To Evaluate the Effectiveness of Alveolar Distraction Osteogenesis in Increasing the Vertical Height of Vertically Deficient Edentulous Ridge

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ABSTRACT

The reconstruction of the alveolus is challenging because the deformity involves deficiencies in both the bone and mucosa. Vertical alveolar distraction osteogenesis increases the vertical height of vertically deficient alveolar ridge with new bone formation as well as obtaining a significant increase in surrounding soft tissue in a more physiologic way and hence is being increasingly used by many clinicians. The Development of miniature internal alveolar distraction devices has made alveolar distraction Osteogenesis practical clinically. We describe 10 cases that were referred to Department of Oral & Maxillofacial surgery of Dental College with vertically deficient edentulous ridge in mandible anterior region in which vertical alveolar distraction was performed. The osteotomies for alveolar distraction during surgery were done using the oscillating saw, Disc, and Fissure burs. The distraction of 1mm per day was started after latency period of one week until the desired amount of distraction was achieved. As a result of alveolar distraction in our 10 cases, a segment of bone was transported vertically to reconstruct the desired alveolar crest which was confirmed radiographically. The mean vertical bone gain achieved using paired t-test before and after distraction activation was 4.3 mm (range, 3.2 to 7.2 mm) with standard deviation value of 1.31 using paired t-test. New bone was regenerated in the distraction gap supporting the transported bone, and distraction osteogenesis avoids the donor site morbidity associated with bone grafting and the complications that accompany the recipient site. The complications which we faced were minor and easily treated.

KEYWORDS: Distraction Osteogenesis, Surgery, Alveolar Ridge

INTRODUCTION

Atrophy of the mandibular alveolar ridge often results in such complaints as insufficient retention of the lower denture, pain by overloading the alveolar mucosa, eating and speech difficulties, altered facial appearance, and psychosocial problems. The degree of vertically deficient alveolar ridge varies in different patient, and is much greater in the mandible than that in the maxilla. The indications for alveolar ridge augmentation are acquired or congenital alveolar defects. Common etiologies of acquired alveolar bone loss are post extraction, traumatic avulsions of teeth, periodontal disease or after tumor resection.[1]

Different reconstructive and regenerative methods are available for increasing the height of resorbed alveolar ridge. These include visor osteotomies, guided bone regeneration [GBR] with or without bone graft and grafting with different alloplastic materials. All procedures has its own merits and demerits such as donor site morbidity in case of soft and hard tissue graft, unpredictable resorption of alloplastic grafts, limitation of guided bone regeneration to small size alveolar defect, hence it makes a study on vertical alveolar distraction osteogenesis in augmentation of resorbed alveolar ridge[2] worth.

Vertical alveolar distraction osteogenesis works in a more physiologic way by causing augmentation of alveolar ridge height by osteogenesis and histiogenesis of surrounding soft tissue with low morbidity, less infection rate and a significant shorter waiting period for prosthetic rehabilitation of patients.[3] The procedure was carried out in 10 patients that were referred to the Department of Oral and Maxillofacial Surgery of Dental College for increasing the vertical height of vertically deficient edentulous ridge for complete denture prosthetic rehabilitation.

MATERIAL AND METHOD

The present study was conducted in Department of Oral and Maxillofacial Surgery of Dental College on 10 patients (5 males and 5 females) with age ranging from

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42 to 68 years (mean age 56.4 years) and who fulfill the following criteria of the study.

INCLUSION CRITERIA:

- Vertically deficient edentulous ridge in mandibular anterior region.
- Radiographically at least 5 mm of anterior mandibular bone height remaining.
- Patient willing to undergo the described procedure.
- Patient deemed fit for surgery

EXCLUSION CRITERIA

- Radiographically presence of less than 5 mm of anterior mandibular bone height.
- Medically compromised patient.
- Uncooperative patient.

SURGICAL TECHNIQUE: The operations were done under general anesthesia. The exposure of mandibular ridge between the mental foramina was done by interforaminal incision in the buccal fold and a full thickness mucoperiosteal flap was raised with due care of the periosteum by only minimally exposing it since its role in blood supply to the segmented bone.[3,4] Using bending pliers, the bone plates of the distraction device are contoured to the surface of the bone[5]. The plates are also bent to give the proper distraction vector, which is chosen based on the desired direction of distraction, the final bone segment position, and avoidance of occlusal interference. Once the device is contoured, it is attached using one screw for each plate, so that the intended osteotomies line can be marked, followed by device removal (Figure 1).

