Maxillary Split-Crest Technique with Immediate Implant Placement in a 13-year old Patient with Two Years Follow up: A Case Report

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Abstract

This case report presented a divergent approach in which a modified split-crest technique using the piezoelectric tip, one drill and tapered implants was applied. The split-crest surgery was performed with immediate placement of two tapered self-tapping dental implants in the anterior maxilla of a young 13-year old female patient. The patient lost four of her maxillary anterior teeth as a result of an accident at the age of 9 years with subsequent severe alveolar ridge resorption. The average bucco-palatal ridge width was less than 4 mm. The average gain of alveolar ridge width was evaluated using the cone beam volumetric tomography (CBVT) and it was 1.92 ± 0.04 mm at 6 months postoperatively. The implant stability attested using the Periotest M showed PTM values -2.3 and -2.8 for the 2 implants at 6 months postoperatively. After two years the PTM values were -2.4 and -2.8 with 100 % survival rate of the osseointegrated implants. The implants were restored by using Peek (polyetheretherketone) bridge. Satisfying function and esthetics to the patient were also achieved.

KEYWORDS: Dental implants, bone augmentation, maxillary deficiency, split-crest

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INTRODUCTION

Tooth loss as a result of trauma or congenital absence presents a major problem in young individuals. It causes functional impairment in addition to psychological disturbances.¹ Missing teeth in youth has been reported to have a negative impact on individuals’ own emotional condition, social relations, and speech, smiling and overall performance.² Oral rehabilitation is mandatory in such cases even before reaching complete skeletal and dental maturation. Removable partial denture has been considered as the first treatment option in such conditions due to the ease of construction and relatively lower cost. Certain drawbacks such as high caries incidence, periodontal problems, and increased residual alveolar bone resorption were accompanied with such treatment modality, in addition to its removable nature which is not favorable by many patients. Another recommendation to replace the missing teeth is the resin-bonded bridge. It was reported that this type of bridge has satisfying survival rates with debonding as a major concern. These led many authors to discuss the use of implants in young patients.³ The success and predictability of dental implants placement in adults requires optimum quality and quantity of alveolar bone. Proper treatment planning as well as correctly performed surgical techniques is essential. In addition appropriate prosthetic restoration with good oral hygiene maintenance is also needed. The same factors are also applicable to reach high success of dental implants when placed in children, adolescents, or young adults in certain cases. The distinctive and significant difference between treating pediatric and adult patients is that the outcome and success of treatment is highly influenced by the craniofacial growth and dento-alveolar development. The implants present for several years during facial growth can be embedded, relocated, or displaced during the growth of the jaws. The growth changes occurring should be compensated by continuous design adjustment.⁴,⁵ The most important target for using dental implants in growing patients is the preservation of bone. In case of partially missing teeth, the insertion of dental implants can change the load mechanism to which bone is subjected and hence retards its resorption. Tooth loss as a result of trauma can affect the availability of sufficient bone volume for placing dental implants in many young healthy individuals due to the subsequent alveolar bone resorption following tooth extraction.⁶,⁷ Various procedures may be necessary to provide adequate bone for implant placement. Bone augmentation with autogenous bone or any other grafting materials can be implemented. Guided bone regeneration (GBR) procedures using barriers and bone expansion or splitting techniques have been adopted for management of such vol-

![Figure 1: Pre-operative intraoral photograph showing the four missing upper anterior teeth with the maxillary ridge deficiency.](image-url)
Figure 2: Preoperative CBCT showing the deficient maxillary alveolar ridge width measurements.

Many drawbacks was reported using GBR including invasiveness, supplementary donor site, resorption of grafting materials, membrane collapse, exposure to infection and delaying of implant installation for grafting maturation have also been associated and recorded with using of autogenous grafts and membranes.\(^7\)\(^-\)\(^11\) Hence, employing some noninvasive techniques of ridge splitting and expansion can be carried out and has been discussed, without subjecting the patient to much trauma. Several ridge split techniques have been reported in the past years including split crest osteotomy, ridge expansion osteotomy, and frequent modifications of those techniques.\(^12\) The unusualness presented in this case report is performing the split-crest technique with its modification followed by immediate implant placement in such young patients in management of the atrophic maxillary ridge. The first author has previously described a modified approach of this technique within which expansion of the alveolar ridge and immediate implant placement are combined in a single process. Few instruments were essential including a piezoelectric tip and one tapered osteotomy drill. The tapered implants were positioned into the determined osteotomy sites within the split channel. This placement was used to expand the bone during seating of the implants.\(^13\) To our knowledge this is the first case reporting the application of these approaches at such a young age.
CASE REPORT

