Split-crest and immediate implant placement an Alternative Technique for Implant Placement in Atrophic Edentulous Maxilla and Mandible: 5-year follow-up of 160 treated implant sites.

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ABSTRACT: The aim of this study was to evaluate the behavior of the alveolar ridge split technique (ARST) in a series of surgical cases in anterior mandibula for two-implant overdenture. Sixty patients were included in this study, for a total of 160 implants. The surgeries took place under local anesthesia and consisted of a mid-crestal incision and subsequent bone management with a piezoelectric system. Once the approximately 3 mm expansion had been achieved, the implants were installed and defects present were filled using a mixture of 50% autogenous bone and a xenograft (Bio-Oss). There was a fracture of the bone plate in 8 cases, the fractured plates stabilized with osteosynthesis screws. In 140 cases the implants were immediately installed. Four implant failures reported due to membrane exposition. The osseointegration success was estimated to be 97.5%. It can be concluded that the bone splitting/expansion seem to be a reliable, predictable, relatively noninvasive technique and presenting limited intraoperative complications to correct narrow edentulous ridges.

KEY WORDS: alveolar ridge splitting, bone atrophy, bone graft, dental implants, piezosurgery.

INTRODUCTION

Nowadays, dental implants are considered to be the most reliable and convenient treatment modality for edentulous patients and the implant surgery became more and more popular amongst dental surgeons. However, to satisfy the ideal goals of implant dentistry, both volume and quality of the hard and soft tissues need to be ideal. Short implants could facilitate, up to certain limits, the management of vertical bone loss, they are associated with less morbidity than vertical bone augmentation [1]. Also, extra-short implants are a viable treatment alternative [2]. For instance, bone thickness on both the vestibular and the lingual/palatal sides of the alveolar ridge should be greater by 1.5mm than the implant diameter to allow implant placement. In addition, if the alveolar width is less than 6 mm, transversal bone augmentation is generally required to allow implant placement [3].

One of the most common problems that could face dentists is the rapid bone resorption of the alveolar ridge after natural tooth loss; the presence of teeth ensures the stability of the maxillary and mandibular alveolar bone, so their loss also leads to bone loss in the medium and long term [4]. Studies shown that about 80 % of anterior maxillary sextant need bone grafting [5]. Thus, dental surgeons should be prepared to apply bone grafting during implant surgery.

Ridge augmentation in deficient alveolar ridge areas are achieved by block graft (autogenous or allograft), guided bone regeneration (GBR), distraction osteogenesis and alveolar ridge split technique (ARST) or bone expansion.

Dr. Hilt Tatum 1970s introduced the alveolar ridge splitting technique (ARST) or bone spreading [6]. The ARST became popular in the 1990s through some promising research that demonstrated its efficiency (Simion et al., 1992; Scipioni et al., 1994; Summers et al., 1994) [7,8,9]. In 2000, Vercellotti et al. introduced piezosurgery in the treatment of the atrophic jaw. Piezosurgery made split technique easier, safer, and also reduced the risk of complications in the treatment of extreme atrophic crests [10].

In this study we documented and evaluated a case series of 160 implants, where horizontal ridge augmentation was applied using ridge split with simultaneous implant placement.

MATERIAL AND METHOD

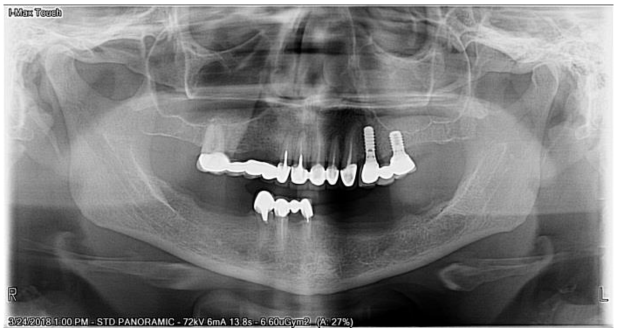
Sixty patients consecutively treated to restore partial or total edentulism, 45 women and 15 men, between 36 and 68 years of age (mean age 54.2 ± 12.3 years). Between June 1, 2014, and July 1, 2019, 74 procedures of split ridge bone augmentation technique were used by performing a greenstick fracture of the buccal bony wall and 160 implants were inserted. Implants were placed simultaneously or 6 weeks following the initial surgery. The decision of delaying the implant placement was determined by the ability of achieving a minimum of primary stability after implant placement (torque of greater than 20 N). Initial alveolar ridge width, measured with a periodontal probe, ranged between 3 and 6 mm and a minimum bone height dimension of 8 mm prior to surgery, 50.8% of the sites were less than 4 mm, 65% of sites were on mandible. Patients with good systemic health or controlled systemic disease were selected. Smokers and patients engaged in excessive alcohol consumption were excluded.