The horizontal bone osteotomy was made, leaving a minimum of 4mm of bone superior to it to maximally preserve the blood supply to the bone segment and vertical bone osteotomies were performed with a slight divergence to the crest with minimal undermining resulting in an inverted trapezoidal segment of the transport segment, so as not to interfere with mobility during distraction. The Osteotomies were performed with rotary instruments (reciprocating saw, discs, fissure burs) and chisel at a distance of 5 mm from the mental nerve[2]. The complete mobility and its attachment to the lingual mucoperiosteal were confirmed. The alveolar distractor was positioned and fixed in place with 1.5 X 6 mm monocortical screws.[3,6,7] To check the mobility and appropriate direction of movement between the transport segment and the basal bone, the transport segment was immediately raised to a height of 5 mm and then returned to its original place with the vestibular incision closed with 3-0 vicryl suture .[8,9]

The distraction protocol which we carried out in all 10 cases was as follow, after a waiting period of 7 days for healing of the surgical wound, the distraction device was activated at the rate of 1 mm per day (subdivided in 2 activations of 0.5mm daily) until the desired amount of distraction was obtained .The distractor was maintained in position for 2 to 3 months while the neocallus formed between the basal bone and the distracted segment matured which was confirmed by radiographs. After this waiting period, the distractor was removed and prosthesis given.[3,10,11]

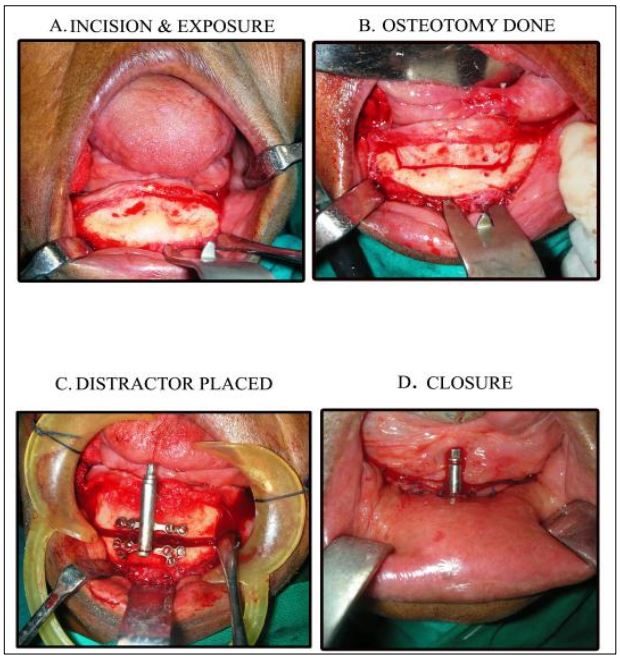

Figure 1: Surgical Procedure

RESULTS

In our study on 10 patients with vertically deficient edentulous ridge in mandibular anterior region who underwent alveolar distraction osteogenesis by the extra osseous subperiosteal alveolar distractor. The mean vertical bone gain achieved using paired t-test before and after distraction activation was 4.3 mm (range, 3.2 to 7.2 mm) with standard deviation value of 1.31 using paired t-test. (Table 1)

The clinical assessment of the mean increase in the vertical height in the canine region using paired t-test preoperative and post operative 3 months later was 3.05 mm (range, 2. to 4mm) with standard deviation value of 0.6852(Table 2)

The complications that were encountered were minor and summarized as follow:

In 2 out of 10 cases, there was slight difficulty in osteotomies. None of the cases reported surgery related paresthesia since in all 10 cases preservation of mental nerve was done.

Severe hematoma was seen at the floor of mouth in 2 out of 10 cases. Suture dehiscence was seen in 2 out of 10 patients. Minor discomfort during activation of distractor was seen in 3 out of 10 patients. In 1 out of 10 patients perforation of the mucosa was seen. The lingual tilt of the distracted segment was seen in 1 out of 10 patients. None of the 10 cases reported postoperative infection and ulcer of the mucosa.

Table 3 shows the radiographic measurement values of the 10 cases.

Period	Mean	Std.Dv.	Mean diff	SD diff	% of change	Paired t-test	P-value
Pre Op	5.2770	1.2741	4.3765	1.3132	82.9354	10.5387	0.0000*
3 months	9.6535	2.0782					

* p<0.05

Table 1: Comparison of before and after activation (with multiply by magnification factor) with respect to length of distraction by radiographic assessment using paired t-test

Period	Mean	Std.Dv.	Mean diff	SD diff	% of change	Paired t-test	P-value
Pre Op	3.5000	1.0274	3.0500	0.6852	87.1429	14.0769	0.0000*
3 months	6.5500	1.0395					

*p<0.05

Table 2: Comparison Of Pre Operative And 3months Time With Respect To Vertical Height By Clinical Assessment Using Paired T-Test

CASE	AGE	SEX	LENGTH OF DISTRACTION BEFORE ACTIVATION (LD1) IN MM	LENGTH OF DISTRACTION AFTER ACTIVATION (LD2) IN MM	VERTICAL BONE GAIN(VBG=LD2-LD1)	MAGNIFICATION FACTOR(MF) OF RADIOGRAPH	TOTAL VERTICAL BONE HEIGHT GAINED: VBGXMF
1	50	F	7	16	9	0.82	7.20
2	42	F	4	8	4	0.82	3.20
3	45	F	6	11	5	0.81	4.05
4	59	M	7	14	7	0.82	5.74
5	68	F	4	8.5	4.5	0.81	3.65
6	62	M	5.5	9.5	4	0.83	3.32
7	55	M	8	13	5	0.82	4.10
8	54	M	8.5	12.5	4	0.82	3.28
9	65	M	7	13	6	0.82	4.92
10	64	F	7.5	12.5	5	0.81	4.05

