 1: CBCT cross sectional view of immediate post-placement (T1) of short implant in the mandible.

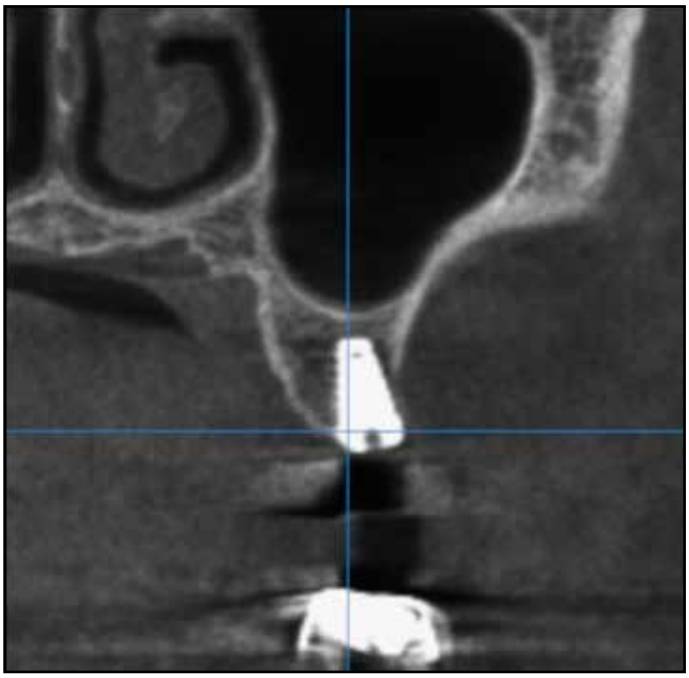

Figure 2: CBCT cross sectional view of immediate post-placement (T1) of short implant in the maxilla.

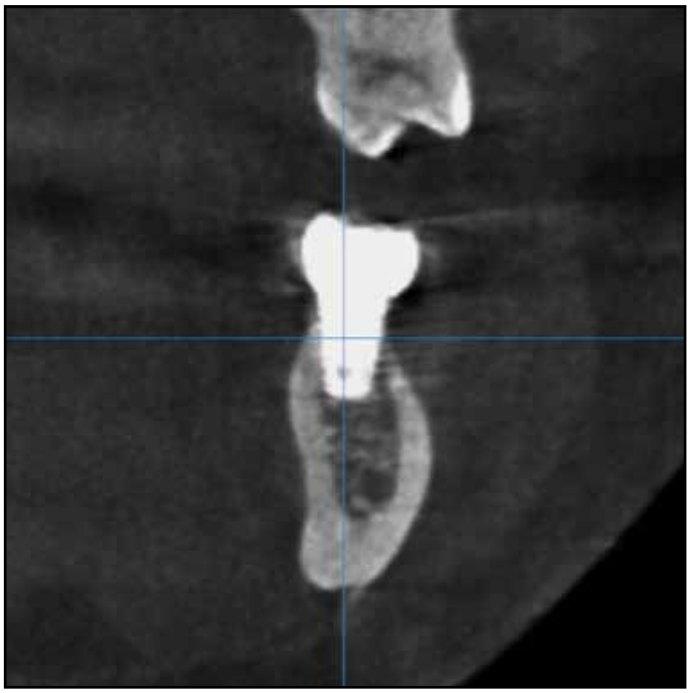

Figure 3: CBCT cross sectional view after 1 year of loading (T3) of a short implant in the mandible.

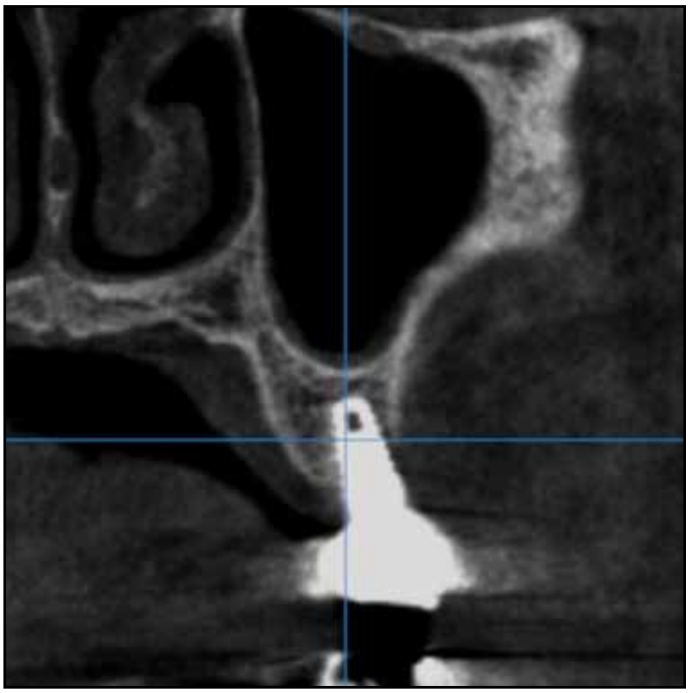

Figure 4: CBCT cross sectional view after 1 year of loading (T3) of a short implant in the maxilla.

ness and occlusion. Stability of implants in the two groups was tested using Periotest® M (Medizintechnik Gulden, Bensheim,Germany).

Outcome Measures

- Stability was tested using Periotest® M at |the loading stage (T2) and 1 year after loading (T3). Periotest® M values of (-8 to 0) were considered the ideal values that denote successful osseointegration.
- The marginal bone loss (MBL) around the short implants was assessed using CBVT within the first 24 hours post-surgically (T1) and also after 1 year (T3) (Fig.2, Fig.4). The CBVT raw DICOM data set images CT was imported to the third party software for secondary reconstruction.
- Any biological or prosthetic complications were recorded.
- Implants failure: - implant mobility and removal of stable implants dictated by progressive marginal bone loss or infection.

Statistical Analysis

The statistical software used was IBM SPSS (IBM Corp., Armonk, NY, USA), and Excel (Microsoft, Redmond, WA, USA).The patient was the statistical unit of the analyses. A parametric statistical approach was applied. Differences in the proportion of patients with implant failures and complications (dichotomous outcomes) between maxilla and mandible were compared using the Fisher's exact test. The mean differences, standard deviation (SD), confidence intervals, values and results of the Students' t-test for the changes by time in marginal bone level around implants of each group were used.

RESULTS

During the 1 year follow-up period no dropouts occurred .The main baseline patient and intervention characteristics are presented in (Table 1). There were no failures in the mandible while there were two failures in maxillary implants (Table 2). The failure in the maxilla occurred in two patients, one failure occurred in the preloading stage and the other occurred four months after loading (PTMV > 0). Post-operative swelling occurred in five cases, three in the maxilla and two in the mandible. The data of all patients was evaluated in the statistical analyses.

Implant stability was measured by Periotest M at preloading stage (T2) and 1 year after loading (T3). At the pre-loading stage the mean periotest values were -1.99 ± 0.3 in the maxilla and -2.42±0.26 in the mandible. At 1 year after loading the mean periotest values were -1.23 ± 0.31 in the maxilla and -2 ± 0.23 in the mandible. Statistical analysis showed no significant differences ($P \geq 0.05$) between the mandible and maxilla at T2 and T3 (Table 3).

The marginal bone loss around implants was measured at the mesial, distal, buccal and lingual aspects of all implants. The mean marginal bone loss 1 year after loading in the maxilla was -1.55 ± 0.29 mm while in the mandible it was -1.10 ± 0.12 mm, statistical analysis showed no significant difference ($P \geq 0.05$) between the two groups. The results of Students' t-test for the marginal bone loss around implants of each group were presented in (Table 4).

