CORPUS PUBLISHERS

# Advance Research in Sciences (ARS)

Case Series

# A Case Series for Immediate Dental Implant Placements by means of Osteotome Technique

**Saad Al-Almaie*, Ali Al Orf, Majedah Alshuwaiqi**

*King Fahad Military Medical Complex, Saudi Arabia*

**Volume 1 Issue 3, 2023**

**Article Information**

Received date: June 27, 2023

Published date: July 11, 2023

***Corresponding author**

Saad Al-Almaie, King Fahad Military Medical Complex, Ph no: +966-504805413, Saudi Arabia

**Keywords**

Dental Implants; Reconstructive Surgery; Bone Regeneration; Osteotome Technique; Dento-Alveolar bony defects

**DOI:** 10.54026/ARS/1012



## Abstract

**Purpose**: To overcome the limitations of implant placement in Knife edge ridges, Summer introduced Osteotome technique in 1994. It has been claimed that bone condensing for preparation of the implant site in soft bone avoids the risk of heat generation and also implants can be placed precisely with increased primary stability. The purpose of this study was to analyze the use of the osteotome technique, followed by immediate implant placement, using cases presenting different conditions as dento-alveolar bony defects and to define management solutions in the event of existing bone resorption.

**Material and Methods:** A group of twenty patients treated with bone expansion by means of osteotome technique, followed by single immediate implant placement were placed either in the maxillary or mandibular regions. Clinical findings have been recorded (complications, infection, and wound dehiscence) during the whole follow up period. The amount of bone expansion at the alveolar ridge after implant placement was measured clinically, gingival margin was evaluated clinically, and the marginal bone resorption (crestal bone loss) were evaluated radiographically for the restored implant one-year after implant's functional loading.

**Results:** The surgical sites for the implant areas showed no post-operative complications, infection nor wound dehiscence during the whole follow up period. No prosthetic complications were recorded at follow up visits. The amount of bone expansion at the alveolar ridge were ranged 2.6-4.2 mm. The amount of marginal bone resorption from time of implant placement to one-year's after implant's functional loading were ranged 0.8-1.9 mm. The contour, height, and width of gingival at the implant site was corresponded to the soft tissues that surround the adjacent natural teeth) The gingival margin as esthetic outcome were achieved for most of the restored implants one-years after implant's functional loading.

**Conclusion:** Based on the results of this study, the Osteotome technique is a good technique for the purpose it was introduced i.e. for Knife edge ridges and the advantages for this technique for patients include less surgical trauma and a shorter treatment time.

## Introduction

Dento-alveolar bony defects are very common and poise a significant problem in dental treatment and rehabilitation. Reconstruction of dento-alveolar bony defects using minimally invasive techniques would greatly enhance the success and patient acceptance of this area of reconstructive surgery. Over the past three decades, great strides have been made in the field of alveolar bone preservation and augmentation. Review of the literature identify many techniques and materials that have been used successfully to obtain esthetically and functionally acceptable alveolar ridge for successful implant [1]. The alveolar ridge revealing a knife-edge morphology or non space-maintaining defects, usually requires a local alveolar ridge expansion procedure. In such situations the ridge may be expanded by splitting [2], or spreading [3,4] of the bone, resulting in a sufficient width for implant bed preparation. Summers in 1994 modified this procedure by developing a special osteotome technique and a set of instruments [5]. The osteotome set consists of matched and tapered hand instruments which create implant sites by widening the ridge and condensing the bone in lateral and apical directions. The tapered osteotomes allow for minimal heat generation, greater tactile sensitivity, faster and larger bone apposition by compressing the bone laterally and thus creating a denser interface for the implant to be placed [6, 7]. Numerous bone volume and defect classification systems have been proposed and developed. Characteristic bone volume changes after tooth loss were evaluated in the mandible by Atwood [8, 9]. A maxillary alveolar process of resorption following Atwood's description for mandible was presented by fallschussel in 1986 [10]. Another classification was proposed by cawood and howell [11]. The dental implant approach to different volumes is more specific than the Atwood classification permits, and as such, several bone volume classifications for implant dentistry have been developed. Weiss and Judy developed a classification of mandibular atrophy and its influence on subperiosteal implant therapy in 1974 [12]. Louisiana state university and kent presented a classification of alveolar ridge deficiency designed for alloplastic bone augmentation in 1982 [13]. Another classification was proposed by zarb and lekholm in 1985 for residual jaw morphology with the insertion of Branemark fixtures [14]. In 1985 misch and judy established four basic divisions of alveolar bone for implant dentistry in the maxilla and mandible, which follow the natural resorption phenomena represented by Atwood [15, 16]. In this study, the classification by Misch and Judy in 1985 had been selected. Alveolar ridge defects are classified according to their three-dimensional morphology form, severity, and extent [17]. A defect limited exclusively to the Bucco-lingual direction with normal ridge height has been classified as a class I or class B defect. A bone loss running in the apical-coronal direction only was described as a class II or class A defect. The defect that exists in both axes, i.e., a combined vertical and horizontal defect, has been characterized as a class III or class C defect and has a combination Bucco-lingual and apical-coronal resorption of alveolar bone resulting in loss of ridge height and width [18,19]. The extent of alveolar ridge defect considered mild if less than 4 mm, moderate when 3 to 6 mm, and extensive when greater than 6 mm17. Various bone augmentation techniques have been employed to reconstruct these different ridge defects. The predictability of the augmentation procedures depends on the horizontal and vertical extents of the defect. The purpose of this study was to analyze the use of the osteotome technique, followed by immediate implant placement, using cases presenting different conditions as dento-alveolar bony defects and to define management solutions in the event of existing bone resorption.


