Journal of Advances in Medicine and Medical Research

33(11): 31-37, 2021; Article no.JAMMR.68539
ISSN: 2456-8899
(Past name: British Journal of Medicine and Medical Research, Past ISSN: 2231-0614, NLM ID: 101570965)

Evaluation of the Split-crest Technique with Simultaneous Implant Placement in Atrophic Edentulous Maxillary and Mandibular Bone: A 5-Year Follow-up Study

Houssam Abou Hamdan[1*], Georges Aoun[2], Jean Nassar[1] and Talal H. Salame[3]

[1]Department of Periodontology, Faculty of Dental Medicine, Lebanese University, Lebanon.
[2]Department of Oral Medicine and Maxillofacial Radiology, Faculty of Dental Medicine, Lebanese University, Lebanon.
[3]Department of Oral Rehabilitation, Faculty of Dentistry, University of Sydney, Australia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMMR/2021/v33i1130922
Editor(s):
(1) Dr. Ashish Anand, G. V. Montgomery Veteran Affairs Medical Center, USA and University of Mississippi Medical Center, USA and William Carey School of Osteopathic Medicine, USA.
Reviewers:
(1) Firas Abd Kati, Middle Technical University, Iraq.
(2) Bertrand Chew Shen, NUS, Singapore.
Complete Peer review History: http://www.sdiarticle4.com/review-history/68539

Case Study

Received 02 March 2021
Accepted 11 May 2021
Published 12 May 2021

ABSTRACT

Aim: To evaluate the behavior of the alveolar ridge split technique in a series of surgical cases.
Materials and Methods: One hundred and fifty implants were included in this study for a total of 60 patients. The surgeries consisted of a mid-crestal incision and subsequent bone management with a piezoelectric system. The implants were placed after the alveolar bone was expanded by about 3mm and present bony defects were filled by a mixture of 50% autogenous bone and a xenograft (Bio-Oss®). Bone fracture of the buccal alveolar plate occurred in 8 cases, and those were stabilized with osteosynthesis screws. Implants were simultaneously placed in 140 cases, out of them 4 failures occurred due to membrane exposition.
Results: The osseointegration success was estimated to be 97.5%.
Conclusion: This study concluded that the bone splitting/expansion seem to be a reliable,

**Corresponding author: E-mail: dr.h.abouhamdan@gmail.com;*

predictable, relatively noninvasive technique with limited intraoperative complications.
Clinical significance: The study revealed that the alveolar ridge split can be used as an effective technique for atrophic edentulous maxillary and mandibular bone

Keywords: Alveolar ridge split technique; bone atrophy; bone graft; dental implants; piezosurgery.

1. INTRODUCTION

Nowadays, dental implants are considered to be the most convenient treatment modality for edentulous patients and the implant surgery became more and more popular amongst dental surgeons. However, quality and volume of the hard and soft tissues need to be optimal to satisfy the goals of implant dentistry.

One of the most common problems that could face dentists is the rapid bone resorption of the alveolar ridge after natural tooth loss, in the medium and long terms [1]. Studies showed that about 80 % of anterior maxillary sextant need bone grafting [2]. Thus dental surgeons should be prepared to apply bone grafting during implant surgery.

Short implants could facilitate, up to certain limits, the management of vertical bone loss. They are associated with less morbidity than the vertical augmentations of alveolar bone [3]. Extra-short implants are also a viable treatment alternative [4].

Bone thickness on both the vestibular and the lingual or palatal sides of the alveolar ridge should be greater by 1.5mm than the implant diameter. In addition, if the alveolar width is less than 6 mm, transversal bone augmentation is generally required to allow implant placement [5].

Ridge augmentation could be achieved by block graft, guided bone regeneration (GBR), distraction osteogenesis and alveolar ridge split technique (ARST) or bone expansion.

The ARST or bone spreading has been introduced by Tatum in the 1970s [6]. In the 1990s, after multiple researches that demonstrated its efficiency, the ARST became popular (Simion et al. [7]; Scipioni et al. [8]; Summers et al. [9]). In 2000, Vercellotti et al. introduced piezosurgery, that made ARST easier and safer, the risk of complications, were reduced, when treating extreme atrophic crests [10].

