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EVALUATION OF BONE LENGTHENING FOLLOWING ALVEOLAR DISTRACTION OSTEOGENESIS- A CLINICAL STUDY

Dental Science

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ABSTRACT

The alveolar ridge augmentation procedures have been used for decades, with many modifications introduced in these procedures. Alveolar distraction osteogenesis (ADO) has been gaining importance as a ridge augmentation procedure and has proved to be effective in solving the problem of resorbed ridges. The present study aims to calculate the vertical alveolar bone gain following alveolar distraction in atrophied ridges. **Material and methods:** The prospective study was conducted on ten patients with the resorbed edentulous alveolar ridge. Ridge augmentation was done in all the patients by distraction osteogenesis technique with clinical assessment on study models and radiographic using OPG and CBCT. A distractor device was fixed and activated after 5-7 days at a rate of 0.5mm twice a day for 12 weeks. **Results:** A significant mean vertical bone gain of 5.08±1.09 mm and 4.82mm ± 0.70mm was observed after 12 weeks using panoramic radiography and computed tomography, respectively. Clinically, a statistically significant increase in vestibular depth of 5.08±1.09 mm was observed in study models. **Conclusion:** Alveolar distraction osteogenesis has proven effective for vertical ridge augmentation with simultaneous soft tissue expansion. The technique is a good alternative for adequate bone formation in deficient alveolar ridges undergoing prosthetic rehabilitation.

KEYWORDS

Alveolar distraction osteogenesis, Vertical distraction osteogenesis, Osteotomy Rehabilitation.

INTRODUCTION

Edentulous patients with resorbed mandibles often have reduced retention, denture instability, and impaired chewing. In addition, the diminished vertical height of the alveolar process results in loss of the vertical dimension of the face and poor facial aesthetics. Rehabilitation of such an atrophied, edentulous mandible has been a challenge. [1]

Distraction osteogenesis (DO) is an emerging technique that has overcomed the challenges related to traditional bone augmentation procedures, showing promising results with some unparalleled advantages. It is a biological process of new bone formation between the surfaces of bone segments that are gradually separated by incremental traction allowing the body's natural healing mechanisms to generate new bone. [2]

The concept of DO, also called callostasis, was first explored in limbs by Codivilla (1905) and later popularized by Ilizarov, who established the fundamental principles for DO by pursuing this both experimentally and clinically. [2] In 1991, McCarthy [3] utilized these principles of DO in the correction of maxillary and mandibular defects. Block [4] et al. 1996 reported the first alveolar distraction osteogenesis (ADO) in dogs. In this same period, Chin and Toth [5] averred the first alveolar distractor exercised to alveolar defects in humans after traumatic tooth losses.

ADO can be applied for horizontal and vertical ridge augmentation procedures with its unique ability to simultaneously correct soft and hard tissue deficiencies. However, even after numerous advantages and applications of ADO in the augmentation procedures as recorded in literature, there is still significant dispute regarding treatment protocols, type of distraction device, and minimal bone height required for the distraction procedure. [6]

Hence, this study intended to clinically and radiographically appraise vertical alveolar bone lengthening in atrophied ridges following ADO for dental prosthetic rehabilitation.

MATERIALS & METHODS

Patients aged 40-60 years with alveolar ridge atrophy who were willing to participate in the study were selected from the outpatient department of Oral & Maxillofacial surgery at Navodaya Dental College, Raichur Karnataka. The institutional ethical committee approved the study, and informed consent was taken from the participants as the study protocol routine.

Complete edentulous patients maintaining good oral hygiene and no reported allergy to local anesthesia, with a minimum of 6-7 mm of bone height above vital structures needing vertical ridge augmentation, were included in the study. In addition, patients who are systemically compromised or taking any medication/drug that could jeopardize treatment outcomes also patients with a habit of tobacco usage were excluded from the study. Based on the criteria, 10 edentulous patients (7 males, 3 females) with ridge resorption were selected, among which 2 were post-trauma and 8 post periodontal disease cases.

Presurgical assessments included a detailed case history with routine blood investigations, clinical photographs, vestibular depth measurement with vernier calipers, preoperative study models, radiographic evaluation with – Cone beam computed tomography(CBCT) and Orthopantomogram (OPG). (Fig 1)

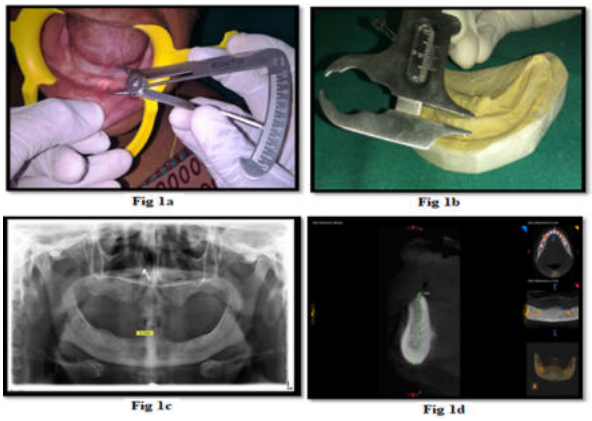
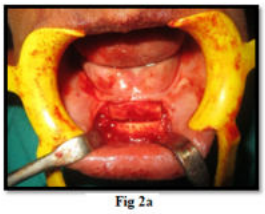


Figure 1: Presurgical Assessments- (1a) Clinical depth vestibular depth measurement (1b)vestibular depth measurement as on study model (1c) Radiographic vertical depth measurement as on OPG and (1d) CBCT(Carestream Software).