**Figure 1:** Defect limited exclusively to the bucco-lingual direction with concavity due to bone loss.

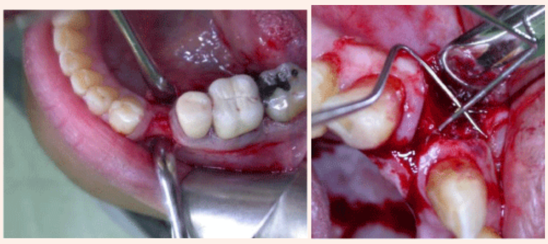

**Figure 2:** A full-thickness flap was elevated using a mid-crestal incision and 2 buccal and palatal releasing incisions with the amount of bone resorption vertically in mm using Peri-Prop.

**Figure 3:** Osteo-condensation with series of bone expansion devices with a cylindrical instruments and tapered tip and an appropriate diameter to widen the implant bed.

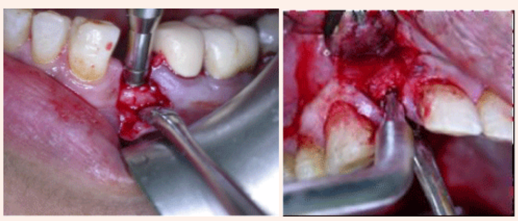

**Figure 4:** The osteotomes were inserted and removed along a straight path and mesiodistal direction to reduce the stress on the buccal and lingual bone plate.

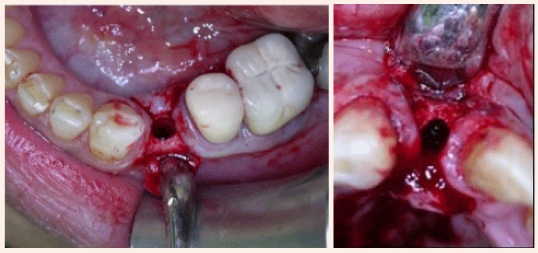

**Figure 5:** After the final diameter of the implant bed was established and the crestal bone thickness reached 6.35 mm or more, based on the implant diameter and consider a minimum of 1 mm of bone around the implant.

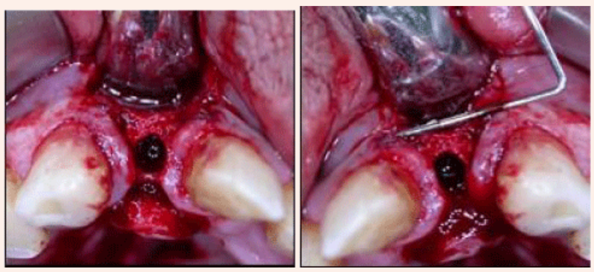

**Figure 6:** A split of the labial bone plate with osteotome kit and the crestal bone thickness reached 6.35 mm or more, based on the implant diameter and consider a minimum of 1 mm of bone around the implant.

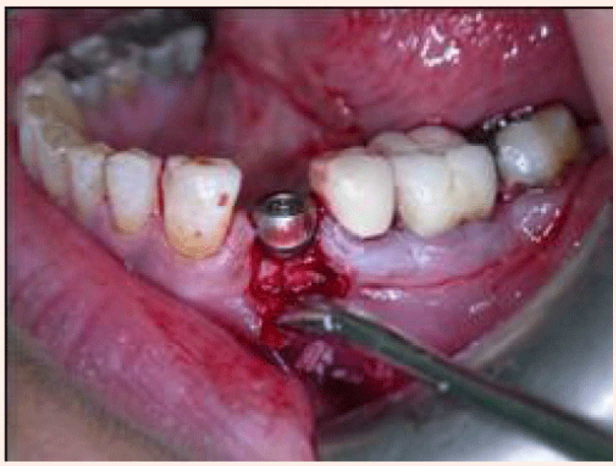

**Figure 7:** Endosseous implant was immediately placed after the bone expansion was completed for posterior area

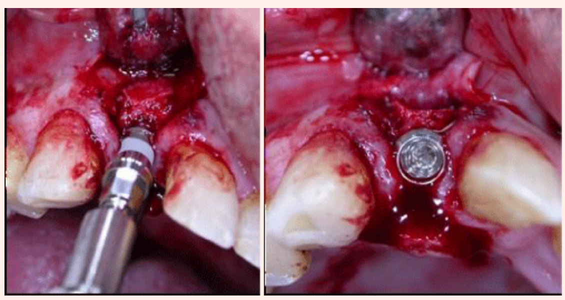

**Figure 8:** Endosseous implant was immediately placed after the bone expansion was completed for anterior area.

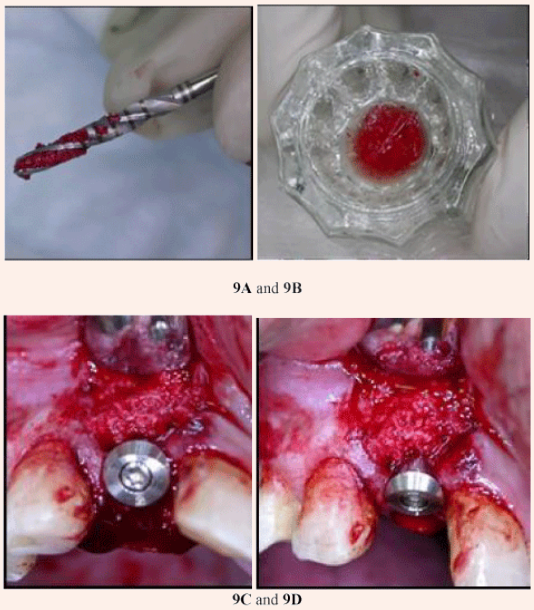


**Figure 9:** Autogenous bone graft can be taking from the same implant socket (9A), collected in surgical dapping dish (9B), and the autogenous bone graft was used to fill the gap after osteotome technique with immediate implant placement (9C, and 9D).