SURGICAL TECNIQUE

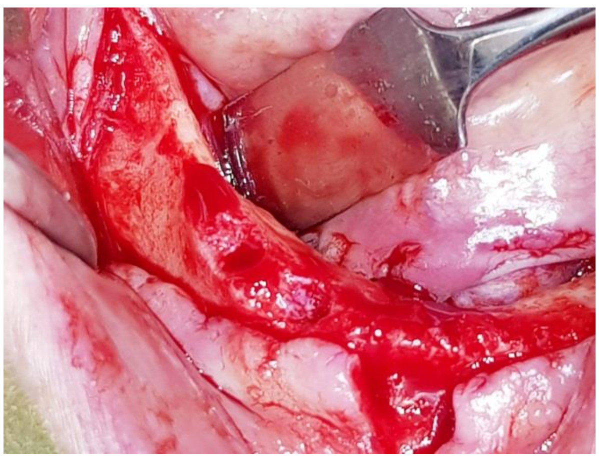
For all patients, the procedure was performed under local anesthesia. A mid-crestal incision as well as mesial and distal discharge incisions on the vestibular side and a full-thickness vestibular flap was elevated. When a full arch or a hemi arch was treated, the discharge incisions were performed at the most distal site and then at the canine or the central incisor sites. Then a full-thickness vestibular flap was elevated for maxilla and vestibular and lingual for mandible. Using the piezosurgery unit (Mectron), three cuts, for each implant, where conducted during the proceedings of the ridge splitting: one mid crestal cut on the alveolar ridge, with a depth of 8 to 10 mm and two vertical cuts on the buccal bone plate. Those vertical mesial and distal bone discharge incisions were prepared 1.0 to 1.5 mm away from the teeth and 3.0 to 5.0 mm from the closest implant-planned site.

In mandible, and to increase resilience of the vestibular bony flap, a partial width and basal longitudinal discharge notch was performed with the vibrating tip. In the first phase of the implant bed preparation, the pilot drill was utilized; then expanders of increasing diameters (ACE) were used to gradually expand the vestibular bone flap and create the implant bed. The elastic nature of the bone was utilized so as to prevent fracture, thus after every sequential expander was introduced it was kept in place and removed delicately, maintaining the bone resiliency. In the last stage, the final drill was used to prepare the implant bed. The implants were placed immediately in the osteotomy site while maintaining a primary stability greater than 20N. In other case a two-step technique is adopted and implants will be placed 3 months later. Eighty implants (CowellMedi) and eighty implants (BLT, Straumann) were placed. The guided bone regeneration (GBR) was performed in addition, using a mixture of 50% autogenous bone and a xenograft (Bio-Oss), and all the defect will be covered with a pericardium collagen membrane (Jason). On mandible, due to its low elasticity, the buccal plate could loose its stability and should be then fixed with two screws using a bone block fixation kit (Straumann). Then, the implant placement will be reported three months later. On maxilla, vestibular periosteal releasing incision and on posterior mandible vestibular and lingual releasing incision performed. On the lingual mandibular side, a full-thickness muco-periosteal flap was elevated until reaching the mylohyoid line. Then, detachment of the mylohyoid muscle insertion, usually located in the first molar area, from the lingual flap was accomplished by applying gentle traction with a blunt instrument in a coronal direction. This allows stable primary wound closure without tension, which can result in premature exposure of the augmentation area, jeopardizing the final outcome. The wound was sutured using a 4-0 PGA suture. A combination of horizontal mattress and O sutures was performed to insure the best wound closure. In case of crest width superior to 4 mm and where the gap do not exceed 3 mm, and with a primary stability superior to 30N, a healing abutment was placed. In case of gap over 3 mm or a primary stability inferior to 30N, the implant was left to heal while submerged. Postoperative instructions were advised to the patient. Antibiotics (Augmentin 1 g) twice a day and analgesics were prescribed for 5 days and chlorhexidine mouth wash 0.2% for 14 days. Sutures were removed after 14 days.