In this study we documented and evaluated a sample of 160 implants, where horizontal ridge augmentation was applied using ARST with simultaneous placement of dental Implants.

2. MATERIALS AND METHODS

The study followed 60 patients (45 women and 15 men), between June 1, 2014 and July 1, 2019, aged between 36 and 68 years (mean age 54.2 ± 12.3 years). All patients were treated to restore partial or total edentulism (Fig. 1).

Only patients with no or controlled systemic diseases were selected. Smokers, alcoholics and patients with uncontrolled systemic diseases were excluded. Prior to each surgery, the alveolar ridge width, ranged between 3mm and 6 mm with 50.8% of the sites were less than 4 mm wide. Ridges inferior to 3mm were excluded because of lack of marrow bone, and of technical difficulties. A minimum of 1 mm of bone loss during the osteotomy will jeopardize the cortical bone. The minimum alveolar bone height was 8 mm. Sixty five percent of the sites were on the mandible. A total of 74 procedures of split ridge bone augmentation were performed using greenstick fracture of the buccal plate of the alveolar bone. One hundred and sixty implants were inserted afterwards right at the same session of ridge splitting or 12 weeks later depending on the ability of achieving a minimal primary stability after implant placement. In all patients, the Initial alveolar ridge width was measured using a periodontal probe before and after the procedure.

2.1 The Surgical Technique

All procedures were performed under local anesthesia. To expose the alveolar bone, full-thickness flaps were elevated on the vestibular side of the maxilla and on both the vestibular and the lingual sides of the alveolar bone of the mandible.

The ARST procedure was performed using a piezosurgery® touch unit (Mectron s.p.a., Genova, Italy) starting by three cuts for each site. A mid crestal 8mm to 10mm

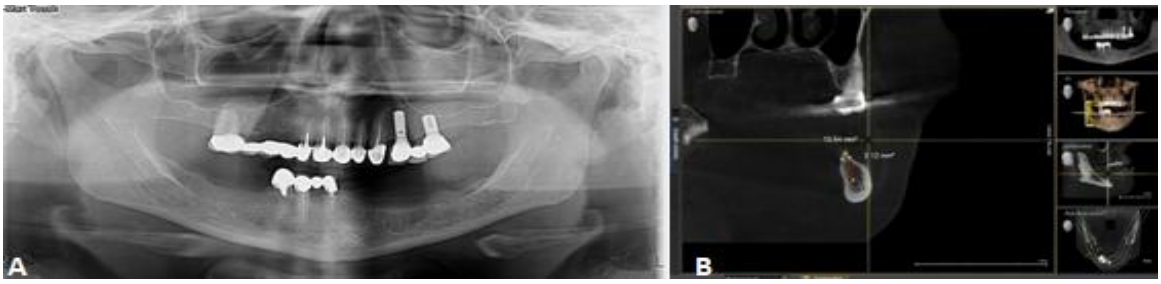

Fig. 1. The case of a 50-year-old female with a partially edentulous and severely resorbed mandible. A) Preoperative panoramic view; B) Cross-sectional view showing advanced horizontal bone resorption

deep cut on the top of the alveolar ridge and two mesial and distal discharge incisions were cut vertically on the buccal plate of the alveolar bone starting from the two extremities of the mid crestal cut. Those vertical discharge incisions were done 1.5mm away from any adjacent tooth and 3mm to 5mm away from the closest implant site. In the mandible, and since the bone is harder than the maxillary bone, a basal longitudinal discharge groove of partial width was performed to increase the resilience of the bony flap.

2.2 Implant Bed Preparation

In the first phase a pilot implant drill was utilized to indicate implant site, then ACE Osteotome Bone Expanders (Brockton, MA, USA) of increasing diameters were inserted into the implant site to gradually expand the vestibular bone flap and create the implant bed. The elastic nature of the bone was utilized; however, and after every sequential expander was introduced, it was kept in place for a moment and then removed delicately to maintain the bone resiliency. In the last stage, the final implant drill was used to finish the preparation of the implant bed.