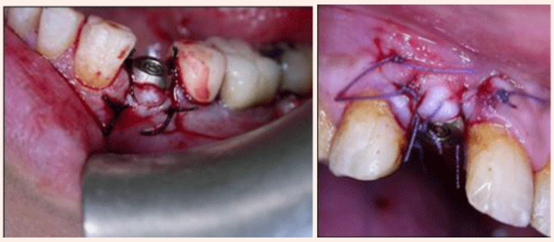

**Figure 10:** Surgical site was closed using 4-0 silk suture.


**Figure 11:** The amount of bone expansion achieved and good esthetic results obtained.

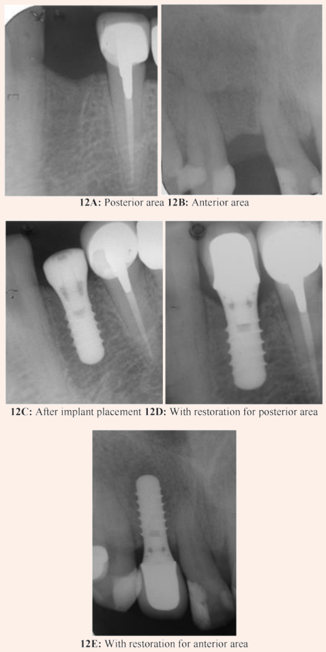


**Figure 12:** Periapical X-ray had been taken before, and after implant placement (12A–12C), and one-year of implant's functional loading which showed the amount of marginal bone level, one-year of implant's functional loading (12D, and 12E).

**Figure 13:** Surgical site was closed using 4-0 silk suture.

## Materials and Methods

Twenty patients, 9 males and 11 females (aged between 30–50 years old), were selected and treated with bone expansion by means of osteotome technique, followed by single immediate implant placement were placed either in the maxillary or mandibular regions. In all cases, the teeth for these patients had been extracted 3–8 years ago. the patients were currently wearing an acrylic resin removable partial denture. The patients desired an implant-supported restoration. The patients were offered the option of block-graft augmentation by taking bone either from the chin, the mandibular ramus, or maxillary tuberosity, then waiting approximately 4 months to 6 months, followed by implant placement. Then, the patients would possibly have to wait for another 2 months prior to final uncover and prosthetic restoration. This was unacceptable to these patients. The second option was to try placement of dental implants by lateral bone condensing and expansion for dental implant placement by means of osteotomes technique. These patients chose the second option due to reduce timed but wanted to avoid any bone grafting procedure. Osteotome technique was required for ridge expansion due to local alveolar non space-maintaining ridge defects and knife edge ridge configurations at the planned implant site caused by traumatic tooth removal, and loss of teeth following progressive periodontitis. Bone expansion was required due to bone resorption, to achieve satisfactory conditions for the placement of implants with diameters chosen according to the treatment plan. The indications were crestal thickness ranging from 2.9 to 4.1 mm and A defect limited exclusively to the Bucco-lingual direction with normal ridge height which had been classified as a class I or class B defect. For the purpose of analysis, different parameters were chosen and recorded for each case, including patient age and gender, implant positions, initial and final bone widths measurements, marginal bone resorption, and additional particulars or other procedure requirements. The pre-operative and post-operative radiographs taken immediately after implant insertion, and 1 year after restoration and functional loading of the implants. The implant shoulder and the alveolar crest were used as reference points radiographically. The length of the transmucosal conical smooth portion of the ITI implants was subtracted from the distance between the implant shoulder and the crestal bone level. Measurements of the distance between two reference points were performed to estimate the amount of marginal bone resorption radiographically. The gingival margin for the adjacent teeth had been used as reference points for the estimation of gingival margin for the restored implant one-year after implant's functional loading.

Clinical exam for cases # 6 and 16 revealed significant buccal and labial concavity due to bone loss (Figures 1A, and 1B).

In cases with poor remaining bone conditions, after implant insertion, guided bone regeneration (GBR) will be appropriate managements for such cases with autogenous bone graft that had been taken and collected from the implant socket by the pilot drill which is designed to collect that amount of bone during the preparation of the implant socket to correct bone contour defects (Figures 9A–9D).

Resorbable collagen membranes were covered all GBR areas then, primary wound closure was achieved after mobilization of the full thickness flap. Surgical site was closed using 4-0 silk suture (Figures 10 A, and 10B). The patients were advised to take Amoxicillin 500 mg cap 8 hourly along with analgesics and chlorhexidine mouthwash twice daily for 7 days. Sutures were removed after 7-10 days. Six weeks post-surgery showed good soft-tissue healing (Figures 11A, and 11B). Periapical X-ray had been taken before, after implants placements, and one-year of implant's functional loading which showed the amount of bone resorption one-year of implant's functional loading (Figures 12A–12E). The marginal bone level for the restored implants one-year after implant's functional loading were estimated on the periapical X-ray, by using the marginal bone level for adjacent teeth as reference points (Figures 12A–12E). The final implant-supported crown was inserted 4 weeks later (Figures 13A, and 13B).