Table 3: Radiographic Measurement of Vertical Bone Gain During Distraction In mm

*LD I (LENGTH OF DISTRACTION PREACTIVATION BETWEEN THE SUPERIOR PORTION OF BASAL PLATE AND THE SUPERIOR PORTION OF TRANSPORT PLATE)
*LD 2 (LENGTH OF DISTRACTION POSTACTIVATION BETWEEN THE SUPERIOR PORTION OF BASAL PLATE AND THE SUPERIOR PORTION OF TRANSPORT PLATE
* MAGNIFICATION FACTOR (MF) = REAL SIZE OF ACTIVATION ROD (RS) DIVIDED BY IMAGE SIZE (IS) OF ACTIVATION ROD

DISCUSSION

Since the 19th century, there have been numerous attempts to develop techniques to extend the long bones. Distraction osteogenesis of the long bones was pioneered by Illizarov.[3] More recently, distraction techniques have been applied to the facial bones and soft tissues, including use in the treatment of inadequate height of the alveolar ridge. [12,13]

To increase the height of vertically deficient alveolar ridge is challenging since the deformity involves deficiencies in both the bone and mucosa. Development of miniature internal distraction devices has made significant contribution in alveolar distraction osteogenesis.2 CHIN & TOTH demonstrated the first alveolar ridge augmentation application in humans after the traumatic alveolar loss (traumatic avulsion of teeth).[2,13]

Distraction osteogenesis, which is an alternative to more commonly used techniques such as autogenous onlay bone grafting, alloplastic graft augmentation, and guided bone regeneration (GBR), provides a number of advantages. For example, with autogenous onlay bone grafting there can be considerable bone resorption. In comparison to GBR, distraction osteogenesis has the advantage of allowing greater vertical growth of the bony ridge. The significant risk of infection and membrane exposure incurred during GBR can be avoided with distraction osteogenesis. Distraction osteogenesis also requires substantially less time than the alternative technique. The principal advantage of distraction osteogenesis, however, is the simultaneous occurrence of histiogenesis and osteogenesis.[15]

The rate of distraction (1 m.m daily) allows the mobilized alveolar segment to be transported slowly without causing any discomfort to patient [14].The correct distraction rate allows for lengthening with neocallus formation in the distraction gap and a proper soft tissue response since rapid distraction causes nonunion and too slow causes premature union. For this we follow the distraction protocol consisting of 0.5 mm distraction twice daily (in all 10 patients) carried out till the desired distraction achieved, once in the morning and at night (half turns twice daily).[5,14,15] The increase in the bone volume is due to regeneration of the distant, distraction zone that acts as a regeneration chamber. The site bearing

the prosthesis is primarily transported as mature bone hence a stable denture bearing area that is less prone to residual ridge resorption than onlay grafts is seen.

For radiographic evaluation of alveolar distraction osteogenesis, study of Mazzonetto et al was taken[7, 11]. The method used to obtain the magnification factor (MF) of each panoramic radiography permitted radiographic analysis to be performed at different radiology departments, making the identification of real bone gain more accurate. This radiographic analysis seems to be an important tool to verify the technique success as well as in planning the implant length. The mean vertical bone gain achieved in the anterior mandible in their study was 6.73 mm, while in our study on 10 patients the vertical bone gain was 4.30 mm.

In our study on 10 cases, the increased radio opacity of the distracted region in panoramic radiograph was seen in 4 to 8 weeks post distraction period; this was in agreement with the study of Massimo Robiony et al[12]. After 12 weeks of consolidation phase that allows the maturation and corticalization of the regenerated bone, the surgical removal of the distraction device was done under local anesthesia.[14]

In our study on 10 patients, after a latency phase of 7 days[7] during which soft callus is formed, followed by distraction phase which usually lasted 1 week during

which traction is applied at the rate of 1mm/day with 0.5 mm and 0.5 mm in morning and evening[14,15] respectively to the transport bone fragment and the tension favors formation of new immature woven and parallel fibred bone commences which was confirmed radiographically.

In our study on 10 patients, the osteotomy was carried out at a distance of atleast 5 mm from the mental nerve and as a result, in none of the patients postoperative paresthesia of lower lip was seen, this correlated with the study of A. Rachmiel et al.[2]

In comparison with other surgical techniques, alveolar distraction osteogenesis also has some disadvantages besides surgery related which we faced in our study, the need for absolute compliance of the patient and the family is of utmost importance (for daily rotation of the distraction screws at home), and the need for close and frequent follow up is obvious.

In view of our results of 10 cases, as well as review of the other studies, it can be said that even after some minor complications that we faced in our study, vertical alveolar distraction osteogenesis is a good alternative for increasing the height of decreased alveolar ridge in mandibular anterior region for complete denture prosthetic rehabilitation, though our study on sample size of 10 patients was small, further study still required regarding the bone resorption of the distracted segment during the prosthetic loading. Improvement of the technique and of devices used, with an adjusted distraction protocol, could lead to a further reduction in the number of complications and better results of alveolar distraction osteogenesis.

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