2.3 Implants Placement

The implants were placed simultaneously, if a primary stability could be maintained otherwise a two-step approach was adopted where implants were placed in about 3 months after surgery. In the mandible, and due to its low bone elasticity, the buccal plate could become loose and the primary stability could be lost. In this case the mobile plate would be secured with two screws from the Straumann® bone block fixation kit (Basel, Switzerland) and the implant placement will be delayed for another three months.

A total of 80 Cowell Medi (USA Inc.) implants and 80 Bone Level Tapered (BLT) and Tissue Level Straumann® (Basel, Switzerland) implants were placed. A guided bone regeneration (GBR) procedure was performed on every implant using a mixture of 50% of autogenous bone and 50% of xenograft bone substitute (BIO-OSS® L); all defects were covered by a Jason® native pericardium collagen membrane (botiss biomaterials GmbH, Zossen, Germany) (Fig. 2).

Wounds were closed using a 4-0 PGA suture thread. A combination of horizontal mattress and O sutures were performed to insure the best wound closure. In case of crest width superior to 4 mm and the gap between the buccal and the lingual/palatal plate do not exceed 3 mm with a good primary stability, a healing abutment was placed. In case of a gap over 3 mm with a low primary stability, the implant was left to heal while submerged. Postoperative instructions were advised to all patients. Antibiotics (875mg of amoxicillin and 125mg of clavulanic acid twice a day) and analgesics were prescribed for 5 days and chlorhexidine mouthwash 0.2% for 2 weeks and sutures were removed after 14 days.

Table 1. Buser's criteria of success

Criteria of success
Absence of persistent subjective complaints such as pain, foreign body sensation and/or dysesthesia
Absence of peri-implant infection with suppuration
Absence of mobility
Absence of continuous radiolucency around the implant

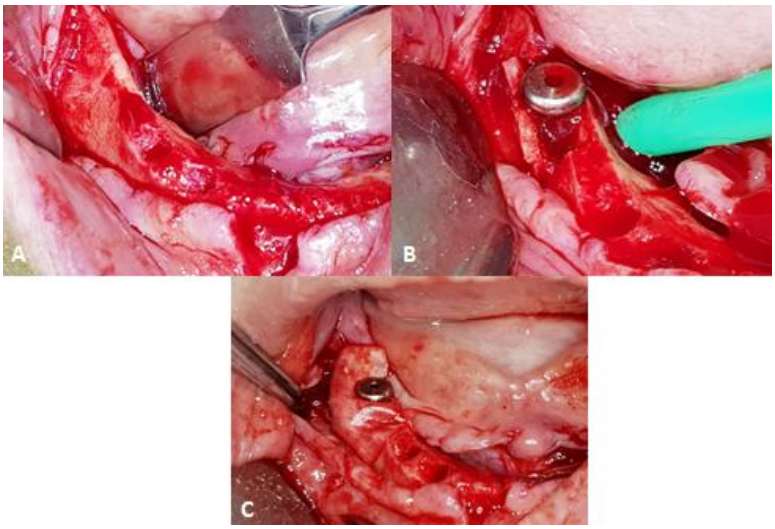

Fig. 2. The same case of the 50-year-old female with a partially edentulous and severely resorbed mandible. A) Occlusal view showing a 3 mm crest width; B) After bone splitting, immediate implant placement of a 6 mm Straumann® Standard Plus Implant; C) A collagen membrane covering the entire surgical site

2.4 Clinical Evaluation

Clinical follow-ups were performed after two weeks and three months, and a radiological follow-up with a cone beam CT scans were done one year and 5 years after the surgeries. Following Buser Criteria [11], factors that determined implant success were pain, mobility, infection, and radiolucency around the implant (Table 1).

3. RESULTS

During surgeries, eight vestibular plates were fractured and were stabilized with osteosynthesis screws using the bone block fixation kit (Straumann). Twenty implants were to be placed in a second stage surgery due to low primary stability.

Two membranes were found to be exposed during the first follow up session, and this led to cervical exposure and bone resorption on 4 implants. At the next follow-up session 6 weeks later, the implants at the exposed sites were removed and replaced immediately by shorter, 8 mm, implants. All failures occurred in the maxilla where the initial ridge width was about 3.0 mm. No complications were observed or reported afterwards.