## Results

The data obtained for all 20 cases are presented in Table 1. Age of patients ranged from 30 to 47, and 11 patients (55%) were female. Only 7 cases (35%) required the use of autogenous bone grafts to increase the ridge widening after immediate implant placement. In two of these cases, the bone expansions were performed together with splitting of the bone from the labial side of the bone defect with immediate implant placement, to improve the bone conditions, aiming at later rehabilitation of the site (case # 16, and 19). The bone expansion proved useful even in the case of an immediate implant placed after bone splitting with initial stability of these implants. There was no implant loss in any of the 20 cases described, because all of them were osseointegrated on their last evaluation. No other surgery complications related to any of the bone splitting or autogenous grafts used or to implant placement were presented. Nine cases (45%) involved an esthetic region, if the esthetic zone area were considered to upper bilateral 2nd premolars. The gingival margin for the restored implants one-year after implant's functional loading were estimated, by using the gingival margin for adjacent teeth as reference points. There was gingival recession at some area of the some of restored implants with crowns one year after implant's functional loading, were the soft tissues were thin but did not affect the esthetic outcome for the gingival margin and did not appear to be significant for esthetic satisfaction from the patients' standpoint. There was marginal bone resorption within the normal range of bone remodeling 1 year after implant's loading function. The mean marginal bone resorption for the maxilla (1.215 mm) compared to mandible (1.566 mm). More Bone resorptions were recorded due to the implants were inserted more than the coated surfaces for some cases. For the mandibular cases, despite greater bone resistance, it may be possible to reach satisfactory bone expansion in these sites with non-traumatic expanders, thus allowing placement of implants with planned diameters. For the cases with autogenous bone graft, the amount of bone grafts was calculated by subtracted the bone expansion from the final bone width.

## Discussion

Dental implants are becoming the only predictable alternative treatment for many clinical situations, and their long-term success over time has been well established [20]. Thus, continuous efforts have been made to develop "tissue compatible" implants, which are compatible with the surrounding host tissues to assure the development of a bone metal interface. In addition, different researches were introduced to improve bone density and the quality of the implant site to obtain higher osseointegration percentages [21-26]. In the present study, the Straumann implant (ITI Dental Implant System) fixtures were used, which are sand blasted and acid etched. According to marinucci et al & others [27-32] this surface treatment is biocompatible, allowing the attachment, proliferation and differentiation of osteoblasts, thus optimizing osseointegration and enhancing the clinical

| Case Number | Gender | Age | Implant position | Use of Autogenous Bone Grafts | Initial Bone Width (mm) | Final bone width (mm) | Bone expansion (mm) | Marginal bone resorption (mm)-one year after implant's loading | Gingival margin for restored implant-one year after implant's loading |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Female | 32 | Lower Right 1st premolar | No | 3.4 | 6.2 | 2.8 | 1.6 | Same as adjacent teeth |
| 2 | Male | 39 | Lower Left 2nd premolar | Yes | 3.6 | 6.9 | 2 | 1.7 | -0.5 |
| 3 | Male | 44 | Lower Left 1st molar | No | 3.8 | 8 | 4.2 | 1.5 | Same as adjacent teeth |
| 4 | Female | 30 | Lower Right lateral Incisor | Yes | 2.8 | 5.8 | 2.2 | 1,45 | -0.3 |
| 5 | Female | 41 | Lower Right 2nd premolar | no | 3.2 | 6.3 | 3.1 | 1,5 | Same as adjacent teeth |
| 6 | Female | 33 | Lower Left 1st premolar | No | 2.7 | 6.2 | 3.5 | 1,4 | -0.2 |
| 7 | Male | 45 | Lower Left 2nd premolar | Yes | 3.5 | 6.2 | 2.1 | 1.8 | Same as adjacent teeth |
| 8 | Female | 38 | Lower Right 1st molar | No | 4.1 | 7.1 | 3 | 1.81 | -0.4 |
| 9 | Male | 36 | Lower Left central Incisor | Yes | 3 | 6.4 | 3 | 1.4 | Same as adjacent teeth |
| 10 | Female | 34 | Lower Right 1st premolar | No | 3.7 | 6.7 | 3 | 1.5 | -0.3 |
| 11 | Male | 42 | Upper Left 1st Molar | No | 3.9 | 8.1 | 4.2 | 1.1 | Same as adjacent teeth |
| 12 | Female | 34 | Upper Right Central Incisor | No | 2.9 | 6.8 | 3.9 | 1.2 | Same as adjacent teeth |
| 13 | Female | 44 | Upper Right 2nd premolar | No | 3.2 | 6.4 | 3.2 | 1.25 | -0.3 |
| 14 | Male | 36 | Upper Left 1st premolar | Yes | 3.4 | 6.7 | 3.2 | 1.2 | -0.5 |
| 15 | Male | 39 | Upper Left 2nd premolar | No | 4 | 6.6 | 2.6 | 1.5 | Same as adjacent teeth |
| 16 | Male | 35 | Upper Left lateral Incisor | Yes | 2.7 | 6.5 | 3.3 | 1.1 | -0.6 |
| 17 | Female | 35 | Upper Left 1st premolar | No | 3.4 | 6.4 | 3 | 1.35 | Same as adjacent teeth |
| 18 | Female | 37 | Upper Right 2nd premolar | No | 3.3 | 6.9 | 3.6 | 0.9 | Same as adjacent teeth |
| 19 | Female | 47 | Upper Right lateral Incisor | No | 3.1 | 6.3 | 3.2 | 0.95 | -0.4 |
| 20 | Male | 38 | Upper Left 1st premolar | Yes | 3.2 | 6.7 | 3.1 | 1.6 | Same as adjacent teeth |