DISCUSSION

Restoration of the atrophic ridges presented a challenge in the past due to the limitation of implant placement especially in the posterior

Table 1: Summary of the Main Results		
	Maxilla	Mandible)
Female	8 (53.34%)	10 (66.67%)
Mean age of recruitment	32.73 ± 0.97	33.67 ± 1.28
No. of patient	15	15
Total no. of implant inserted	15	17
Implant length and diameter	6.5 (4.5)	6.5 (4.5)
No. of implants placed with less than 25 n/cm torque	6	1
No. of patients receiving 1 implant	15	13
No. of patients receiving 2 implants	0	2
Drop outs	0	0
Implant failure	2	0
Complication	3	2

Table 2: The Results of Fisher's Exact Test					
	Test group	Percentage	Control group	Percentage	P value
Implant failure	2 (15)	13.33%	0 (15)	0%	0.4828
Complications	3 (15)	20%	2 (15)	13.33%	> 0.9999

mandible and maxilla and the risk of approximating vital structures. In the past, the only solution was performing bone augmentation procedures, which required extended treatment periods, extra expenses and surgical complications. An alternative for restoration of such atrophic ridges is the use of short implants. Short implants were commonly associated with lower survival rates due to the reduced bone-to implant contact. Moreover, the posterior region commonly shows moderate to extensive bone resorption which results in increased crown height space and unfavorable crown-to-implant ratio. However, recently, the development of modified implant designs and sur-

Table 3: Statistical Analysis Ahowed no Significant Differences (P ≥ 0.05) Between the Mandible and Maxilla at T2 and T3

Time	Maxilla		Mandible		Mean difference	95% CI	P value
	Mean ± SD	95% CI	Mean ± SD	95% CI			
Pre-loading stage	-1.999 ± 0.3	-2.14 to -1.84	-2.42 ± 0.26	--2.56 to 2.29	-0.44 ± 0.4	-1.26 to 0.38	0.2795
1 year after loading (T3)	-1.23 ± 0.31	-1.39 to -1.07	-2 ± 0.23	--2.12 to 1.88	-0.77 ± 0.39	-1.56 to 0.03	0.0585

Table 4: The Results of Students' T-test for the Marginal Bone Loss Around Implants of Each Group

Time	Maxilla		Mandible		Mean difference	95% CI	P value
	Mean ± SD	95% CI	Mean ± SD	95% CI			
Insertion (T1) 1 year after loading (T3)	-1.55 ± 0.29	-1.7 to -1.4	-1.10 ± 0.12	--2.16 to -1.04	-0.44 ± 0.3	-0.18 to 1.06	0.1549

face treatments contributed for to the increased survival rates of short implants. Clinical literature has demonstrated no significant differences in the survival rate of short and standard implants.[21,22]

Care was taken to standardize the study conditions for all patients and to exclude conditions that might affect the success of short implants, such as smokers and medically compromised patients and patients exhibiting parafunctional habits - such exclusion was executed in line with the recommendations of previous studies.[23,24] These criteria limited the number of patients recruited in the current study. The primary stability of the implant, which results from the initial interlocking between alveolar bone and the body of the implant, affects the secondary stability of the implant because the latter results from subsequent contact osteogenesis and bone remodeling.[25,26] Implant stability is a prerequisite for the long-term clinical success of osseointegrated implants.[27]

In this study, implant stability was assessed by means of PeriotestM®, which is considered as a fast, safe and non-invasive method of measurement that is useful for long-term implant follow-up. This was in accordance with Wijaya et al.[28] who concluded that the implant mobility checker (Periotest®) was reliable and a reproducible method for dental implant mobility assessment.

At the pre-loading stage (T2) and at 1 year after loading (T3), there was no statistical significance difference in mean PeriotestM® values in both mandible and maxilla. The PeriotestM® value of one short maxillary implant was (+3) after 1 year

of loading (T3) and was considered as a failed implant while the other implant was lost at the pre-loading stage (T2). This was in accordance with Al Hashedi et al.[29] where they considered the positive implants periotest values as questionable and requiring further clinical examination before loading. Al-ghamdi et al.[30] also reported that from the observed primary stability it can be concluded that short implants are able to achieve desired primary stability in areas with good bone quality.

The percentage of implant failure in maxilla was 13.3% while in mandible it was 0%. Many researchers[31,32] considered bone quality as a significant risk factor for failures. Goodacre et al.[33] reported that implants placed in poor bone quality areas showed failures rates 16% higher than those placed into greater bone density areas. Another 5-year report of a prospective single-cohort study reported by Perelli and co-workers in 2012,[34] reported that implant failure in 110 short implants placed in posterior atrophic maxilla after 5 years was 10% and at the end of the follow-up period the implant survival rate was 90%, and 93.1% with regard to prosthetic reconstruction. On the other hand another study by Weng et al.[35] reported a 25% failure rate when short implants were placed in the posterior maxilla, especially during the first 18 months of loading.

Crestal bone loss is another important parameter to guarantee long-term clinical service. The maintenance of a stable marginal bone level becomes more critical when short implants are used.[36,37] In the present study the crestal bone loss around implants was measured at the mesial, distal, buccal and lingual aspects of all implants by using CBVT which was taken at baseline (T1: immediately after insertion) and 1 year after loading (T3). There was no statistical significant difference between the two groups for the marginal bone level changes around short implants from the baseline (T1) till after 1 year of loading (T3). After 1 year of loading the short implants placed in the maxilla showed a mean marginal bone loss of -1.55 ± 0.29 mm while the short implants placed in the mandible showed a mean marginal bone loss of -1.10 ± 0.12 mm.

Perelli et al.[34] reported a minimal crestal bone resorption around short implants placed in the posterior atrophic mandible after 5 years follow-up, he reported 1 mm marginal bone loss around 5 mm implants and 2 mm bone loss around 7 mm implants. In contrast with our study Renouard and Nisand9 placed 96 short implants in the posterior atrophic maxilla. The mean marginal bone resorption after 2 years in function was 0.44 ± 0.52 mm. Recently Felice et al.38 evaluate the efficacy of short (5 or 6 mm-long) dental implants versus 10 mm or longer implants placed in crestally-lifted sinuses. They placed 16 short implants and 18 longer implants and they found that there was no significance difference in the mean crestal bone loss after 1 year follow up.

The use of short dental implants could be considered as an alternative to avoid complicated bone augmentation procedures. The possibility of restoring the dentition without the need for complicated surgical procedures has widened the scope for treatment options and increased patients` acceptance which contributes towards improved oral function and general health

CONCLUSIONS

Within the limitations of the current study it was concluded that: 1) Short implants are considered a successful treatment option for restoration of atrophic ridges with deficient vertical bone height

in both the maxilla and the mandible; 2) Short implants placed in the atrophic mandible showed higher success rate and less crestal bone resorption than those placed in the atrophic maxilla

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

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2% Lidocaine with Epinephrine Versus 0.75% Ropivacaine for Local Anesthesia

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Abstract

Introduction: It is common practice during removal of wisdom teeth to administer local anesthetics to the surgical site.Lidocaine is the most commonly used local anesthetic. Ropivacaine is longer-acting,but it is infrequently used in the dental setting. This study aims to compare post-operative pain and patient preference after extraction of mandibular third molars using 2% lidocaine with 1:100,000 epinephrine or 0.75% ropivacaine.

Methods: After moderate sedation or general anesthesia was established, patients received 3 mL of lidocaine on one mandibular side and3 mL of ropivacaine on the opposite side. The patients' post-operative pain was scored for each side from 0 to 10 in the post-operative care unit (PACU), at 6hours post-procedure, and the following morning. A preferred side was also recorded at 6 hours post-procedure and the following morning.

Results: The mean pain score in PACU for the lidocaine side was 1.07, and for the ropivacaine side was 1.13. The mean pain score at hour 6 for the lidocaine side was 3.15, and for the ropivacaine side was 2.42. The mean pain score the following morning for the lidocaine side was 2.73, and for the ropivacaine side was 2.38. There was a significant difference overall in pain scores between the drugs(p=0.008). In terms of patient preference, at hour 6, 17 preferred lidocaine, and 35 preferred ropivacaine. The following morning, 18 preferred lidocaine, and 25 preferred ropivacaine. At hour 6, the preference for ropivacaine was significant ($p = 0.018$), but on the following morning it was not ($p = 0.360$).