The success rate of implants placed in the areas that were augmented using the ARST, in this study was estimated to be 97.5% (Fig. 3). No difference was found between implants placed simultaneously or in a two-step surgery. No difference found between implants with healing abutments and implants kept submerged for a second stage surgery. Implant location did not affect its success in any way.

Fig. 3. The same case of the 50-year-old female with a partially edentulous and severely resorbed mandible. A) A cross-sectional view 5 years after implant placement; B) A panoramic view 5 years after surgery

4. DISCUSSION

The ARST fulfills all requirements for best bone healing/regeneration of bony defects, such as minimal extent of bone loss, the presence of bony walls, the closed healing environment, the space provision and the mechanical wound stability [12].

A spongy bone should separate the buccal and palatal/lingual plates [13]. Therefore, the indications are more limited as compared to bone block graft and the guided bone regeneration [12]. In these conditions, the guided bone regeneration and the Lateral ridge split technique have demonstrated predictable results with a high success rate; ARST being a technique that allows the placement of implants in the same surgical act and allows maintaining the patient's cortical bone [14].

Similar to different systemic reviews [15-17], this study showed ARST as a one-stage alveolar ridge augmentation procedure could be a better alternative to the traditional two-stage horizontal grafting technique. It showed that ARST is more effective and predictable in gaining bone width, and that short term and long-term survival rates are higher for implants placed in both the maxilla and the mandible when following this technique.

Studies showed that the survival and success rates of implants placed in the expanded ridges using ARST are consistent with those of implants placed in native, non-reconstructed bone [13]. The reason for that could be that the gap created by sagittal osteotomy of the ridge undergoes spontaneous ossification, following a mechanism similar to that occurring in fractures [13]. By reducing the healing period, the ARST offers an important time and financial economy [18]. In this study, the survival rate of the placed implants was 97.5%, and it is similar to the rate obtained with standard implant placement procedures [13].

Additionally, a notable difference was observed when using the technique in the maxilla and in the mandible, as more alveolar plates were fractured in the mandible and this is consistent with the results obtained in other studies [13]. The cause for that could be that the alveolar ridge splitting in the mandibular bone may be more difficult to perform than in the maxillary bone due to the thicker less flexible cortical plate [13]. The drawbacks of this anatomical condition include greater difficulty in expanding the bone, the risk of a more invasive and more traumatic surgical procedure, and the risk of fracture of the buccal plate. In this study minimal resorption was observed after a considerable time following healing. This could be due the use of the guided bone regeneration procedure in combination to the ARST which could prevent the post-surgical resorption of the crestal bone in very narrow ridges as suggested by Ella et al. (2014) [19]. Their study showed that the lack of bone substitute resulted in significant resorption (~ 5%) of the thin crests (3-4 mm wide).The delayed lateral ridge expansion technique is more predictable and could be used more safely in patients with high bone quality and thick cortex and a narrower ridge in the mandible [20].

In analyzing osseointegration, we found no difference between simultaneous and late implant placement.

5. CONCLUSION

Our study demonstrated that the ARST is a predictable and effective bone augmentation procedure. The implant success rate was found to be 97.5%, as in the results existing in the literature. In comparison to other bone augmentation techniques, it allows the simultaneous implant placement and offers an important time and financial economy even in case of two-step surgery.

CONSENT

It’s not applicable.

ETHICAL APPROVAL

It’s not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chen ST, Wilson TG Jr, Hämmerle CH. Immediate or early placement of implants following tooth extraction: review of biologic basis, clinical procedures, and outcomes. Int J Oral Maxillofac Implants. 2004;19Suppl:12-25.