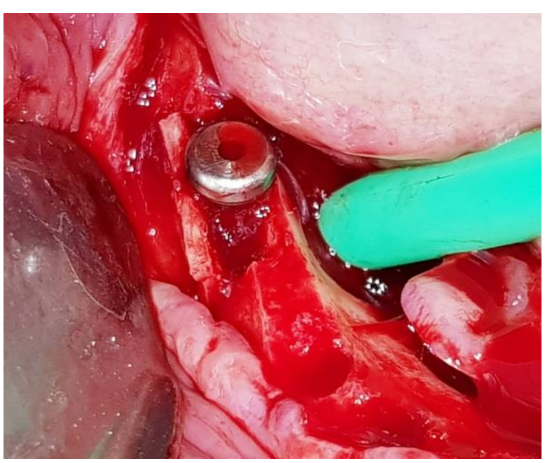
Fig 1: A full mandibular arch rehabilitation with ARST in the 46 position.



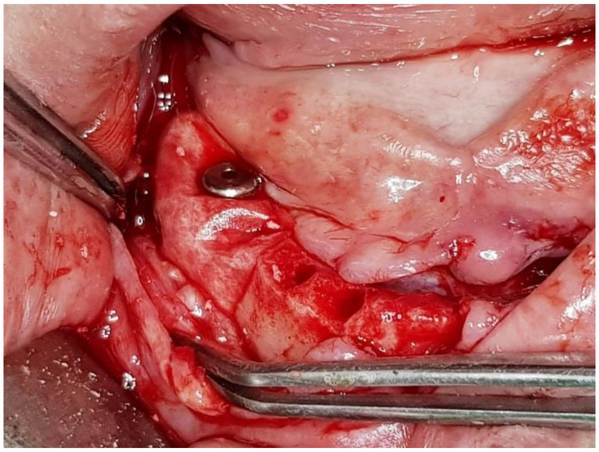
Preoperative panoramic radiograph.



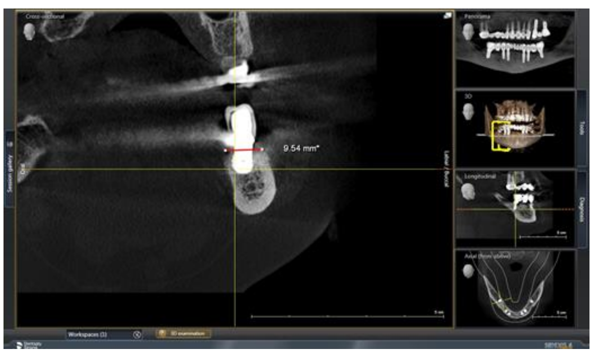
Clinical view during surgery showing a crest width of 3mm



Clinical view during implant insertion, after ridge expansion.



Regeneration performed with collagen membrane and bone grafting material.

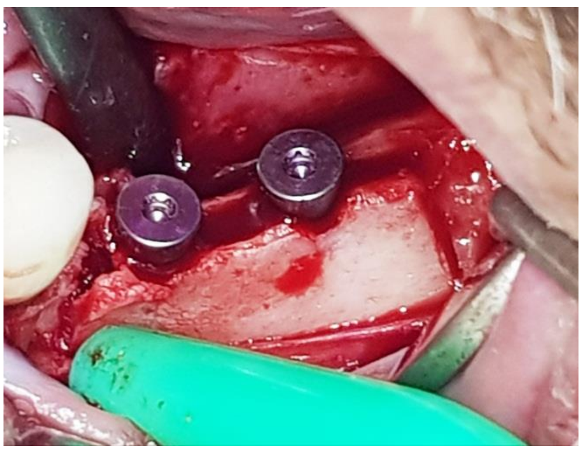


A CBCT coronal view of grafted area 3 months later showing a crest width over 10 mm and implant placed in correct position and optimal bone profile.

Postoperative panoramic radiograph two months later showing full arch rehabilitation.

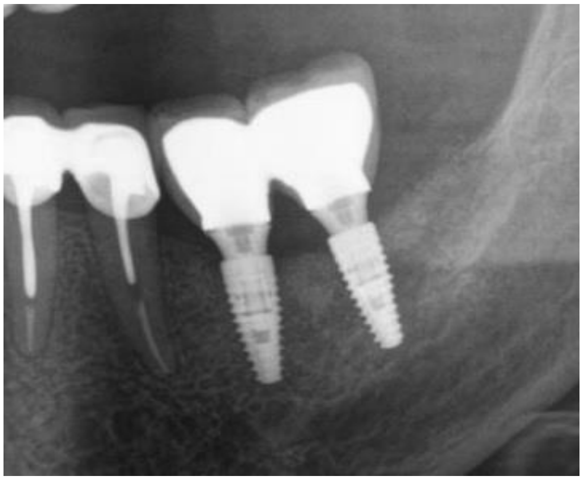
Fig 2: An ARST and immediate implant placement of 36 and 37.