Conclusion: If ropivacaine could become more readily available for oral surgeons and dentists, it may provide longer analgesia compared to the more routine shorter-acting local anesthetic lidocaine. This has potential for increased patient satisfaction, a smoother transition from local analgesia to oral medications, and a decrease in postoperative opioid use.

KEY WORDS: Local anesthesia, 3rd molar removal, pain control

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INTRODUCTION

It is common practice during outpatient surgical removal of wisdom teeth to administer local anesthetics to the surgical site in addition to the planned general anesthetic or moderate sedation.[1] This serves to reduce the required depth of general anesthesia or sedation required during the operation, and to offer immediate postoperative pain control. The choice of local anesthetic is usually decided by the surgeon. It is unclear whether the shorter acting local anesthetic lidocaine or longer acting ropivacaine is preferred by the patients. This project aims to determine the patient perceived efficacy and preference for one of these two local anesthetics for outpatient oral surgery.

2% lidocaine with 1:100,000 epinephrine is the most commonly used local anesthetic for dental extractions.[2] It is an amide local anesthetic that works by binding the voltage-gated sodium channels and preventing depolarization. It therefore anesthetizes the nerve and prevents pain signals from reaching the brain. Epinephrine is added in order to cause vasoconstriction to keep more of the drug near the nerve and prevent systemic circulation.[3] It allows smaller doses of anesthetic to be used and allows it to last longer. 2% lidocaine with epinephrine is very safe and effective, and side effects are rare when administered correctly. The most common side effects include metallic taste, ringing in the ear, headache, lightheadedness, nausea, vomiting, and paresthesia.[4] One advantage of lidocaine as a local anesthetic is the short onset time (2-3 minutes), which is determined primarily by the pKa of the drug (7.8).[5] Another advantage is its adequate duration of action for average outpatient procedures (30 minutes to 2 hours), which is determined primarily by protein binding (60-80%). For this study, a 3 mL inferior alveolar nerve (IAN) block and buccal nerve injection of 2% lidocaine with 1:100,000 epinephrine was used. This was meant to be the "control" side of the mouth.

Ropivacaine is another amide local anesthetic, but it is infrequently used in the dental setting.[6] It is, however, frequently used for neuraxial anesthesia or peripheral nerve blocks of the limbs.[7] One reason for its infrequent dental use is its expense: 0.75% ropivacaine costs the provider around $20-30 for a 20 mL vial, while 2% lidocaine with epinephrine costs roughly $5-10 for 20 mL.[8] In addition, ropivacaine is not yet available in dental cartridges and would require practitioners to use less familiar and perhaps less convenient equipment. Ropivacaine has a similar mechanism of action to other amide local anesthetics: it works by binding to the voltage-gated sodium channels and preventing depolarization.[6] Side effects are similar to those of lidocaine, and they are also very rare when administered correctly.[9] Ropivacaine is similar to another commonly used local anesthetic bupivacaine, but it is the pure S-enantiomer. Bupivacaine is used extensively in dentistry and for regional anesthesia. It is highly lipophilic which contributes to its high potency.[10] Bupivacaine consists of the R- and S-enantiomers, but the R-enantiomer is what is correlated to its higher neurotoxicity and cardiac toxicity. Therefore, ropivacaine was developed with the hopes of a similar duration of action to bupivacaine but with a higher safety profile. When compared to lidocaine, ropivacaine has a slightly longer onset time of 3-5 minutes (pKa 8.07), but a longer duration of action of 2-9 hours (94% protein bound).[11] The anticipated benefits of using ropivacaine are improved immediate postoperative comfort, increased potency, and potential for being pre-

ferred by the patient for its longer soft-tissue anesthesia. For this study, a 3 mL IAN and buccal nerve injection of 0.75% ropivacaine was used.

A 2002 study entitled "Ropivacaine for dental anesthesia: a dose-finding study" compares and contrasts three different concentrations of ropivacaine in the dental setting: 0.2%, 0.5%, and 0.75%.[11] The study found that only 0.75% ropivacaine produced adequate anesthesia for a mandibular nerve block. 0.75% ropivacaine was sufficient to provide pulpal anesthesia lasting 2-6 hours, pinprick anesthesia for 3-6 hours, and soft tissue anesthesia of the lower lip for 5-9 hours. A subsequent study performed in 2004 entitled "The efficacy of ropivacaine as a dental local anaesthetic" confirmed 0.75% ropivacaine as a suitable anesthetic for long oral procedures where prolonged postoperative analgesia was desired.[12] In this study, the onset of action of ropivacaine was found to be 2-5 minutes, and the duration of action was 3-8 hours.

This study may help indicate a patient preference for the use of either short or longer acting local anesthetics in this unique surgical situation: an area that affects breathing, eating and speaking. This decision is frequently made by the surgeon but should ideally be directed by common patient experience and need.

Aim: This study compared the degree of post-operative pain in the immediate recovery and early home period when subjects underwent the surgical removal of two mandibular wisdom teeth using two slightly different modes of local anesthesia: 2% lidocaine with 1:100,000 epinephrine vs. 0.75% ropivacaine. For these subjects, the patient preference for either or neither of these two local anesthetics was also compared.

METHODS

This study took place in the Oral and Maxillofacial Surgery and Anesthesiology Clinic at The Ohio State University College of Dentistry. Patients already consented for the surgical removal of 2 mandibular wisdom teeth (with or without maxillary wisdom teeth extractions) using either general anesthesia or sedation were screened by the investigators and offered the opportunity to participate in this research project. The project was explained to them in detail, and consent forms were signed and collected from the patients. This study was also approved by The Ohio State University Institutional Review Board, following principles in the Helsinki Declaration.

On the day of the surgery, the patients were brought to the operating room. An intravenous catheter was placed and Standard American Society of Anesthesiologists (ASA) monitors were attached (pulse-oximeter, electrocardiography, and blood pressure cuff). For both sedation and general anesthesia, 2 mcg/kg of IV fentanyl was administered. Patients receiving moderate sedation received 2mg boluses of IV midazolam until an adequate level of sedation had been achieved. For those patients receiving general anesthesia, IV propofol was administered until the patient lost consciousness, after which the level of general anesthesia was maintained using either propofol or sevoflurane. If an endotracheal tube was deemed necessary, 1 mg/kg of IV succinylcholine was also given.

Once general anesthesia or moderate sedation had been established, the local anesthetic was injected as planned by the surgeon using 3 mL for each mandibular side. Forced randomization divided patients into one of two groups to

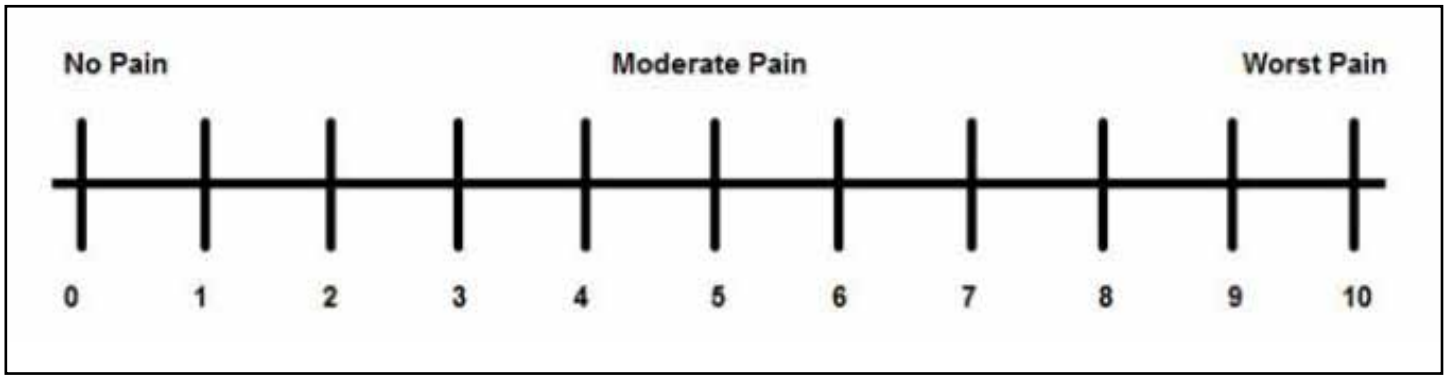

Figure 1: Visual Analog Scale.

determine the methods of local anesthesia on each side according to the case number. For an odd case number, 2% lidocaine was used on the right side of the mouth and 0.75% ropivacaine on the left side. For an even case number, 2% lidocaine was used on the left side of the mouth and 0.75% ropivacaine on the right side. The subjects were blinded as to which side received which anesthetic. The anesthetic used on each side of the mouth was recoded and provided to the surgeon, who was not blinded to the study.