2. Cha HS, Kim JW, Hwang JH, Ahn KM. Frequency of bone graft in implant surgery. Maxillofac Plast Reconstr Surg. 2016;38(1):19.
   DOI: 10.1186/s40902-016-0064-2.
3. Karthikeyan I, Desai SR, Singh R. Short implants: A systematic review. J Indian Soc Periodontol. 2012;16(3):302-312.
   DOI: 10.4103/0972-124X.100901.
4. Ravidà A, Barootchi S, Askar H, Suárez-López Del Amo F, Tavelli L, Wang HL. Long-Term Effectiveness of Extra-Short (≤ 6 mm) Dental Implants: A Systematic Review. Int J Oral Maxillofac Implants. 2019;34(1):68-84.
   DOI: 10.11607/jomi.6893.
5. Buser D, Martin W, Belser UC. Optimizing esthetics for implant restorations in the anterior maxilla: Anatomic and surgical considerations. Int J Oral Maxillofac Implants. 2004;19Suppl:43-61.
6. Tatum H Jr. Maxillary and sinus implant reconstructions. Dent Clin North Am. 1986;30(2):207-229.
7. Simion M, Baldoni M, Zaffe D. Jawbone enlargement using immediate implant placement associated with a split-crest technique and guided tissue regeneration. Int J Periodontics Restorative Dent. 1992;12(6):462-473.
8. Scipioni A, Bruschi GB, Calesini G. The edentulous ridge expansion technique: A five-year study. Int J Periodontics Restorative Dent. 1994;14(5):451-459.
9. Summers RB. A new concept in maxillary implant surgery: The osteotome technique. Compendium. 1994;15(2):152,154-156.
10. Vercellotti T. Piezoelectric surgery in implantology: a case report--a new piezoelectric ridge expansion technique. Int J Periodontics Restorative Dent. 2000;20(4):358-365.
11. Buser D, Janner SF, Wittneben JG, Brägger U, Ramseier CA, Salvi GE. 10-year survival and success rates of 511 titanium implants with a sandblasted and acid-etched surface: a retrospective study in 303 partially edentulous patients. Clin Implant Dent Relat Res. 2012;14(6):839-851.
    DOI: 10.1111/j.1708-8208.2012.00456.x.
12. Sculean A, Stavropoulos A, Bosshardt DD. Self-regenerative capacity of intra-oral bone defects. J Clin Periodontol. 2019;46(Suppl 21):70-81.
    DOI: 10.1111/jcpe.13075.
13. Chiapasco M, Casentini P, Zaniboni M. Bone augmentation procedures in implant dentistry. Int J Oral Maxillofac Implants. 2009;24Suppl:237-259.
14. Abou Hamdan H, Salame T H, Aoun G. Full Mouth Rehabilitation Using Alveolar Ridge Splitting Technique with Immediate Implant Placement in the Maxilla and Delayed Implant Placement in the Mandible: A Case Report with 4 Years Follow-Up. Journal of Advances in Medicine and Medical Research. 2021;33(7):81-89.
    DOI: 10.9734/jammr/2021/v33i730877.
15. Waechter J, Leite FR, Nascimento GG, Carmo Filho LC, Faot F. The split crest technique and dental implants: a systematic review and meta-analysis. Int J Oral Maxillofac Surg. 2017;46(1):116-128.
    DOI: 10.1016/j.ijom.2016.08.017.
16. Mestas G, Alarcón M, Chambrone L. Long-Term Survival Rates of Titanium Implants Placed in Expanded Alveolar Ridges Using Split Crest Procedures: A Systematic Review. Int J Oral Maxillofac Implants. 2016;31(3):591-599.
17. Bassetti MA, Bassetti RG, Bosshardt DD. The alveolar ridge splitting/expansion technique: a systematic review. Clin Oral Implants Res. 2016;27(3):310-324.
    DOI: 10.1111/clr.12537.
18. Starch-Jensen T, Becktor JP. Maxillary Alveolar Ridge Expansion with Split-Crest Technique Compared with Lateral Ridge Augmentation with Autogenous Bone Block Graft: a Systematic Review. J Oral Maxillofac Res. 2019;10(4): e2.
    DOI: 10.5037/jomr.2019.10402.
19. Ella B, Laurentjoye M, Sedarat C, Coutant JC, Masson E, Rouas A. Mandibular ridge expansion using a horizontal bone-splitting technique and synthetic bone substitute: an alternative to bone block grafting? Int J Oral Maxillofac Implants. 2014;29(1):135-140.
    DOI: 10.11607/jomi.2201.

20. Sohn DS, Lee HJ, Heo JU, Moon JW, Park IS, Romanos GE. Immediate and delayed lateral ridge expansion technique in the atrophic posterior mandibular ridge. J Oral Maxillofac Surg. 2010;68(9):2283-2290. DOI: 10.1016/j.joms.2010.04.009.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/68539