The present case report is about a 13-year-old girl who was referred to the first author’s private clinic. It was noticeable from the first visit that the patient was in the same height and body form as her mother. She was healthy with ordinary normal medical history documented by the Cornell Medical Index Questionnaire.\(^1\) It was reported that she was subjected to a bicycle accident at the age of 9 years and subsequently lost four of her upper anterior teeth as a result. She had been wearing a partial denture since the accident and she was not satisfied with having a removable prosthesis. She suffered from the inconvenient use of her partial denture and inability to correctly pronounce certain words. Her removable prosthesis required frequent removal for cleaning purposes following eating and she was often teased for this. She was afraid to participate in various sporting activities for fear of denture dislodgement. This led to a negative impact on her social life. Clinical intraoral examinations revealed the absence of the maxillary anterior teeth with presence of severely atrophic ridge (Figure 1). Radiographic examination showed severe loss of the bone width at the edentulous area (Figure 2). Wrist carpal radiographs and multiple cephalometric radiographs were taken and performed with superimposed orthodontic tracings to assess the degree of skeletal maturity of the jaw bones. No changes occurred over a period of 6 months, leading to the assumption that bone growth was nearly complete. The study protocol was reviewed and approved by the Ethical Committee at the Faculty of Oral and Dental Medicine, Cairo University. Clinically the edentulous site demonstrated insufficient bucco-palatal ridge width (less than 4 mm) with more than 10 mm of residual bone height and sufficient vertical inter-maxillary arch space, upon centric occlusion. No local or systemic conditions that may contraindicate minor oral surgeries were detected. Oral habits that might endanger the osseointegration process, such as smoking or parafunctional habits were not recorded. The patient and her mother were fully informed about
the associated risks of the procedures. The mother as the responsible guardian signed an informed consent form to document her approval.

**METHODS**

Pre-surgical evaluation was performed including visual examination and palpation of the entire oral and para-oral tissues. Study casts were prepared to evaluate the inter-maxillary space and type of occlusion. The bucco-palatal alveolar ridge width at the implant site was measured using a bone caliper. Periapical and panoramic radiographs for the recipient sites were taken. CBVT was performed on the assigned sites for the study in order to determine the bucco-palatal alveolar ridge width at the implant sites preoperatively.

**SURGICAL PROCEDURES**

The patient was anesthetized locally by infiltration anesthesia. A palatal sub-crestal incision was created for the surgical site. Two oblique releasing incisions were then made on the buccal aspect. Dissection of the full thickness mucoperiosteal flap was performed to provide complete exposure of the alveolar bone. Using piezoelectric surgery unit (tip model: SG1, NSK Variosurg ultrasonic surgical system, Japan) a horizontal crestal cut was created along the crest of the bone (Figure 3). The cut depth extended through the cortical bone to reach the spongy bone. The depth of the horizontal cut was approximately the same length of the implant to be inserted. Two vertical cuts were then created and these were connected to the horizontal crestal cut. After ridge
submerged and the platform remained flush with the crestal bone then cover screws were inserted into the implants. This positioning of the implants created expansion through deformation between the split bony plates. Closure of the flap was performed using interrupted sutures with a 4-0 black silk suture material (Assut sutures®. Switzerland).

Post-surgery Patient Management
1. Augmentin® (Medical Union Pharmaceuticals Co. Egypt) 1g tablets were prescribed twice daily for 5 days.
2. Analgesics were prescribed as following: Brufen® (Khaira Pharmaceuticals and Chemical Industries Company, Cairo, Egypt) 200 mg t.d.s for 5 day.
3. Oral hygiene recommendations were provided including the use of a soft toothbrush.

Second Stage Surgery
After a healing period of 6 months postoperative periapical radiographs as well as CBVT
were done (Figure 5) and the clinical and radiographic increase of the alveolar ridge width was recorded. Surgical re-entry after 6 months was undertaken in order to assess the success of the modified split-crest technique and to position the healing collars on the newly exposed implants (Figure 6). Periotest M (Periotest® M, Medizintechnik Gulden, Bensheim, Germany) was used to test implant stability at 6 months (Figure 7) before cementing the bridge and again after 2 years post-operatively.