Preoperative CBCT showing a 3 mm crest width on 36 and 37.



Clinical view during implant insertion, after ridge expansion. The healing abutment placed immediately.

Cicatrisation 2 weeks after surgery

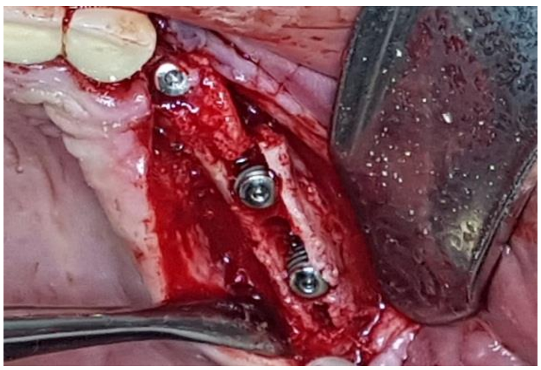


one-year follow-up radiograph. 2 implants have been placed and the dentition rehabilitated with the definitive prosthesis.

Fig 3: A rehabilitation of upper left maxilla with ARST with sinus lift by crestal approach and immediate implant placement.

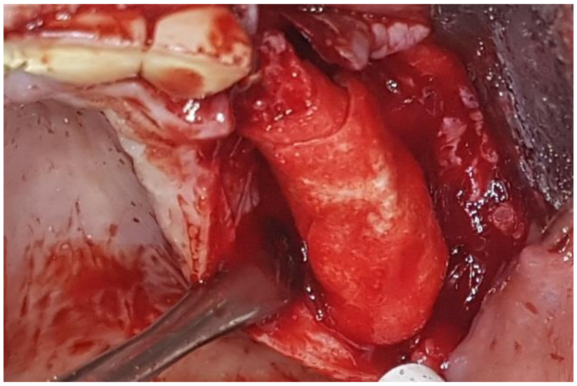
Clinical view during surgery showing a crest width of 3mm. Preparation of implants position.

Clinical view during implant insertion, after ridge splitting.

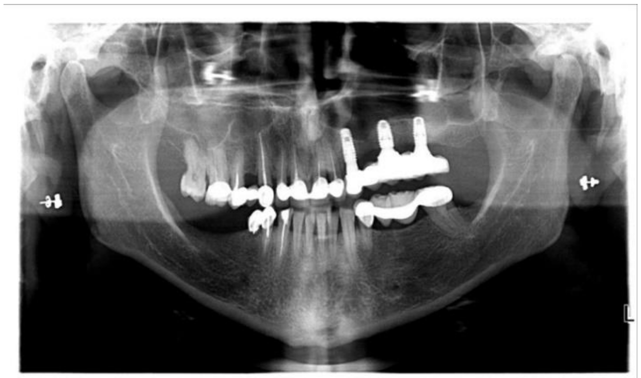


Clinical view during implant insertion, after ridge expansion

Clinical view during implant insertion, after ridge expansion and filling the gap with autogenous bone.

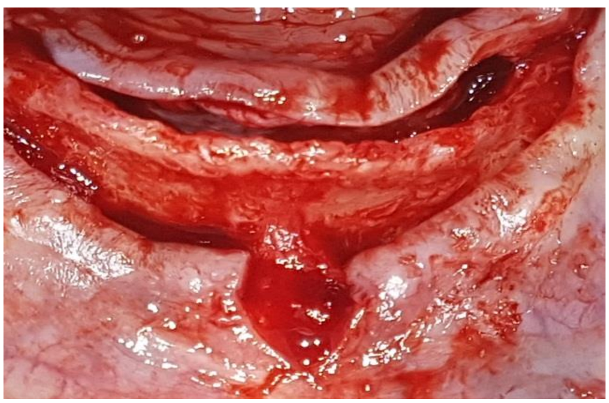


Clinical view during implant insertion, after ridge expansion. The collagen membrane covering the entire of the surgical site.



