“Accuracy of Clinical Implant Position with Cad/Cam Assisted Surgical Guide through a Modified Bone Expansion Technique in an Atrophic Premaxilla: A Case Report”

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ABSTRACT

Aim: To evaluate the accuracy of CAD/CAM surgical guide through a modified bone expansion technique in an atrophic premaxilla.

Background: Achieving the virtual plan of the implant position is a challenging clinical situation especially in an atrophic bone which requires extensive grafting procedures increasing the cost and time of treatment.

Case description: An 18 year old male patient reported with history of partial edentulism in relation to 11, 12 and 21 for past two years. An acrylic stent was fabricated with radiographic markers for virtual planning of implant treatment with pre-operative CBCT. A modified bone expansion technique with a palatal approach which involved the pilot drill preparation slightly 1 mm off the mid crest as compared to the conventional midcrestal approach was carried out in the atrophic pre-maxillary region. A CAD/CAM surgical guide was used for the surgical procedure. Postoperative CBCT with radiographic markers was used for evaluating clinical outcome.

Conclusion: The modified bone expansion technique was able to achieve the planned implant position within the recommended limits of deviation at the same time maintain the integrity of the thin cortical plates.

Clinical significance: A simple modification of the conventional approach of bone expansion can help attain the goal of prosthetic driven treatment plan and also conserve the bone at the osteotomy site.

Keywords: Surgical guide; Dental implant; Bone expansion; Palatal approach; CAD/CAM

Abbreviations: CBCT: Cone Beam Computed Tomography; CAD/CAM: Computer Aided Design/ Computer Aided Milling; VAS: Visual Analog Scale

INTRODUCTION

Replacement of missing teeth with implants has become an indispensable part of the clinical practice over the past few decades [1]. According to reports as early as 1986, the survival rates of single tooth implants range between 90% and 96.3% over a period of 10 years [2]. The success of the implant lies not only on the proper diagnosis, case selection, and treatment planning but also on the meticulous execution which impacts the ultimate functional and aesthetic harmony. Ideal implant position is a key determinant of implant success. Virtual implants planning with the use of technologies like Cone Beam Computed Tomography (CBCT) and Stereo lithographic surgical templates have made implant planning and positioning much more easily. Following loss of tooth it has been observed that the pattern of bone remodeling in the anterior maxilla occurs at the expense of the buccal cortical plate causing a lingual shift of the alveolar ridge [3]. The original protocol proposed by Branemark recommended placing implants upright centered in the crest, completely surrounded by bone. But according to Cawood and Howell classification this can be achieved only in class III maxilla [4]. Also reliable long term effects require sufficient bone thickness of 1 mm or more in the maxillary aesthetic zone to prevent loss of the buccal bone.

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margin and maintain the integrity of the gingival architecture. Several procedures like ridge augmentation and ridge splitting have been enormously substantiated in the literature which would ultimately increase the treatment time, cost and pose risk of post-operative pain, nerve or arterial injury [5].

The bone expansion technique involves horizontal augmentation with minimal trauma and aims to conserve all bone in the surgical site and to selectively displace the bone laterally [6,11]. The main advantage of the crest-expanding technique is that it is a less invasive procedure; the facial wall expands after the medullary bone is compressed against the cortical wall [6,11]. A case report is presented to exhibit the accuracy of the modified bone expansion technique in achieving a clinically acceptable position of implant in an atrophic maxillary aesthetic zone.

CASE DESCRIPTION
An 18 year old male patient reported to the Department of Prosthodontics Rajarajeswari dental college and Hospital, with a chief complaint of unaesthetic appearance due to missing tooth in the upper front teeth region of jaw (Figure 1).

Figure 1: Case scenario: Atrophic maxillary ridge with clinically missing 11, 21 and 22 teeth.

Patient presented with a history of extraction following trauma in relation to 11, 12 and 21 region before 2 years. Following intra oral examination, patient was presented with various treatment options like removable and fixed prosthetic options including implants. The young patient was persistent on undergoing an implant retained fixed prosthetic treatment.

Preoperative planning
An acrylic stent with radiographic markers was fabricated using the diagnostic cast and a preoperative CBCT of maxilla was made with the radiographic assessment stent (Figure 2) for the virtual planning of implant position.
Radiological examination revealed severe buccal bone resorption post extraction in relation to 11, 12 and 21 regions rendering the edentulous site unfavorable to conventional drilling technique.