function of implants. In addition, the compression of bone to improve bone density has been successfully utilized in reconstructive surgery [33]. With modifications, this method has been introduced to dental Implantology [34]. The use of the osteotome technique has been investigated in clinical studies with emphasis given on the survival rate of the implants [35-39]. This is in accordance with Ernesto & Anitua [40], where they reported that previously complex sites having narrow buccolingual width that needed ridge augmentation prior to implant placement with the subsequent hazards of bone grafts and membranes, can be treated with one stage approach provided that adequate stability is achieved. A low speed, high torque hand piece was used in all of these cases during the cortical perforation only. The osteotomy site was then prepared with osteotomes eliminating the need for bone drilling with the possibility of overheating. This is in accordance with Brisman [41] who stated that the overheating of bone during preparation of the implant site can lead to bone necrosis, interfacial formation of connective tissue between bone and implant, loss of osseointegration and consequently loosening of the implant. Clinically, the present work demonstrated, none of the implants showed infection or mobility. In addition to thread engagement, body design and surface roughness help to provide a frictional interface with the receptor site, this in turn, will assist in mechanical retention by facilitating bone ingrowths during osseointegration [42]. Numerous investigators have reported that SLA rough surfaces of the ITI implants, obtain a stronger bone anchorage when compared with smooth titanium surface and can also positively influence cellular and tissue responses to implants [43-47]. A positive correlation exists between implant surface roughness and the degree of initial and long-term mechanical fixation [42, 48]. The macro and micro roughness, and the performance of the rough SLA surface is superior to smooth surfaces with respect to bone contact levels, removal torques and micro-texture (due to the acid etching) of the implant. It has been found to osseointegrate even under immediate, full occlusal loading conditions [49-51].

Different studies showed an animal histologic study compared the osteotome technique to conventional implant placement with burs in 52 New Zealand white rabbits using 104 implants placed in the distal femoral condyles [52]. The implants were studied after 2, 4, and 8 weeks of placement. The authors concluded that the osteotome technique increases new bone formation and leads to an enhanced osseointegration of dental implants in trabecular bone. In a multicenter study, this technique has shown success rates as high as 96% [53]. Another recent study evaluated sinus elevation along with the osteotome technique in a longitudinal radiographic study and concluded that the osteotome technique represents a substantially less-invasive alternative for predictable implant installation in maxilla. Different studies showed the limitation of the osteotome technique compare to microdent threaded expanders [54, and 55] that it is mainly designed for the maxilla. With the limitation of this study and as analysis of 20 cases in almost one year of functional loading of the restored implants, the osteotome technique with the design and surface characteristics of the SLA ITI, provide a number of advantages as there is marked decrease in the need to graft ridges, allow for greater tactile sensitivity, less surgical time for surgeons with much less cost to the patient. It is a safe and effective mean of widening thin ridges that can be performed under local anesthesia. Also, it includes no thermal injury to the bone during implant osteotomy, thus eliminating the harmful role of heat production in subsequent bone healing [56]. In our study, we did not record any clinical complications for all of the 20 cases either at the maxilla or the mandible. Based on all of these excellent descriptions, Osteotomes can offer several significant advantages over the traditional graded series of drills [57]:

1. Drilling removes bone. When adequate quantities of dense bone are available, this is not a problem. But when the alveolar bone is compromised in quality or quantity, the need is to preserve the remaining bone and improve its quality. This technique retains the total bone mass.

2. It is an alternative to block grafting in select cases to increase the ridge width for implant placement.

3. Allows immediate placement of implants in narrow ridges at the time of expansion.

4. Osteotomes take advantage of the fact that bone is viscoelastic and can be compressed and manipulated. Compression creates a denser bony interface with increased bone to implant contact and therefore good initial stabilization of the dental implant.

5. Heat is a major detriment to osseointegration, but the osteotome technique is an essentially heatless and therefore should not destroy the viable bone-forming cells.

6. This technique also allows for greater tactile sensitivity.

7. It is minimally invasive and cost effective.

8. Faster prosthetic restoration is possible.

Buchter et al [34] compared the influence of the osteotome technique on the osseointegration and biomechanical behavior of cylinder implants (SLA, ITIs) with a conventional preparation of the implant site in an animal mode (six Gottingen minipigs). They conclude that the decreased implant stability by using the osteotome technique is based on microfractures in peri-implant bone. Therefore, Considerable care needs to be taken in their use due to the possibility of uncertain amount and direction of force being exerted towards the apex. From our study we found out that the mean marginal bone resorption for maxilla after one year of functional loading were less than the mean of marginal bone resorption for mandible which insured what strietzel et al. [58] reported in there study that the use of the osteotome technique in good quality bone (types 1 and 2) produces more bone resorption than the standard technique. This may be due to the higher forces for bone compression applied in the compact bone. If much force is used to insert implants, the trauma on the bone will cause more bone resorption and osseointegration will take more time [59]. Further investigation with a larger sample over longer period of time is necessary before a definite conclusion can be reached on a comparison of alveolar regeneration of the mandible and maxilla. Finally, we would like to remark that actually implant surface is as much important as the surgical technique in clinical survival rate. Experimental data showed that new implant surfaces, such as the SLA (Sandblasted, Large grit and Acid etched), promote greater osseous contact at earlier time points [60-62]. Due to the amount of bone resorption for this study we can figure out the importance of atraumatic tooth extraction and immediate or early implant placement into extracted socket.