**Prosthetic Procedures**

Two weeks after fixation of the healing collars, indirect impressions were taken using OsteoCareTM impression transfers for the open tray transfer technique. Impressions were given to the dental laboratory for construction of milled Peek bridge 15. After fixation of the abutments, the final bridge was cemented using zinc polycarboxylate cement (Figure 8).

**Clinical Follow-up Evaluation and Success Criteria**

The patient underwent immediate ‘post surgery’, 6 month, and 2 year post-operative examination and evaluation. The examination and evaluation criteria included review for: absence of peri-implant infection, no complaint of local pain at the site of implant insertion and no complaint of neuropathies.

*Figure 9a: 6 months postoperative periapical radiograph showing the implants in place.*

*Figure 9b: Two years’ postoperative periapical radiograph showing the implants in place.*
or paraesthesia. In addition the patient was evaluated for absence of clinically detectable mobility.

**Radiographic Follow-up Evaluation**

Standardized periapical radiographs (Figures 9a, 9b) using the parallel technique in addition to panoramic radiographs and CBVT were undertaken preoperatively, immediately postoperatively (within the first 24 hours), 6 months and after 2 years. CBVT scans were used to evaluate the total gain in alveolar ridge width, in the bucco-palatal dimension. They were also used to assess the stability of the marginal bone around the implant after the procedure and to record the post-operative ridge width. The raw data obtained from the CBVT scan was imported into bespoke third party software for secondary reconstruction and further clinical interpretation. The results recorded from each of the data sets were compared. The pre-operative image was fused to the postoperative image by manual registration through landmarks in the cranium. Accurate registration (superimposition) was automatically performed by the software. Each image (primary and secondary) was color coded for identification. Firstly, key point measurements were recorded onto the primary image. The measurements on the primary image were held and the primary image was removed to leave the secondary image. New measurements were then recorded on the secondary image in the identical plane, direction and cut as that of the primary image to ensure standardization. The obtained data was then presented.

**RESULTS**

Two self-tapping titanium dental implants were placed in the 13-year old female patient during the split-crest procedure. The diameter of the 2 inserted implants was 3.75 mm with a length of 10 mm. Wound healing was normal around all the positioned implants without any signs of infection, suppuration or mucositis at the peri-implant area. Initial pain and minor swelling was noted. These conditions were completely resolved by the tenth day postoperatively. Osseointegration was clinically and radiographically checked and proven to be successful. Criteria of success were the lack of mobility as checked by Periotest M and the absence of radiographic radiolucency at the bone-implant interface. The 2 years follow up period showed the continued success of the treatment with no further bone loss as revealed radiographically. The preoperative bone width at the site of the first implant measured 3.72 mm. This changed after 6 months postoperatively to be 5.61 mm. The bone width gain was 1.89 mm. At the area where the second implant was inserted the bone width was 3.70 mm which changed after 6 months postoperatively to be 5.65 mm. The bone width gain
was 1.95 mm. The average bone width preoperatively was 3.71 ± 0.014 mm which changed to 5.63 ± 0.028 mm 6 months postoperatively showing a significant ridge width bone gain of 1.92 ± 0.042 with a p-value 0.0001. The two implants were successfully osseointegrated when clinically assessed at 6 months postoperatively. The degrees of implant stability measured by Periotest M were -2.3 and -2.8 for the 2 implants after 6 months postoperatively. After 2 years the Periotest M values were -2.4 and -2.8. After the prosthesis was loaded, speech and pronunciation improved. Oral function was efficiently restored with high patient satisfaction within a limited time period. The follow-up period for two years reported no apparent vertical discrepancy between the implants and the adjacent natural teeth (Fig. 10). The patient reported positive psychological consequence following the implant restoration and bridge fixation. 100% success and survival rates were recorded at the end of the two years follow up period.