Figure 2: Customized radiographic assessment stent: 5 mm lead foil strips vertically and 2 mm lead foil strips horizontally attached with cyanoacrylate resin fabricated for Preoperative CBCT.

As conventional drilling technique will result in removal of bone in an already reduced bone volume, lateral compaction with bone expansion was adopted. Also an approach about 1 mm palatal to the mid crest was planned for the pilot drill in this particular clinical situation to preserve the thin labial cortical plate undergoing resorption.
Virtual planning of implant size and position was carried out with measurements respect to the radiographic markers in relation to 21 (Figure 3) and 12 (Figure 4) using 3 shape implant studio software.

Figure 3: Virtual planning 21: Implant position virtually planned in relation to 21 region with respect to radiographic markers.
Two implants of $3.3 \times 11.5$ mm dimension (Alpha Bio Tec Ltd.) were decided based on the available bone. The data was exported to laboratory for the fabrication of surgical guide using 3D printing technology. A tooth and tissue supported surgical guide was designed to allow only the use of a $2 \times 23$ mm pilot drill for the palatal approach (Figure 5).

The patient was administered with 1000 mg of amoxicillin orally 1 hr before the surgical procedure. The surgical guide was placed intra orally and checked for the stability followed by the administration of a 1:1,00,000 concentration local anesthetic solution. A full thickness mucoperiosteal flap reflection was carried out to visualize the buccal bone architecture. The palatal pilot drill was motor driven through the surgical stent. The MIS bone expansion kit was used for the bone spreading technique. The expansion screws were hand driven with a ratchet till the no. 2 expander drill according to the manufacturer’s expansion protocol. During insertion a waiting period of 20 seconds was maintained for each clockwise rotation with the hand ratchet. The same was made sure during the counter clockwise removal of the expanders. This has been suggested to cause controlled micro fractures of the trabaculae as the bone accommodates the expansion during simultaneous lateral compression [7-9]. The implants were driven with an insertion torque of 35 Ncm to achieve good primary stability and placed 1 mm subcrestally. The labial and palatal cortical plates were intact following the placement of implants. Interrupted sutures were placed to close the flap after placement of healing covers. A Postoperative CBCT was made with the radiographic stent in position and measurements were made to determine the clinical position of implants in relation to 21 (Figure 7) and 12 (Figure 8) respectively.
The deviation observed in the above case report can be attributed to the expansion technique with a palatal approach combined with the bone loss of 0.83 mm ± 0.67 mm and healthier soft tissues which was attributed to the conservation of an intact wide buccal bone plate [12]. This cancellous nature of atrophic bone could lead to marginal errors as the physical properties of bone could not be predicted through virtual planning. Bharagava et al. in 2018 evaluated the bone loss during osteotomy using standard drills, bone trephines and alveolar expanders, it was concluded that there was a clear evidence of lateral condensation of the marrow in the middle third and lower third of the osteotomy length. A general pattern of transition from conservative bone removal at the cortex to pure condensation at the greatest depth of the osteotomy was observed [16]. This shows that with the use of bone expanders more amount of bone gets condensed in the middle and lower thirds of the osteotomy site which could resist the amount of further expansion to achieve the planned position. In an in vitro investigation by Abduo et al., although the superiority of the fully guided protocol in the range of 0.5 mm – 1.0 mm was observed, the deviations of the fully guided and pilot guided protocols were clinically tolerable, and the differences between them were not clinically significant [17].

The deviation from the planned position in this case report fits within the ITI recommendations that a 2 mm safety zone should be considered for computer aided implant surgery and that linear measurements on CBCT can be over or underestimated with a range of error of about 1 mm [18].

CONCLUSION

The clinical implant position with radiographic assessment (CBCT) could be achieved within the limits of deviation which is considered clinically acceptable to support a functionally and aesthetically harmonious restoration through a modified bone expansion technique. More clinical trials are required in future to further claim the accuracy of the proposed technique with substantial follow up periods.

CLINICAL SIGNIFICANCE

This case report shows how the modified bone expansion technique with a palatal approach preserve the buccal cortical bone which is vulnerable to resorption following extraction in the maxillary aesthetic zone at the same time achieving the prosthetic driven implant position which is a challenging clinical situation for a restorative dentist.

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ETHICAL APPROVAL

The study was approved by the ethical committee of the institution with reference no: RRDC&H/PG-04 PROSTHO/2018-19.
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