Small and Tarnow, found that recession occurred in most of the implant restorations during the first 3 months following abutment connection surgery [63]. The majority of recession (80%) occurred on the buccal aspects with the mean recession of 0.9 mm and more pronounced in maxillary teeth. Oates et al, studied the mucosal recession in maxillary and mandibular anterior implants over 2 years [64]. They found the mean recession of 0.6 mm. Sixty percent of the implants showed recession 1 mm. Jemt et al, retrospectively examined the study casts of 23 patients who received single implant restorations in the anterior maxilla for an average of 15 years [65]. They found that the implant clinical crowns were an average 0.6-1.04 mm longer than the contralateral teeth. Seventeen percent of the implant crowns showed recession 1 mm. Suphanantachat S, et al reported in their study that patients were highly satisfied with the outcome of their single-tooth anterior maxillary implants. Clinicians, however, showed lower degree of satisfaction than patients. And they reported also, facial marginal recession, which is considered critical for esthetic satisfaction by clinicians, did not appear to be significant for esthetic satisfaction from the patients' standpoint [66-68].

## Conclusion

The present of series of 20 cases and with the limitation of this study in almost one year of functional loading of the restored implants, the osteotome technique provides a number of advantages as there is marked decrease in the need to graft ridges, allow for greater tactile sensitivity, less surgical time for surgeons with much less cost to the patient. It is a safe and effective mean of widening thin ridges that can be performed under local anesthesia. Also, it includes no thermal injury to the bone during implant osteotomy, thus eliminating the harmful role of heat production in subsequent bone healing. This study did not record any clinical complications for all of the 20 cases either at the maxilla or the mandible. However, further investigations including a large number of patients and considering long-term evaluation of peri-implant alveolar loss bone are necessary to enhance the power of the conclusions concerning use and predictability of osteotome technique.

## Conflicts of interest

None

## Funding

None

## References

1. McAllister BS, Haghighat K (2007) Bone augmentation techniques. J Periodontol 78(3): 377-396.
2. Engelke W, Diederichs C, Jacobs H, Deckwer I (1997) Alveolar reconstruction with splitting osteotomy and microfixation of implants. International Journal of Oral Maxillofacial Implants 12(3): 310-318.
3. Attanasio F, Antonelli A, Brancaccio Y, Averta F, Figliuzzi MM, Fortunato L, Giudice A (2020). Primary Stability of Three Different Osteotomy Techniques in Medullary Bone: An in Vitro Study. Dent J (Basel) 8(1): 21.
4. Nishioka RS, Souza FA (2009) Bone spreader technique: a preliminary 3-year study. J Oral Implantol 35(6): 289-294.
5. Summers RB (1994b) The osteotome technique. Part 2a the ridge expansion osteotomy (REO) procedure. Compendium of Continuing Education in Dentistry 15(4): 422-434.
6. Stavropoulos A, Nyengaard JR, Lang NP, Karring T (2008) Immediate loading of single SLA implants: Drilling vs. osteotomes for the preparation of the implant site. Clin Oral Implants Research 19: 55-65.
7. Hahn J (1999) Clinical uses of osteotomes. J Oral Implantol 25: 23-29.
8. Atwood DA (1963) Postextraction changes in the adult mandible as illustrated by microradiographs of midsagittal sections and serial cephalometric roentgenograms. J Prothet Dent 13: 810-824.
9. Atwood DA, Coy WA (1971) Clinical, cephalometric and densitometric study reduction of residual ridges, J Prothet Dent 26: 280-295.
10. Fallschussel GKH (1986) Untersuchungen zur anatomic deszahntosen Oberkiefers. Z Zahnarztl Implantol 2: 64-72.

11. Cawood JJ, Howell RA (1988) A classification of the edentulous jaw's classes. Int J Oral Maxillo Surg 17: 232-279.

12. Weiss CM, Judy KWM (1974) Sever mandibular atrophy: biological considerations of routine treatment with complete subperiosteal implant. J Oral Implant 4: 431-469.

13. Kent JN (1982) Correction of alveolar ridge deficiencies with non-resorbable hydroxyapatite. J AM Dent Assoc 105(6): 99-100.

14. Lekholm U, Zarb G (1985) Patient selection and preparation. In: Branemark PI, Zarb GA, Albrektsson T (editors): Tissue integrated prostheses: osseointegration in clinical dentistry. Chicago, Quintessence pulp Co, pp 199-209.

15. Misch CE (1985) Treatment planning and implant dentistry (abstract), Misch Implant Institute Manual, Dearborn, Misch, USA.

16. Misch CE (1990) Divisions of available bone in implant dentistry. Int J Oral Implant 7: 9-17.

17. Studer S, Naef R, Scharer P (1997) Adjustment of localized alveolar ridge defects by soft tissue transplantation to improve mucogingival esthetics: a proposal for clinical classification and an evaluation of procedures. Quintessence Int 28(12): 785-805.