Under adequate Local Anesthesia, a vestibular incision was given, followed by the elevation of the labial mucoperiosteal flap till the extent of the defect, exposing the labial cortex without elevation of crestal mucosa ensuring adequate blood supply and soft tissue for distraction histogenesis. A vertical distractor was secured in the

predetermined position, and holes were drilled on either side of the plate. The distractor was then removed, and the osteotomy cuts (Fig 2a) were made using an oscillating saw and straight fissure bur no 701 with utmost care to avoid any injury to the nerve in the vicinity and the bone segment mobilized. This mobilized bone segement was labelled as transport segment. After mobilizing the segment, the distractor was fixed with non-cortical screws in the same position using the predrilled holes as a guide.(Fig 2b) The correct functioning of the distractor was checked, ensuring there were no bony interferences with the occlusion. Finally, the soft tissue was sutured, and medications were prescribed.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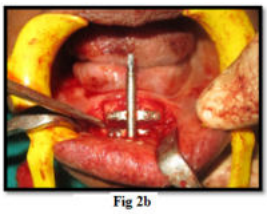
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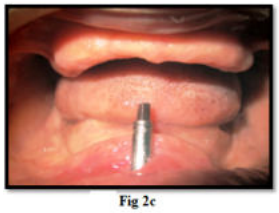
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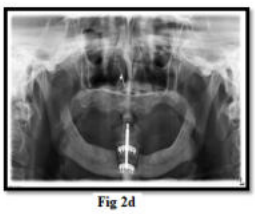


Fig 2d

Figure 2: (2a) Osteotomy cuts made on resorbed alveolar ridge. (2b) Fixation of TRACK distraction device using monocortical screws. (2c) Distracted alveolar segment. (2d) OPG showing distracted bone segment at the end of consolidation period

After a 5-7 days latency period, a distraction process of 1mm/day at a rate of 0.5mm/day twice daily was initiated. An over-correction of 1-2 mm was done considering the possibility of relapse, and a retention period of 8-12 weeks was maintained. At the end of the consolidation period, (Fig2c) radiographs were taken to assess the bone formation between the distracted bone segment and basal bone (Fig 2d), after which the distractor was removed. Following the removal of the distractor, clinical photographs were taken, and study models were prepared along with OPG and CBCT. (Fig 3)

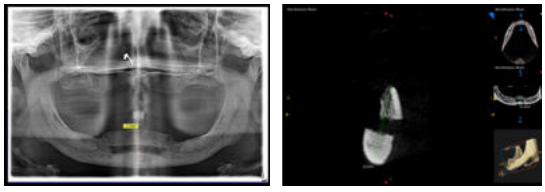


Figure 3: Postoperative Assessment on OPG and CBCT showing vertical bone gain after removal of distractor.

RESULTS

The study population consisted of 10 (7 males, 3 females) patients between age of 40-59 years with resorbed height of the anterior edentulous mandible. Comparison between pre and post distraction vertical bone length was done by using students paired 't' test. A p-value less than 0.05 was considered as significant and 0.001 was highly significant. Data analysis was done by using SPSS v16.0.

Clinical evaluation: The mean pre and postoperative value of vestibular depths as measured using vernier calipers from the depth of the sulcus to the crest of the ridge at midline was 3.60mm and 8.70mm respectively. When pre operative and post consolidation values were compared mean ± SD increase in vestibular depth was found to be 5.10 ± 0.73mm which was statistically highly significant. (Table 1)

Table 1 : Comparison of pre and postoperative vestibular depth using Paired sample test.