Following a 3 minute period for the local anesthetic to become effective, the procedure was started and conducted according to the surgical plan. Following completion of the treatment, the patients were woken up. If intubated, they were extubated awake and transported to the PACU under continuous monitoring until sufficient recovery had occurred.

During the recovery period, patients were asked to rate their pain on a verbal analog scale of 0-10 (0 being no pain, 10 being the worst pain) for each side of their mouth. A questionnaire was given to each patient as they left the facility upon which they were asked to record their pain level from 0-10 on a visual analog scale for each side 6 hours after their appointment and again upon awakening the next morning (Figure 1). In addition, patients were asked to state their preference for a particular side of their mouth at 6 hours after surgery and again the next morning. Patients were contacted later that day, and the results were collected.

60 patients were needed for this study. It was calculated that the use of 60 subjects would provide a power greater than 90% (0.938) to detect a between-group difference of 1 step on the pain scale being used. Paired t-test (difference between the two means-matched pairs) was used to determine the power for the study.

The patients invited to participate in the study were between the ages of 18 and 40 with an ASA classification of I to III. The only other patients excluded were those with any psychological disorder that prevented them from reliably answering the questions or filling out the questionnaire, or those who requested to be removed from the study.

Using volumes of only 3 mL for each local anesthetic offered no higher risk than the surgical and local anesthesia risk to which the subjects had already consented. This 6 mL volume for both 2% lidocaine with 1:100,000 epi-

nephrine and 0.75% ropivacaine is well below the prescribed maximum allowable doses. The maximum recommended dose for ropivacaine is 3 mg/kg (about 200 mg for a 70 kg person).[13] Using 3 mL of 0.75% ropivacaine is 22.5 mg and is well below the maximum dose. The maximum recommended dose for lidocaine with epinephrine is 7 mg/kg (about 500 mg for a 70 kg person).[14] Using 3 mL of 2% lidocaine is 60 mg and is also well below the maximum dose.

Statistical Analysis: The anesthetic used on each side of the mouth for each subject was coded for subsequent data analysis, and then decoded for publication of the results. The pain score data was summarized using means and 95% confidence intervals and analyzed with a repeated measures two-way analysis of variance (ANOVA) using the methods of maximum likelihood estimation and the Satterthwaite degrees of freedom, (SAS MIXED Procedure, SAS (R) Proprietary Software 9.3, SAS Institute, Inc., Cary, NC, USA) in order to account for any violations of normality or of equality of variances.[15-17] The two within-subject factors were drug and time. The interactions of these main factors were included in this statistical model. Tukey testing was applied to pairwise comparisons in order to resolve any found statistically significant effect with greater than one degree of freedom. The ranked preference data was summarized using numerical and relative frequencies and was correlated to local anesthetic at each time by use of the exact test for the Mantel-Haenszel Chi-Square, with Bonferroni adjustment for repeated use of this test at the two times studied.[18] Overall, alpha was set at 0.05 to be considered statistically significant.

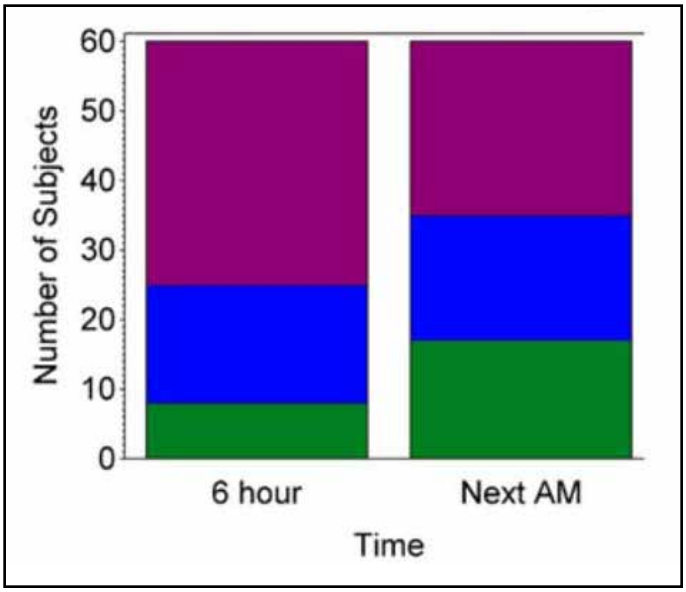

Figure 2: **Mean pain scores for lidocaine vs ropivacaine.**
Key: Lid = 2% lidocaine with 1:100,000 epinephrine. Rop = 0.75% ropivacaine

RESULTS

Overall, about 73 patients initially signed up for the study. Three subjects did not complete the study because either the surgeon missed the IAN block, or the patient required more local anesthetic on certain or both sides of the mouth. The other ten did not complete the study because they did not respond when they were contacted to collect data. Therefore, a total of 60 patients completed the study.

The mean pain scores in PACU, at 6 hours post-procedure, and the morning after the procedure for both lidocaine and ropivacaine are summarized and listed in Table 1 and Figure 2. The mean pain score in PACU for the lidocaine side was 1.07 +/- 1.69 and for the ropivacaine side was 1.13 +/- 1.85. The mean pain score at hour 6 for the lidocaine side was 3.15 +/- 2.46, and for the ropivacaine side was 2.42 +/- 2.31. Finally, the mean pain score the morning after the pro-

Table 1: Mean Pain Scores for Lidocaine vs. Ropivacaine

Time	Drug	Mean Pain Score	Standard Deviation
PACU	Lid	1.07	1.69
PACU	Rop	1.13	1.85
6 hour	Lid	3.15	2.46
6 hour	Rop	2.42	2.31
Next AM	Lid	2.73	2.30
Next AM	Rop	2.38	2.06

Key: Lid=2% lidocine with 1:1000,000 epinephrine. Rop= 0.75% ropivacaine.

cedure for the lidocaine side was 2.73 +/- 2.30, and for the ropivacaine side was 2.38 +/- 2.06.

The repeated measures two-way ANOVA data for pain scores is summarized in Table 2. There was a statistically significant difference overall in pain scores between the two drugs. Given the mean pain values, when looking at the effect of the drug, the P value was 0.008 (alpha = 0.05). However, when comparing the mean pain scores over time, the P value was 0.340 (alpha = 0.05), meaning there was no significant difference in the two drugs over time. If this had been significant, an analysis would have been done to look at the drug at both 6 hours and the morning after the procedure.

The results of the patient preference data are summarized in Table 3 and Figure 3. At hour 6, 17 subjects preferred lidocaine (28.33%), and 35 preferred ropivacaine (58.33%). 8 of the 60 (13.33%) had no preference at hour 6 ($\chi 2$ =6.23; P =0.018). On the morning after, 18 subjects preferred the lidocaine side (30.00%), and 25 preferred the ropivacaine side (41.67%). 17 of the 60 subjects (28.33%) had no preference on the morning after the procedure ($\chi 2$ =1.14; P =0.360).

The patient preference data was analyzed using the Mantel-Haenszel Chi-Square and is summarized in Table 4. At hour 6, the P value was 0.018 (alpha = 0.025), meaning there was a significant difference in the patient preference for ropivacaine over lidocaine. The morning after the procedure, the P value was 0.360 (alpha = 0.025), meaning there was no statistically significant difference in the patient preference for ropivacaine over lidocaine.