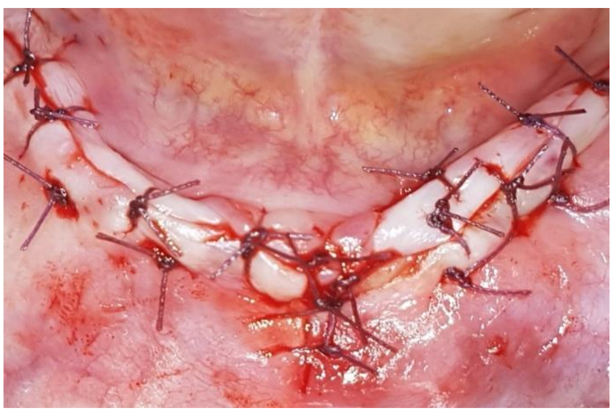
Postoperative panoramic radiograph three months later showing the final prosthesis.

Fig 4: ARST with immediate two implant placement for overdenture supported by implants.

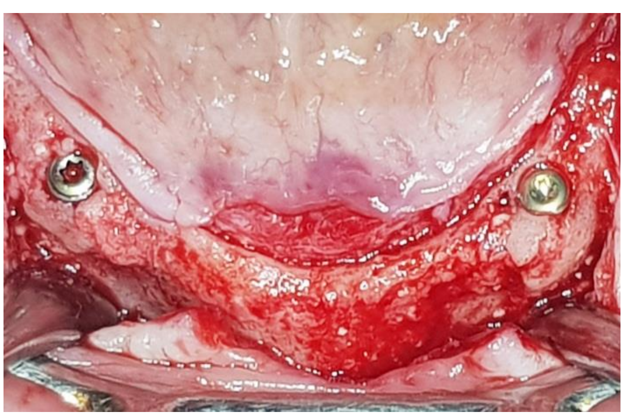


After elevation of full thickness flap and a central vestibular releasing incision. We note the crestal width of 3 mm.

After ARST, The fractured vestibular plates fixed, the gap filled with autogenous bone and covered by collagen membrane.



A perfect wound no tension closure with combination of O and horizontal mattress sutures.

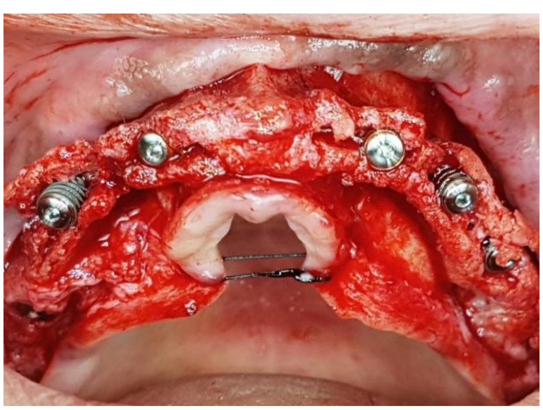


At second stage surgery, removal of osteosynthesis screws. We note the bone thickness around the implants.

After 3 months healing period, locator abutments in place.

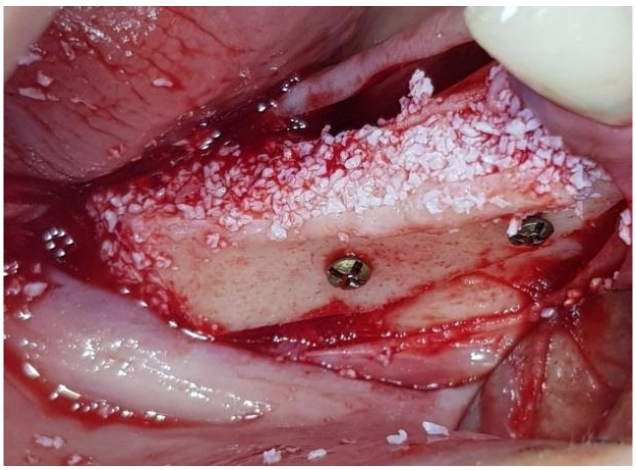
Fig 5: full mouth rehabilitation with ARST with immediate implant placement on maxilla and delayed implant placement on mandibula.

Preoperative panoramic X-ray showing maxillary and posterior bilateral edentulism.