18. Seibert JS (1983) Reconstruction of deformed, partially edentulous ridges, using full thickness onlay grafts. Part II. Prosthetic/periodontal interrelationships. Compend Contin Educ Dent (Lawrenceville) 4: 549-562.

19. Allen EP, Gainza CS, Farthing GG, Newbold DA (1985) Improved technique for localized ridge augmentation. A report of 21 cases. J Periodontol 56(4): 195-199.

20. El-Askary A (2003) Introduction, A. Reconstructive esthetic implant surgery. (1st edn) Ch. 1, Wiley-Blackwell publishing co, USA.

21. Lundgren D, Sennerby L, Lundgren AK (1995) The effect of mechanical intervention on jaw bone density: An experimental study in the rabbit. Clin Oral Implants Research 6: 54-60.

22. Nkenke E, Kloss F, Wiltfang J, Schultze-Mosgau S, Radespiel-Tröger M, et al. (2002) Histomorphometric and fluorescence microscopic analysis of bone remodeling after installation of implants using an osteotomy technique. Clin Oral Implants Research 13(6): 595-602.

23. Misch CE, Wang H, Misch M, Sharawy M, Lemons J, et al (2004) Rational for the application of immediate load in implant dentistry. Implant Dent 13(4): 207-217.

24. Brånemark PI (1983) Osseointegration and its experimental studies. J Prosthet Dent 50(3): 399-410.

25. Davarpanah M, Martinez H, Tecucianu JF, Hage G, Lazzara R (2001) The modified osteotome technique. Int J Periodontics Rest Dent 21: 599-607.

26. Matsumoto H, Ochi M, Abiko Y, Hirose Y, Kaku T, et al. (2000) Pulsed electromagnetic fields promote bone formation around dental implants inserted into the femur of rabbits. Clin Oral Implants Research 11(4): 354-360.

27. Marinucci L, Balloni S, Becchetti E, Belcastro S, Guerra M, et al (2006) Effect of titanium surface roughness on human osteoblast proliferation and gene expression in vitro. Int J Oral Maxillofac Implants 21(5): 719-725.

28. Grognard N, Verleye G, Mavreas D, Vande-Vannet B (2017) Updated secondary implant stability data of two dental implant systems. A retrospective cohort studies. J Clin Exp Dent 9(9): e1121-e1128.

29. Butz E, Aita H, Wang CJ, Ogawa T (2006) Harder and stiffer bone osseointegrated to roughened titanium. J Dent Res 85(6): 560-565.

30. Cooper L (2000) A role for surface topography in creating and maintaining bone at titanium endosseous implants. J Prosthet Dent 84(5): 522-543.

31. Borsari V, Giavaresi G, Fini M (2005) Comparative in vitro study on an ultra-high roughness and dense titanium coating. Biomater 26(24): 4948-4955.

32. Alberktsson T, Wennerberg A (2004) Oral implant surfaces: Part 2 review focusing on clinical knowledge of different surfaces. Int J Prosthod 17(5): 544-564.

33. Giavaresi G, Fini M, Cigada A, Rimondini L, Giordino R (2003) Histomorphometric and microhardness assessment of sheep cortical bone surrounding titanium implants with different surface treatments. J Biomedical Mater Res 67(1): 112-120.

34. Büchter A, Kleinheinz J, Wiesmann HP, Kersken J, Nienkemper M, et al. (2005) Biological and biomechanical evaluation of bone remodelling and implant stability after using an osteotome technique. Clin Oral Implants Res 16(1): 1-8.

35. Elghobashy MTM, Shaaban AM, Melek LNF (2023) Radiographic comparison between Densah burs and osteotome for graftless internal sinus lifting with simultaneous implant placement: a randomized clinical trial. Int J Oral Maxillofac Surg 52(3): 388-395.

36. Glauser G, Naef, R, Schärer P (1998) The osteotome technique a different method of implant placement in the posterior maxilla. Implantol 2: 103-120.

37. Komarnyckyj OG, London RM (1998) Osteotome single-stage dental implant placement with and without sinus elevation: a clinical report. Int J Oral Maxillofac Implants 13(6): 799-804.

38. Zitzmann NU, Schärer P (1998) Sinus elevation procedures in the resorbed posterior maxilla. Comparison of the crestal and lateral approaches. Oral Surg Oral Med Oral Pathol Oral Radiol Endo 85(1): 8-17.

39. Fugazzotto PA (1999) Sinus floor augmentation at the time of maxillary molar extraction: technique and report of preliminary results. Int J Oral Maxillofac Implants 14: 536-542.

40. Rosen RP, Summers R, Mellado JR, Salkin LM, Shanaman RH, et al (1999) The bone-added osteotome sinus floor elevation technique: multicenter retrospective report of consecutively treated patients. Int J Oral Maxillofac Implants 14(6): 853-858.

41. Silverstein LH, Kurtzman GM, Moskowitz E, Kurtzman D, Hahn J (1999) Aesthetic enhancement of anterior dental implants with the use of tapered osteotomes and of soft tissue manipulation. J Oral Implantol 25(1): 18-22.

42. Lee Ernesto A, Anitua E (1996) Atraumatic ridge expansion and implant site preparation with bone expanders. Pract Proced Aesthet Dent 18(1): 17-22.

43. Brisman EL (1996) The effect of speed, pressure and time on bone temperature during the drilling of implant sites. Int J Oral Maxillofac Implants 11(1): 35-37.

44. Skalak R, Zhao Y (2000) Interaction of force-fitting and surface roughness of implants. Clin Implant Dent Relat Res 2(4): 219-234.