Table 2: Repeated Measures Two-Way Analysis of Variance for Pain Scores

Effect	DF-Num	Df-Den	F Value	P Value
Drug	**1**	**177**	**7.32**	**0.008**
Time	**1**	**177**	**1.26**	**0.263**
Drug x Time	**1**	**177**	**0.92**	**0.340**

Key: DF= degrees of freedom. Num = numerator. Den = denominator

DISCUSSION

Overall, based on the data analysis for pain scores, no significant interaction was found for drug and time (P = 0.340). However, a highly significant overall effect of drug was found (P = 0.008). At hour 6, there was a significant preference for ropivacaine over lidocaine (P = 0.018). On the morning after the procedure, there was no significant different in patient preference for either drug (P = 0.360).

In PACU, there was not a large difference in pain scores between the two drugs, and we did not expect to see a difference. This is due to various reasons: both local anesthetics should still have been working. In addition, the patients received IV analgesics which may still have been exerting their effects. Finally, the patients may still have been sedated from their moderate sedation or general anesthesia. These are also reasons why patients who were not receiving sedation or general anesthesia were not included in this study.

At hour 6, we expected to see a difference between the two drugs, and we did see the patients had a statistically significant preference for the ropivacaine side over the lidocaine side. Although the actual difference in pain score for the 2 drugs was not large (2.42 for ropivacaine, 3.15 for lidocaine; difference of 0.73), it was interesting to see that the patient preference for ropivacaine was statistically significant at this time. At this point, the effects of lidocaine should have worn off because the duration of action is normally about 30 minutes to two hours.[5] The ropivacaine should have still been working, as it has a longer duration of action of up to 9 hours.[11]

On the morning after the procedure, we did not expect nor did we see a difference, but we hoped there would be a preference for the ropivacaine side. At this point, the duration of action of both ropivacaine and lidocaine should have been over, so the only source of analgesia would have been the prescription or over-the-counter medications the subjects were given. These medications would affect both sides of the mouth equally.

There were a couple of limitations in the study. Firstly, the study was not double-blind. The researcher and surgeon knew which side received which drug, but the patient did not. A

Table 3: Patient Preference Data			
	Preference by Time		
	Time		
Preference	6	Next AM	Total
None	8/13.33%	17/28.33%	25
Lid	17/28.33%	18/30.00%	35
Rop	35/58.33%	25/41.67%	60
Total	60	60	

Key: Lid = 2% lidocaine with 1:100,000 epinephrine. Rop = 0.75% ropivacaine.

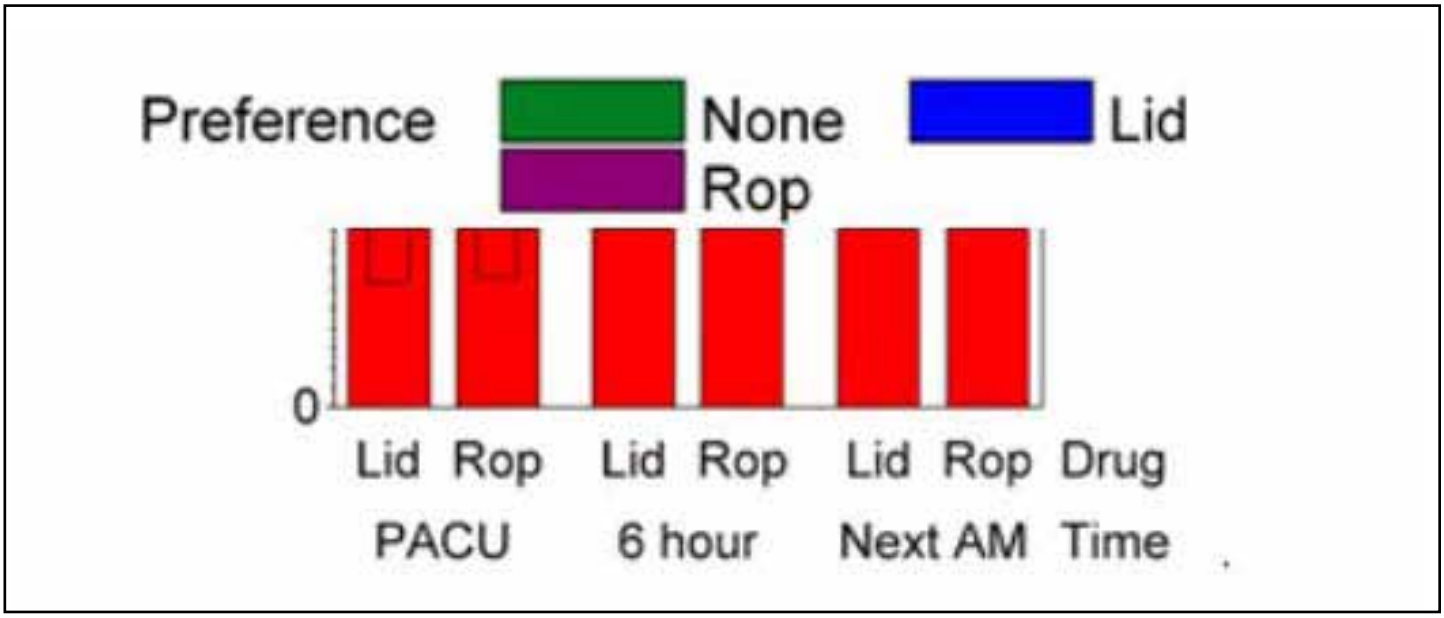

Figure 3: Patient preference data.

Key: Lid = 2% lidocaine with 1:100,000 epinephrine. Rop = 0.75% ropivacaine.

Table 4: Chi-square Analysis for Patient Preference Data			
Time	**DF**	**Chi-square**	**P Value**
6 hour	**1**	**6.23**	**0.018**
Next AM	**1**	**1.14**	**0.360**

Key: DF = degrees of freedom.

potential adjustment for future study would be to make it double blind to avoid any potential bias.

Another possible issue with the study was the lack of epinephrine on the ropivacaine side. Less surgical hemostasis was sometimes observed on the ropivacaine side, and some patients required gel foam and suturing when it otherwise may not have been required. However, adding epinephrine may also cause the ropivacaine to last even longer than it normally does. On the plus side, however, patients with cardiovascular compromise could receive ropivacaine to achieve longer local anesthesia without the use of epinephrine. For future study, a potential adjustment could be to add epinephrine to the ropivacaine, and to compare 2% lidocaine with epinephrine against 0.75% ropivacaine with epinephrine.

One more problem was that although the patients were their own controls, both sides of the mouth were not necessarily the same for each patient. Some had infected or carious molars on one side, with normal teeth on the other. Also, some had full-bony impacted molars on one side, but erupted teeth on the other side. Moreover, some patients were taking out all four wisdom teeth (1, 16, 17, 32), while some may have been missing or retaining their upper third molars. Finally, some may have had baseline pain on one side but not on the other. These differences were not accounted for when analyzing the data, and they may have affected the patients' pain perceptions.

There were a few patients who reported a pain score of 0 for the ropivacaine side, but they preferred the lidocaine side because they did not like the feeling of being numb for too long. Although they had some pain, they still preferred the side which was not numb. Therefore, the benefit of prolonged pain relief through the use of a longer acting local anesthetic may not necessarily outweigh the discomfort of being numb for a prolonged period following surgery for all patients.

Recommendations for future studies would be to have a larger sample size and to make the surgeons blinded to the drugs they were administering. Epinephrine could be added to the ropivacaine side in order to compare both local anesthetics with epinephrine and potentially provide better vasoconstriction and surgical hemostasis on the ropivacaine side. Another recommendation could be to include only patients who had similar dentition on both sides of the mouth (level of caries, eruption, etc). Finally, another study would be to

have two different groups and to compare the amounts of opioids o other forms of oral analgesia medications that are taken post-operatively.