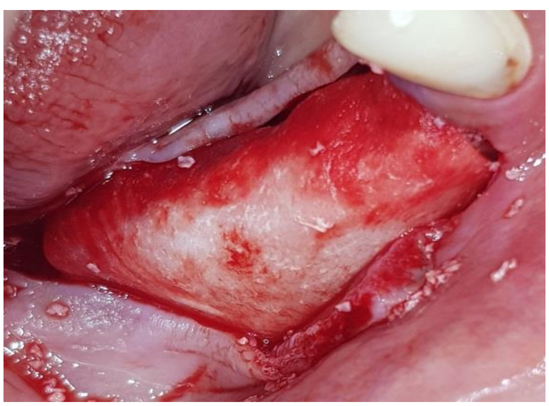


Clinical view during implant insertion, after ridge expansion on maxilla.

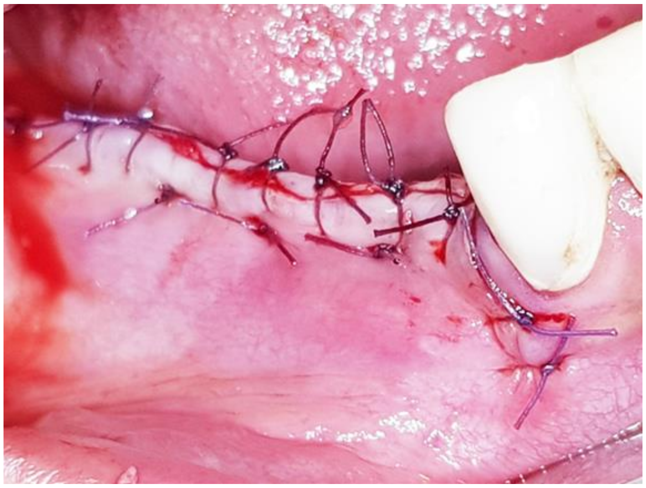
Clinical view during implant insertion, after reflecting and releasing of vestibular and lingual flaps. Note the high mobility of the lingual flap after detachment of the mylohyoid muscle insertion from the lingual flap.



Clinical view after fixating the fractured buccal plate and filling the gap by a mixture of autogenous bone and xenograft.

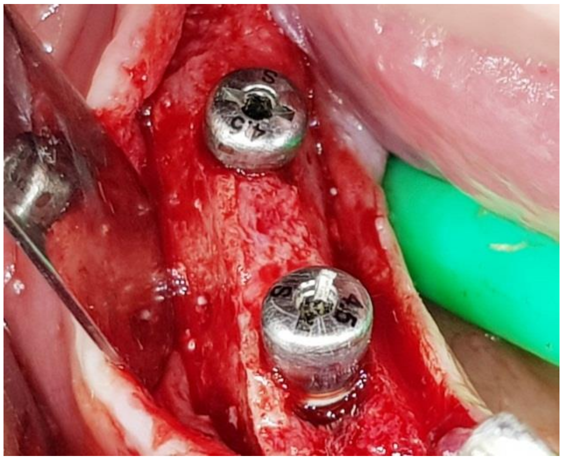


A collagen membrane covering the entire defect.