45. Wilke HJ, Claes L, Steinemann S (1990) The influence of various titanium surfaces on the interface shear strength between implants and bone. Advances of Biomaterials 9: 309-311.

46. Buser D, Schenk RK, Steinemann S, Fiorellini JP, Fox CH, et al (1991) Influence of surface characteristics on bone integration of titanium implants. Histomorphometric study in miniature pigs. Journal of Biomedical Materials Res 25(7): 889-902.

47. Buser D, Nydegger T, Oxland T, Cochran D L, Schenk R K, et al (1999) Interface shear strength of titanium implants with a sandblasted and acid-etched surface: A biomechanical study in the maxilla of miniature Pigs. Journal of Biomedical Materials Res 45(2): 75-83.

48. Cochran DL (1999) A comparison of endosseous dental implant surfaces. Journal of Periodontology 70(12): 1523-1539.

49. Buser D, Mericske-Stern R, Bernard JP, Behneke A, Behneke N, et al. (1997) Long term evaluation of non-submerged ITI Implants. Clinical Oral Implants Res 8(3): 161-172.

50. Rosenlicht JL (2002) Swiss Plus implant system. Part 1: Surgical aspects and inter-system comparisons. Implant Dent 11(2): 1440153.

51. Cochran DL, Schenk RK, Lussi A, Higginbottom FL, Buser D (1998) Bone response to unloaded and loaded titanium implants with a sand-blasted and acid-etched surface: A histometric study in the canine mandible. J Biomed Mater Res 40(1): 1-11.

52. Li D, Ferguson SJ, Beutler T, Cochran DL, Sittig C, et al (2002) Biomechanical comparison of the sandblasted and acid-etched and the machined and acid-etched titanium surface for dental implants. J Biomed Mater Res 60(2): 325-332.

53. Bornstein MM, Lussi A, Schmid B, Belser UC, Buser D (2003) Early loading of non-submerged titanium implants with a sandblasted and acid-etched (SLA) surface: 3-year results of a prospective study in partially edentulous patients. Int J Oral Maxillofac Implants 18(5): 659-666.

54. Nkenke E, Kloss F, Wiltfang J, Schultze-Mosgau S, Radespiel-Tröger M, et al. (2002) Histomorphometric and fluorescence microscopic analysis of bone remodeling after installation of implants using an osteotome technique. Clin Oral Implants Res 13(6): 595-602.

55. Rosen PS, Summers R, Mellado JR, Salkin LM, Shanaman RH, et al. (1999) The bone added osteotome sinus floor elevation technique: multicenter retrospective report of consecutive treated patients. Int J Oral Maxillofac Implants 14(6): 853-858.

56. Siddiqui AA, Sosovicka M (2006) Lateral bone condensing and expansion for placement of endosseous implants: A new technique. Journal of Oral Implantology 32(2): 87-94.

57. Anitua Aldecoa E (2004) BTI: New process for drilling, placing implants and obtaining autogenous bone. Dental Dialogue Enero 19: 4-15.

58. Rodriguez JG, Ortuño EF, Marin BG, Erhardt MCG (2006) Actualización de conceptos. Nuevas tecnologías. Redefinición tridimensionalen rehabilitaciones Implanto soportadas 10: 150-168.

59. Dennis Flanagan (2002) Cortical Bone Spreader Osteotome and Method for Dental Implant Placement; Journal of Oral Implantology 28(6): 295-296.

60. Strietzel FP, Nowak M, Chler K, I Friedmann (2002) A Peri-implant alveolar bone loss with respect to bone quality after use of the osteotome technique. Results of a retrospective study. Clinical Oral Implants Res 13(5): 508-513.

61. Abrahamsson I, Berglundh T, Linder E, Lang NP, Lindhe J (2004) Early bone formation adjacent to rough and turned endosseous implant surfaces. An experimental study in the dog. Clinical Oral Implants Res 15(4): 381-392.

62. Cochran DL, Schenk RK, Lussi A, Higginbottom FL, Buser D (1998) Bone response to unloaded and loaded titanium implants with a sandblasted and acid-etched surface: a histometric study in the canine mandible. Journal of Biomedical Material Res 40(1): 1-11.

63. Szmukler-Moncler S, Perrin D, Ahossi V, Magnin G, Bernard JP (2004) Biological properties of acid etched titanium implants: effect of sandblasting on bone anchorage. J Biomed Mater Res B Appl Biomater 68(2): 149-159.

64. Shalabi MM, Wolke JG, de Ruijter AJ, Jansen JA (2007) A mechanical evaluation of implants placed with different surgical techniques into the trabecular bone of goats. Journal of Oral Implantology 33(2): 51-58.

65. Small PN, Tarnow DP (2000) Gingival recession around implants: a 1-year longitudinal prospective study. Int J Oral Maxillofac Implants 15(4): 527-532.

66. Oates TW, West J, Jones J, Kaiser D, Cochran DL (2002) Long-term changes in soft tissue height on the facial surface of dental implants. Implant Dent 11(3): 272-279.

67. Jemt T, Ahlberg G, Henriksson K, Bondevik O (2006) Changes of anterior clinical crown height in patients provided with single-implant restorations after more than 15 years of follow-up. Int J Prosthodont 19(5): 455-461.

68. Suphanantachat S, Thovanich K, Nisapakultorn K (2010) The effect of marginal recession around anterior maxillary implants on the esthetic satisfaction assessed by the patient and the clinician. CU Dent J 33: 1-14.