If ropivacaine could become more readily available for oral surgeons and dentists, it may provide longer surgical site analgesia after the procedure is completed compared to the more routine shorter acting local anesthetic lidocaine. This has the theoretical benefit of providing a longer period of time for the patient to leave the treating facility to travel home and begin their regimen of oral analgesics before the local anesthetic begins to subside. This has potential for increased patient satisfaction and comfort, a smoother transition from local analgesia to oral medications, and delay of initial or total postoperative opioid or non-steroidal anti-inflammatory drug (NSAID) dosage. This project shows that ropivacaine should be considered, or perhaps even used routinely, for outpatient oral surgery procedures.

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

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A Novel Approach to Repair Severe Damage in the Esthetic Zone for Dental Implant Treatment

Dr. Gerald Rudick[1]

Abstract

The following case reports documents use of platelet rich fibrin (PRF) and titanium mesh for guided bone regeneration (GBR) to facilitate dental implant treatment in the esthetic zone. A 40 year old male patient with a severe hard and soft tissue combination defect in the esthetic zone of the anterior maxilla is treated and photo documentation of the procedure is provided.

KEY WORDS: Orthodontics, periodontics, osteopenia, bone graft

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CASE REPORT

A 40-year old male patient, a heavy smoker, presented with a mobile and sensitive upper right central incisor (#11 FDI tooth numbering system). The preoperative radiograph (Figure 1) revealed that this tooth had been treated endodontically, had a post and core, a crown (Figure 2), and evidence of a possible root resection. He was given a local anesthetic, and the tooth was extracted (Figure 3) however, a large portion of the root remained in the bone. A full thickness flap was opened, and the remainder of the root was removed, revealing a significant bony defect (Figure 4). Due to the significant infection present and the soft tissue deficiencies, the site was not immediately treated with dental implant or regenerative procedures. The soft tissues were approximated, sutured, and a plastic denture tooth was bonded to the adjacent teeth to act as a temporary replacement. A period of five weeks was left in order for the site to detoxify and clear itself of the deleterious tissues.

Prior to re-entering the site, four vials of blood were drawn by venipuncture (Figure 5) and centrifuged for 8 minutes at 2700 rpms to fabricate platelet rich fibrin (PRF). The tubes were opened, and the PRF was withdrawn and pressed to obtain membranes. The exudate of Fibronectin and Vitreonectin were used to wet the grafting materials which were Cerasorb M, Osteogen, Osetodemin with a sprinkling of Metronidazol powder.

After administration of local anesthetic, a mucogingival flap was reflected and the area was debrided with a piezoelectric scaler (Figures 6, 7). An Adin 4.2 x 16mm Touareg S implant was placed achieving torque at the apex and slightly on the sides as the entire labial surface was exposed (Figure 8). A titanium mesh was cut to size and secured with the cover screw of the implant (Figure 9). The implant surface was rinsed with the PRF liquids, the grafting material packed on top of it, covered by two PRF pressed membranes, and the titanium membrane folded on top of it (Figures 10-12). On top of the titanium mesh, two PRF membranes were placed, the soft tissue was reapproximated and then sutured (Figure 13). The site was covered with Coepak periodontal dressing, which also secured the denture tooth (Figure 14). After 5 days, the periodontal pack was removed and a denture tooth was bonded to the adjacent teeth. After 10 weeks of healing, the titanium mesh was removed (Figures 15, 16) and the denture tooth was rebounded to adjacent teeth for esthetics.

Four months after removing the titanium mesh (Figure 17), the labial tissue was reflected to expose the implant and it was observed that bone was developing on the labial surface of the implant (Figures 18, 19). At this time, holes were drilled in the adjacent bone to stimulate bleeding in preparation for a second grafting with Gen-Os porcine xenograft which was then covered with Evolution membrane (Figure 20).

It must be observed that the implant was intentionally placed above the crest of the ridge, in order for the titanium mesh to generate bone above the height of the ridge. After four months the soft tissues were sufficiently healed, so that a titanium abutment was fitted on to the implant (Figure 21), and the temporary crown was totally implant supported (Figure 22). Post-operative photos demonstrated excellent bone regeneration as verified in the radiograph (Figure 23), with the final restoration being a porcelain to metal cement retained crown (Figure 24). ●

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

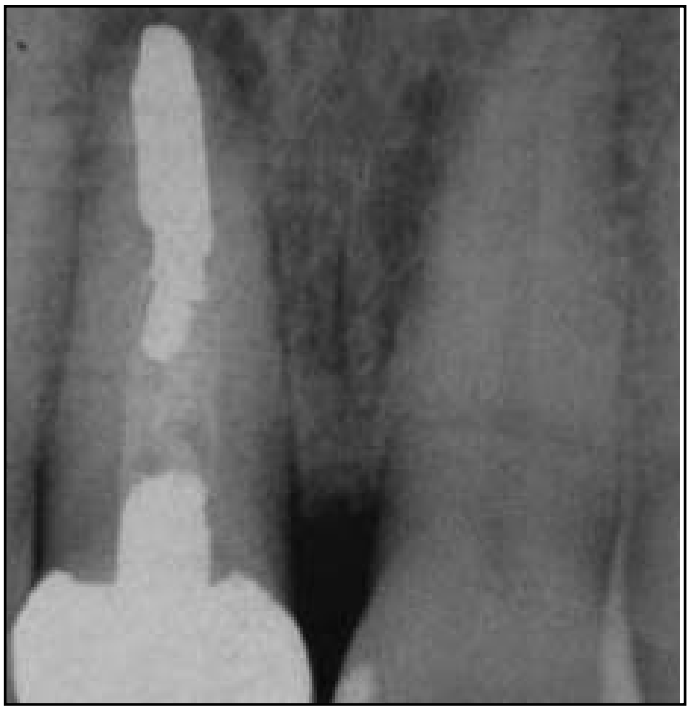

Figure 1: Pre-operative radiograph.

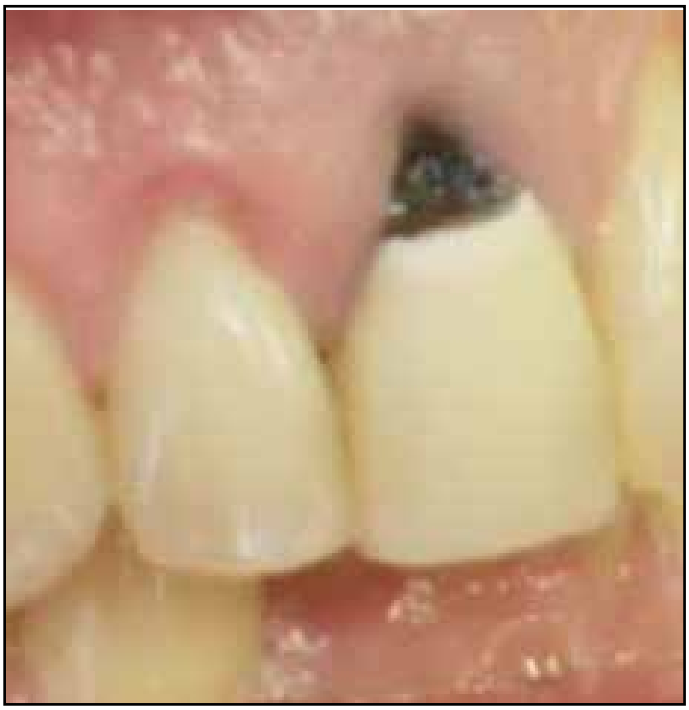

Figure 2: Pre-operative clinical situation.

Figure 3: Tooth fragment removal.

Figure 4: Hard tissue defect.

Figure 5: Tubes of drawn blood.

Figure 6: Piezoelectric cleansing of defect.

Figure 7: Resultant defect.

Figure 8: Dental implant placement.