**DISCUSSION**

The success and predictable long-term outcomes of dental implants in restoring partially edentulous cases in adults has been the base for many clinicians to broaden their application and use for younger patients who have lost their teeth as a result of agenesis and/ or trauma. Implant-supported prostheses can provide the essential requirements for proper function and esthetics. The use of implants in youth differs notably from adults. Special attention must be given to the growth pattern of the young, because a diversity of changes occurs in the dentition and jaws of these individuals. In adult patients, the utilization of osseointegrated dental implants is frequently the treatment of choice as their performance is independent from adjacent teeth. Meanwhile implant placement in young individuals involves the risk of position relationship tribulations due to the “ankylosed” nature of the implant. The implants placed in young individuals might not follow the dento-alveolar development. This nature could lead to infra-occlusion of the ankylosed implant with possible periodontal, occlusal and esthetic consequences in the future. On the other hand, reviewing the concept that has been established by various studies that alveolar remodeling and growth does not end at puberty and that vertical discrepancy between a single dental implant and its neighboring natural teeth may possibly still occur in adulthood encouraged us to insert the dental implant in our young 13-year old patient.

It was documented that the delay of dental implant insertion in youth does not essentially exclude future complications. The placement of dental implant in young patients can provide both functional and psychological benefits. The ankylosed implant is fixed into the alveolar bone and therefore might provide the patient with more natural sensations. In addition to the security most importantly obtainable by a fixed prosthesis which has a tremendous psychological benefit for the patient as occurred in this case report with our female patient who was happy and satisfied with her fixed restoration. Various contemplates were published reporting the use of dental implants in the anterior mandibular area at 5 years of age with affirmative successful treatment results.
Vaneek also presented the results of using both cylindrical or screw implants in youth with age 15-19 years. With the various measures performed, the success rate was constantly higher than 96% over the 5 years study period. These studies are in line with our presented case report which showed 100% success and survival rates of the two inserted implants over the two years follow-up period. On the other hand Shaw previously mentioned that the dramatic growth alterations occurring in infancy and early childhood were not conducive to the maintenance of dental implants. Other researchers suggested that treatment with implants must be postponed until the age of 13 years which is in line with our case, since an implant placed at the age of 7 or 8 may not be in a favorable location at the age of 16 years and concluded that the benefits of implant use in growing patients are as important as the concerns for their premature use. The presence of maxilla with deficient bone is a challenging issue in the use of dental implants for replacing missing teeth. Following tooth extraction as a result of trauma a continuing alveolar bone resorption process is present leading to alveolar bone deficiency. In the non-existence of maxillary teeth, the alveolar ridge development will be defective and the maxilla will remain underdeveloped both in the sagittal and vertical planes causing inappropriate upper to lower jaw relationship which was the condition in the present case report which presented an average deficient ridge width of 3.71 ± 0.014 mm. Many treatment modalities have been implemented for augmenting and correcting this defective alveolar bone. The modification of the split crest technique previously discussed by Zahran et al. was applied and combined with immediate placement of tapered implants to expand the bone as alternative to the use of ridge expanders or osteotomes. The tapered implants in the present case are more controllable during the expansion procedures to ease the bone plates apart gradually minimizing the risk of fracturing the buccal plates. The two inserted dental implants were successfully osseointegrated as revealed by the Periotest M values and the supporting alveolar bone was also preserved. The unusualness of our work is that to our knowledge this is the first attempt in performing the split-crest technique at such a young age. The obtained results of the current report revealed an average bone gain of 1.92 ± 0.042 after 6 months postoperatively, without the use of any bone grafting materials or barrier membranes to block the defective space. These results were similar to many studies performed on adults which have reported satisfactory ridge bone gain without the use of grafting materials with a high success and survival rates. Chiapasco et al. reported a final mean bone gain of 4 mm and Holtzclaw et al. showed a mean bone gain of 4.03 mm. Meanwhile, Sohn et al. reached a bone gain of 2.7 mm. Zahran et al. revealed a total mean bone gain of 2.93 mm also after 6 months which are all in line with the present work done. The conquering implant placement in our 13-year old patient positively allowed us to track her growth, the prognosis, and the positions of the inserted implants in the two years follow-up period which reported no apparent vertical discrepancy between the implants and the natural teeth.
CONCLUSION
The present case report has provided a novel treatment option with 2 years follow-up in which a modified split-crest technique was applied with immediate implants successfully osseointegrated. Adequate alveolar bone width gain was achieved with proper restoration of function and esthetics. This applied treatment modality provides an encouraging therapeutic option in management of deficient maxillary ridges in young individuals.

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