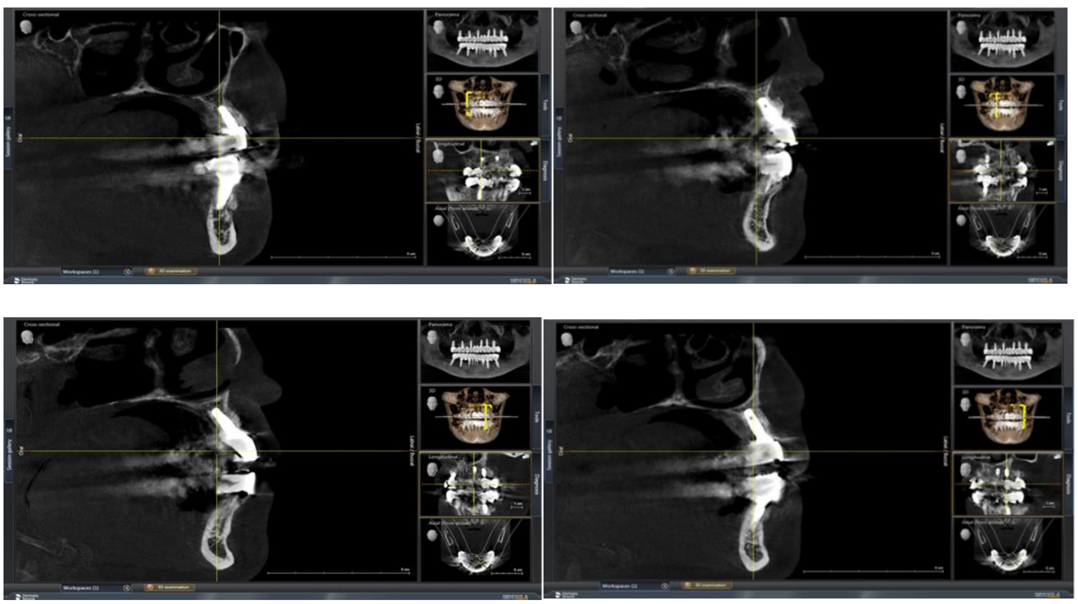


A combination of horizontal mattress and O sutures to insure the best wound closure.

3 months after the ARST, implant placement, healing abutments in place on 45 and 46.



3 months post ARST, implant placement and healing abutments in place on 34 and 36



Post treatment Cone Beam CT Scan showing the optimal bone thickness and the optimal implant positioning.

Panoramic X-ray after prosthetic rehabilitation, showing well osseointegrated loaded implants.

Final prosthesis.

CLINICAL EVALUATION

Clinical follow-ups were performed at two weeks, three months, and a radiological follow-up was performed one year after the operation with a cone beam CT scan.

Implant success was determined according to an assessment of implant mobility, pain, infection, and radiolucency around the implant.

Clinical evidence that the implants remained in position and supported mastication function was used to determine overall implant stability and function. Symptoms of pain or sensitivity upon implant palpation and percussion in combination with peri-implant pockets greater than 5 mm were considered evidence of peri-implantitis. Bone loss of more than 2 mm in a period of 4–6 months or bone loss of more than 4 mm in a period of 12 months after the initial surgery was considered significant for bone resorption with the potential of a negative effect on osseointegration.

RESULTS

In this study, the osseointegration success (determined by Buser's Criteria) rate of implants placed in areas which were augmented with the use of split ridge technique was estimated to be 97.5%. Two membranes exposed and leads to exposition and cervical resorption on 4 implants. The exposed sites were followed up and six weeks later the implants were removed and replaced immediately by shorter implants (8 mm). All failures occurred in the maxilla. Eight vestibular plate fracture and the fractured plates stabilized with osteosynthesis screws using a bone block fixation kit (Straumann), bone fixation reported with no relation to any complications. 20 implants were placed in second stage surgery, due to low primary stability. No difference was found between implants placed immediately or in a two-step surgery. No difference found between implants with healing abutments or with implants kept submerged for a second stage surgery. No difference found between the implant placement region or implant marks. The initial ridge width of the failed implants was 3.0 mm.

DISCUSSION

Multiple systemic reviews studies concluded about the predictability and effectiveness to gain bone width of the ARST as one-stage alternative to extended two-stage horizontal grafting procedures alveolar ridge augmentation technique, as well as the high survival rates in the short and long term for implants placed in the maxilla or mandible [13,14,15].

The ARST fulfill all requirements for best bone healing/regeneration of bony defects, a minimal extent of bone loss, the presence of bony walls, closed healing environment, space provision and mechanical wound stability [11]. Thus, the bone splitting/expansion seem to be a reliable and relatively noninvasive technique to correct narrow edentulous ridges.

Survival and success rates of implants placed in the expanded ridges are consistent with those of implants placed in native, nonreconstructed bone. The gap created by sagittal osteotomy/expansion undergoes spontaneous ossification, following a mechanism similar to that occurring in fractures. New bone formation permits a consolidation between the oral and buccal bone plates of the alveolus, and implants placed in expanded ridges seem to withstand the biomechanical demands of loading. By reducing the healing period, the ARST offer an important time and financial economy [12].

In our study, the survival rate of the placed implants was 97.5%, comparable with results obtained with standard implant placement procedures. A significant difference was observed in implementing the technique in the maxilla vs the mandible. Mandibular ridge splitting may be more difficult to perform than maxillary because the mandibular bone presents with a thicker cortical plate and less flexibility. Drawbacks of this anatomical condition include greater difficulty in expanding, the risk of a more invasive and more traumatic surgical procedure, and the risk of buccal plate fracture.

Bone splitting/expansion can be applied only when the buccal and palatal/lingual plates are separated by spongy bone. Therefore, the indications are more limited as compared to onlay grafts and GBR, which can be also applied in cases presenting with severe horizontal atrophy [12]. The guided bone regeneration and the Lateral ridge split technique have demonstrated predictable techniques with a high success rate, split-crest being a technique that allows the placement of implants in the same surgical act and allows maintaining the patient's bone cortical [16].