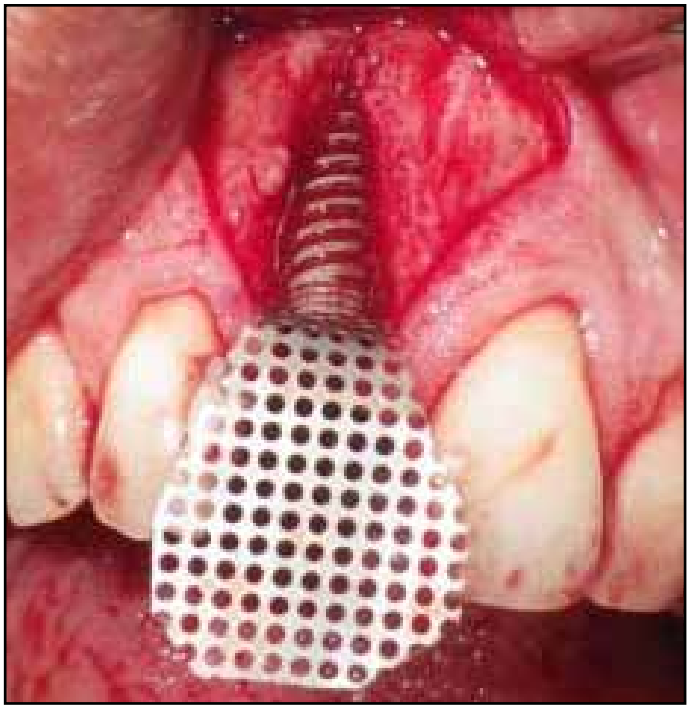

Figure 9: Titanium mesh placement.

Figure 10: Bone graft placement.

Figure 11: Bone graft placement.

Figure 12: Bone graft placement.

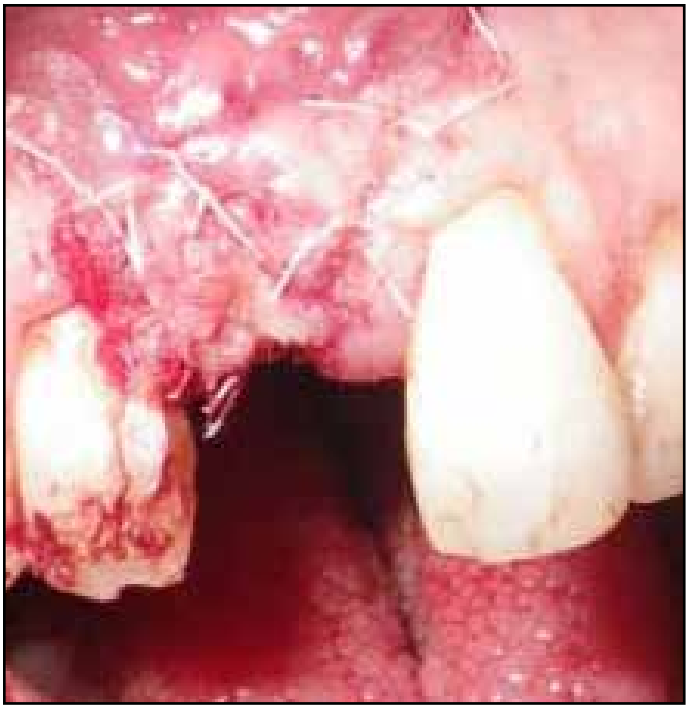

Figure 13: Suture closure.

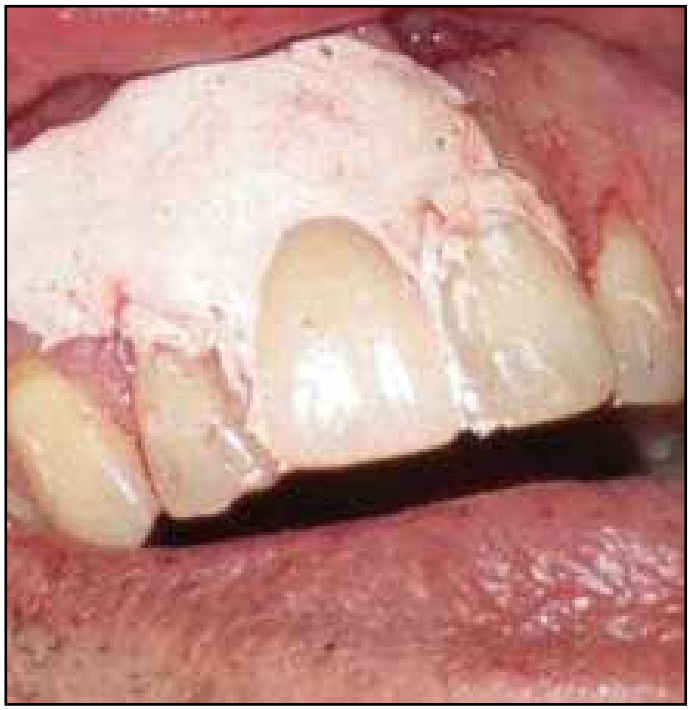

Figure 14: Surgical dressing placement.

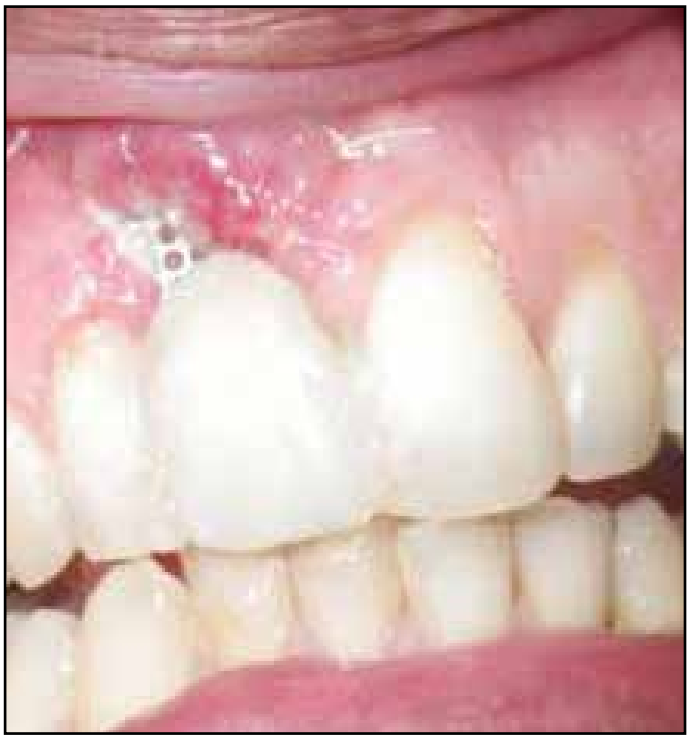

Figure 15: Titanium mesh exposure.

Figure 16: Titanium mesh removal.

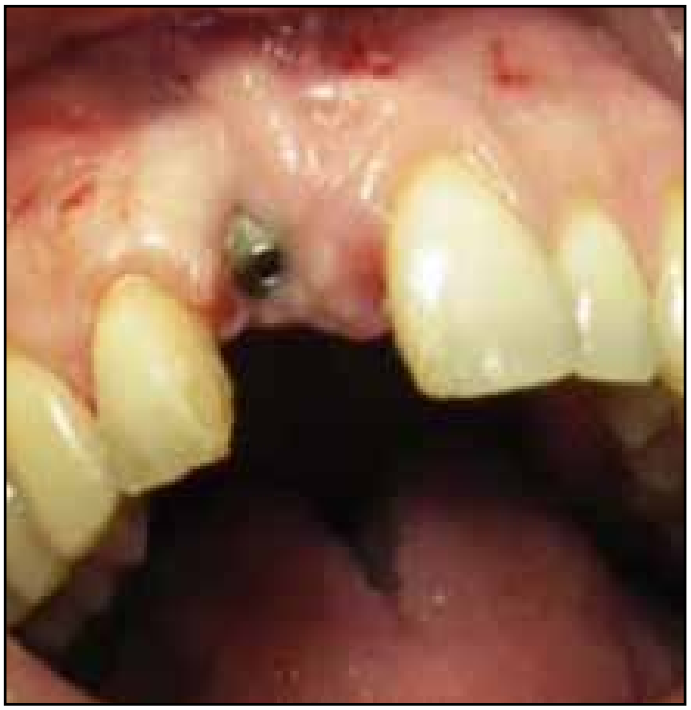

Figure 17: Healed surgical site after Titanium mesh removal.