CLINICAL VESTIBULAR DEPTH	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
PRE-OP VESTIBULAR DEPTH – POST-OP VESTIBULAR DEPTH	-5.100	.73786	.2333	-5.62784	-4.57216	-21.857	9	.000

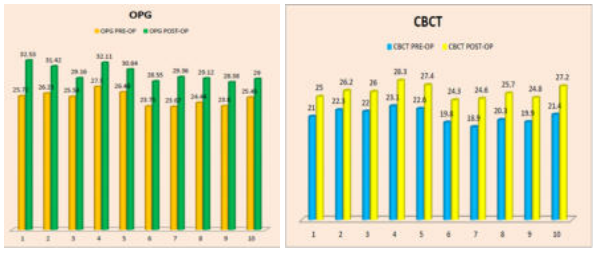
Evaluation on Study Model: The mean value of vestibular depth was 3.80mm and post distraction depth was 8.90mm, as measured on study model. When pre operative and post consolidation values were compared mean ± SD increase in vestibular depth was found to be 5.10 ± 0.73 which was statistically highly significant. (Table 2)

Table 2: Comparison of Pre and Postoperative vestibular depth as measured on study models using Paired sample test

VESTIBULAR DEPTH ON MODEL	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
PRE-OP - POST-OP	-5.1000	.737865	.2333	-5.6278	-4.57216	-21.857	9	.000

Radiographic evaluation of vertical bone gain using OPG: The mean preoperative and post consolidation vertical bone height as measured from base to crest of mandible at midline were 26.13 mm and 31.22 mm respectively. When pre operative and post consolidation values were compared mean ± SD increase in vertical bone height was found to be 5.08±1.09 mm which was statistically highly significant ($p<0.001$). (Graph 1)

Radiographic evaluation of vertical bone gain using CBCT: The mean pre and post consolidation vertical bone height as measured from base to crest of mandible at midline were 21.13mm and 25.95mm respectively. When pre operative and post consolidation values were compared mean ± SD increase in vertical bone gain was found to be 4.82mm ± 0.70mm which was highly significant ($p<0.001$). (Graph 1)



Graph 1 : Radiographic evaluation of Vertical bone gain on OPG and CBCT

DISCUSSION

Distraction osteogenesis is comparatively less invasive, less time-intensive, and associated with less morbidity than bone grafts for reconstruction of missing tissue. During distraction osteogenesis, new bone forms under the mechanical conditions of gradual intermittent traction superimposed on attenuated functional loads that eliminate the need for a bone graft. This technique avoids extensive undermining and alteration in the normal tissue architecture of the labial mucosa. It also generates new mucosa, leading to soft and hard tissue reconstruction.[2]

Various types of distractors are commercially available, both intra and extraosseous. The Track distractor device was selected in the present study, particularly indicated for partial defects or atrophy of the alveolar process and suitable for distracting small alveolar segments. [7] A latency period of 5-7 days considered in this study was sufficient for complete soft tissue healing that coincided with the initial events in the normal process of bone repair. The extent of distraction needed is based on the amount of tissue necessary and available to meet the dental rehabilitation goals. Apart from the amount of distraction needed, the distraction rate and rhythm also hold paramount importance.[8]

Saulacic and colleagues[6] reported in a systematic review that the mean distraction rate was 0.71 ± 0.27 mm. They also observed a lower distraction rate of 0.4 to 0.5 mm in cases where distractor implants and horizontal distraction were used. According to other authors, a distraction rate of 0.5 mm/day results in faster osteogenesis than a distraction rate of 1 mm in elderly patients.

The distraction rate and its rhythm modulate the formation of bone tissue. Excessive traction tends to stimulate the formation of cysts and fibrous tissue, reducing the resistance of the regenerated tissue. In contrast, less traction leads to precocious consolidation, making it

impossible to achieve the desired length.[9] Therefore, a distraction rate of 1 mm/day at a rate of 0.5 mm twice daily was followed in the present study.

Conventional vestibuloplasties have always been criticized for their secondary scar contraction and loss of vestibular depth postoperatively. However, this study faced no such problems as the literature projects that incremental distraction decreases the possibility of soft tissue dehiscence and ischemia of the overlying mucosa due to proliferation of soft tissue and neoangiogenesis.[10]

In the present study, radiographic evaluation via OPGs and CBCT were valuable in assessing vertical bone gain and ascertaining the distraction device's position and the alignment of bony segments postoperatively. By the end of 12 weeks, OPGs revealed radiopacity with small areas of radiolucency, suggesting the formation of new bone in the distraction gap. Bone density was also assessed at the distraction site using density measuring software of CBCT, displaying new bone formation. However, density values were changing at different sites, which suggested a varying degree of mineralization within the distraction gap.

Although the vertical bone gain was attained with DO, certain complications were observed during the study period. Postoperatively, two patients developed sublingual hematoma that subsided gradually within 2 to 3 weeks. In addition, dehiscence of labial mucoperiosteum was observed in two patients during the distraction phase. Hence, the distraction rhythm was changed to 0.5mm/day, and proper oral hygiene was maintained at the dehiscence site with saline and betadine irrigation, leading to spontaneous healing within 5 to 7 days.

CONCLUSION

Despite the complication observed, this technique is a reliable surgical alternative for alveolar reconstruction that offers a new means for correcting some significant vertical alveolar deformities caused by trauma or periodontal defects. However, there is a need for additional meticulously designed longitudinal studies with longer follow-ups, more admissible DO protocols, and various potent distractors to further appraise the efficiency of this procedure.

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