A combination of guided bone regeneration with the alveolar ridge split technique may prevent post-surgical resorption of crestal bone in very narrow ridges. A lack of bone substitute resulted in significant resorption of 3- to 4-mm-wide crests (5%) [17].

The delayed lateral ridge expansion technique can be used more safely and predictably in patients with high bone quality and thick cortex and a narrower ridge in the mandible [18].

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

CONCLUSION

Our study demonstrated that the ridge splitting technique is effective in longitudinal expansion of the alveolar ridge in cases of alveolar atrophy and knifeshaped ridges. The implant success rate was found to be 97.5%, which is comparable to reports in the existing literature. No differences of osseointegration were appreciated between the immediate and late placement of implants after split ridge bone augmentation. These results indicate that the split ridge technique is a valid procedure for augmentation of atrophic and knifeshaped alveolar ridges. In contrast to traditional techniques, it allows for immediate implant placement following surgery and eradicates the possible morbidity from a second surgical site.

Competing Interests

The authors declare that they have no competing interests.

References

1. Karthikeyan, Shrikar R. Desai, and Rika Singh. Short implants: A systematic review. J Indian Soc Periodontol. 2012 Jul-Sep; 16(3): 302–312.
2. 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 Jan/Feb;34(1):68-84. doi: 10.11607/jomi.6893.
3. 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;19 Suppl:43-61.
4. Chen, S. T.; Wilson, T. G. Jr. & Hämmerle, C. H. Immediate or early placement of implants following tooth extraction: review of biologic basis, clinical procedures, and outcomes. Int. J. Oral Maxillofac. Implants, 19 Suppl.:12-25, 2004.
5. Hyun-Suk Cha, Ji-Wan Kim, Jong-Hyun Hwang, Kang-Min. Frequency of bone graft in implant surgery. Maxillofac Plast Reconstr Surg. 2016 Dec; 38(1): 19.
6. Tatum H Jr. Maxillary and sinus implant reconstructions. Dent Clin North Am. 1986 Apr;30(2):207-29.
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):462-73.
8. Summers RB. A new concept in maxillary implant surgery: the osteotome technique. Compendium. 1994 Feb;15(2):152, 154-6.
9. Scipioni A, Bruschi GB, Calesini G. The edentulous ridge expansion technique: a five-year study. Int J Periodontics Restorative Dent. 1994 Oct;14(5):451-9.
10. Vercellotti T. Piezoelectric surgery in implantology: a case report--a new piezoelectric ridge expansion technique. Int J Periodontics Restorative Dent. 2000 Aug;20(4):358-65.

11. Anton Sculean, Andreas Stavropoulos, Dieter D. Bosshardt. Self-regenerative capacity of intra-oral bone defects. J Clin Periodontol. 2019;46(Suppl. 21):70–81.
12. Chiapasco M1, Casentini P, Zaniboni M. Bone augmentation procedures in implant dentistry. Int J Oral Maxillofac Implants. 2009;24 Suppl:237-59.
13. 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):591-9.
14. Bassetti MA, Bassetti RG, Bosshardt DD. The alveolar ridge splitting/expansion technique: a systematic review. Clinical Oral Implants Research, 14 Jan 2015, 27(3):310-324.
15. J. Waechter, F. R. Leite, G. G. Nascimento, L. C. Carmo Filho, F. Faot: The split crest technique and dental implants: a systematic review and meta-analysis. Int. J. Oral Maxillofac. Surg. 2017; 46: 116–128.
16. Sohn, D.-S., Lee, H.-J., Heo, J.-U., Moon, J.-W., Park, I.-S., Romanos, G.E. Immediate and delayed lateral ridge expansion technique in the atrophic posterior mandibular ridge. J Oral Maxillofac Surg. 2010 Sep;68(9):2283-90.
17. Noya Martinez Jose Miguel, Calvo Guirado Jose Luis, Gomez Valverde Maria, Sanchez Andreo Francisco Javier, Donoso Peguero Pilar, Garcia Gil Alberto, Mate SÁnchez De Val Jose Eduardo. Comparison of split-crest technique versus guided bone regeneration. Clin Oral Impl Res. 2017;28(Suppl. 14).
18. Ella, B., Laurentjoye, M., Sedarat, C., Coutant, J.C., 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 Jan-Feb;29(1):135-40.