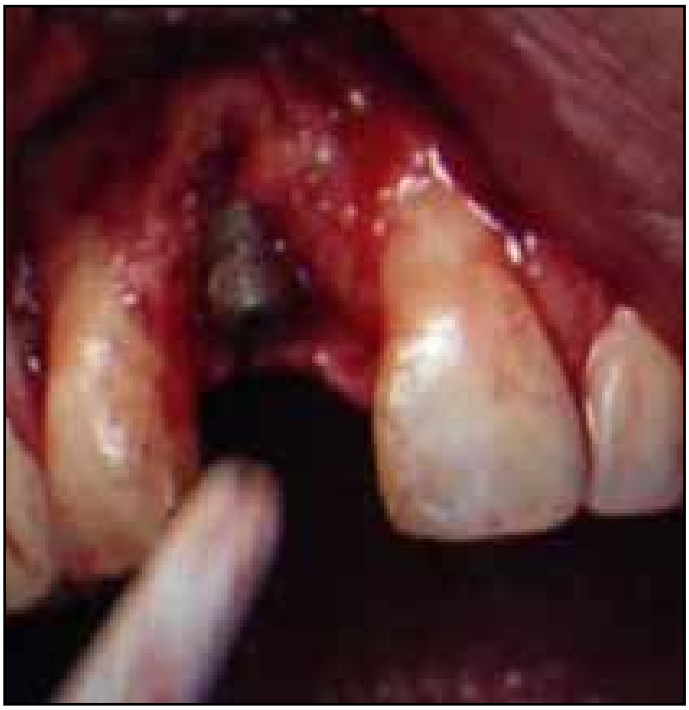

Figure 18: Implant exposure.

Figure 19: Implant exposure.

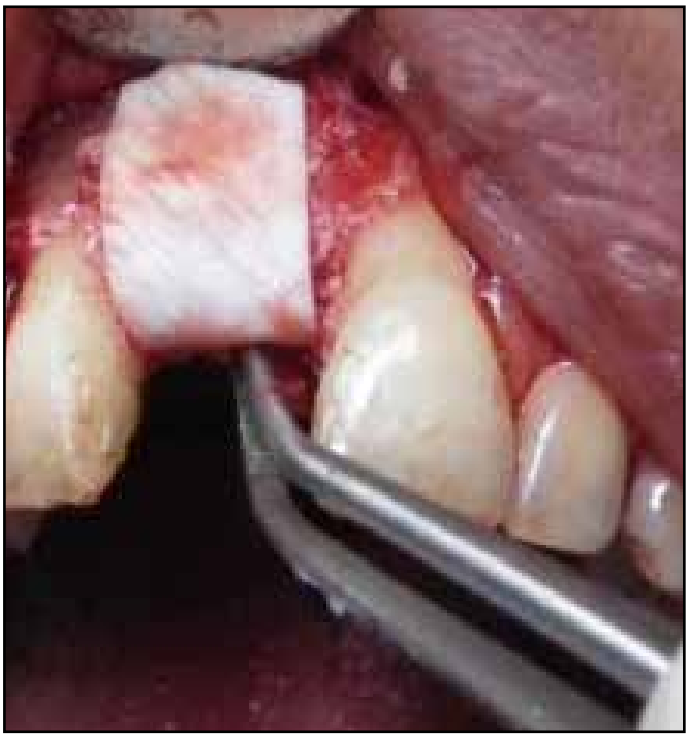

Figure 20: Membrane placement.

Figure 21: Abutment placement.

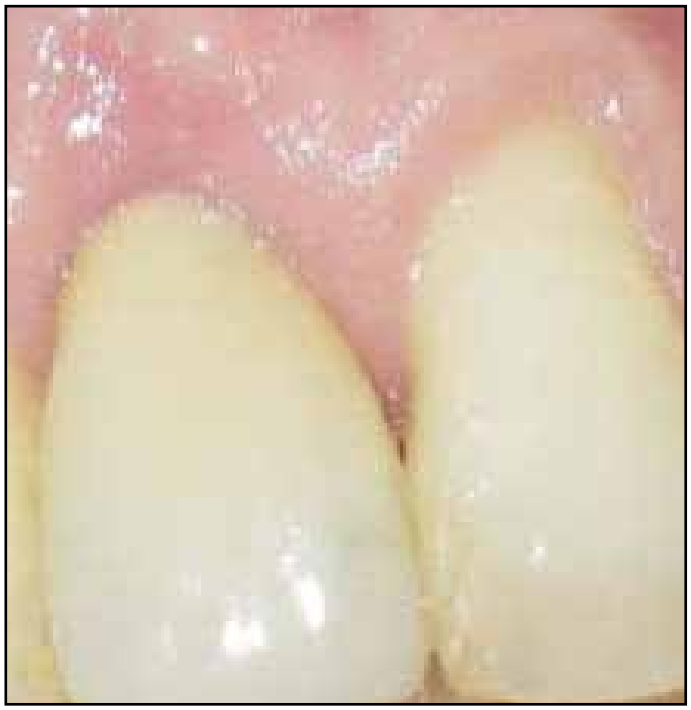

Figure 22: Temporary crown placement.

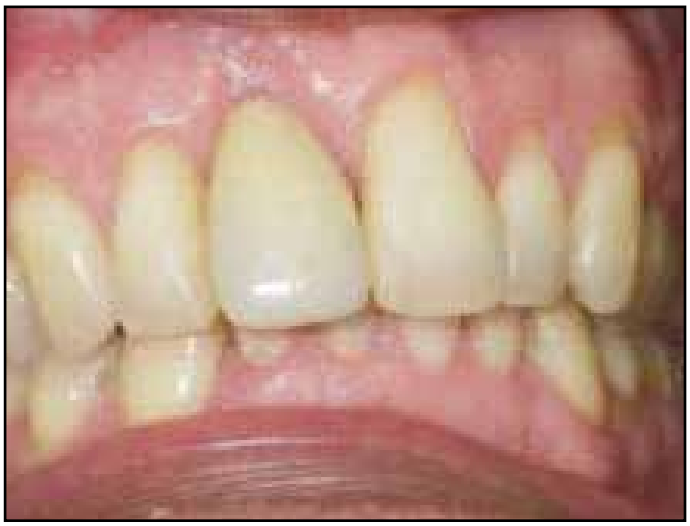

Figure 23: Final dental implant restoration.

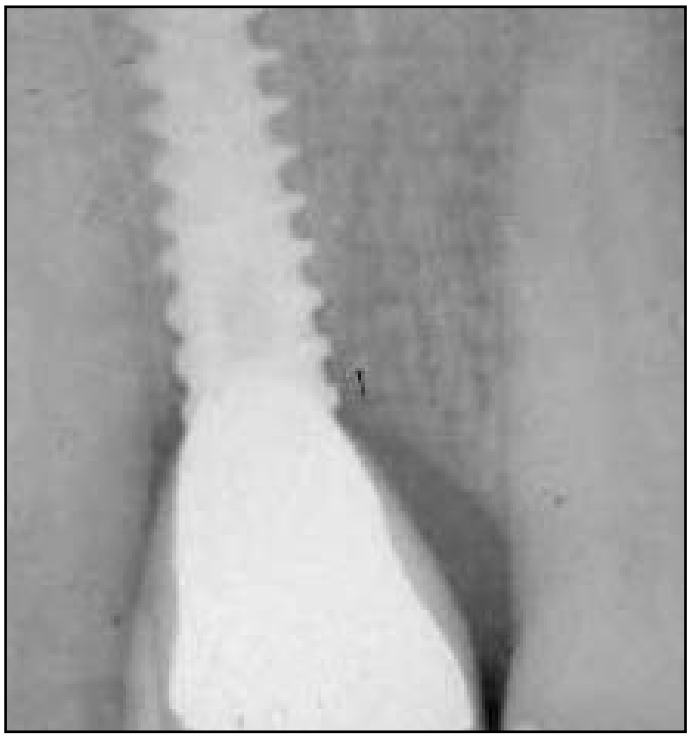

Figure 24: Final radiograph.

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