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# EVALUATION OF TWO DIFFERENT DISTRACTION OSTEOGENESIS TECHNIQUES IN TREATMENT OF UNILATERAL ALVEOLAR CLEFT

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## ABSTRACT

**Purpose:** This study was planned to compare the use of bone borne distractor versus hybrid distractor in repair of unilateral alveolar cleft. **Materials & Methods:** A 16 patients with unilateral alveolar cleft were included in this study. They were divided into two equal groups according to the type of distractor used, ***Group I***: in which the bone- borne distractor (Liou cleft distractor) was used for alveolar cleft repair. ***Group II:*** in which the custom made hybrid distractor was used. **Results:** Stage I distraction: after three months, showed significant difference in the width of the cleft side in both groups as *P*-value was 0.007 in group I and *P*-value was 0.001 in group II. No significant differences in the vitality and mobility of teeth in both groups. The amount of relapse in the regenerate area at the different observation periods 3 and 6 months between both groups were statistically significant (P-value 0.018). Radiographic finding showed no significant difference of the inclination changes of the transported segment in group I (P-value 0.816), while in group II showed significant difference (P-value 0.001). Stage II alveolar cleft grafting: graft resorption and recurrence of fistula was recorded in one case of group II. The differences of the density of the grafted bone between the first month and six months in each group postoperatively were statistically significant in both groups as P-value 0.001 and 0.001 in group I and Group II respectively. **Conclusion:** Both types of distractors are suitable for treatment of alveolar cleft with some drawbacks related to each type of distractor which include, that the hybrid distractor was limited as it decreases the width of the alveolar cleft from 9 to 10 mm distance while the bone borne Liou distractor decrease the distance from 11 to 13 mm, also the high cost of Liou distractor compared to hybrid distractor.

**KEYWORDS:** Distraction osteogenesis, Alveolar cleft, Liou distractor, hybrid distractor.

## 1. INTRODUCTION

Management of the alveolar cleft defect has always been a challenging aspect in patients with orofacial clefts. The alveolar cleft defect results in a collapsed, disunited arch with unsupported lip together with nasal and dental elements. Therefore, repair of the osseous defect and closure of the fistula are considered important aspects of complete cleft management.[1]

Secondary osteoplasty of the alveolar cleft defect with bone grafting is considered the treatment of choice because, it is predictable and satisfying the goals of alveolar cleft repair.[2]

Unfortunately, a significant number of patients have bone graft failure as they have very wide defects with collapsed cleft segments or they may have scarred alveolar cleft defect with insufficient soft tissue covering, all of this make further attempts of bone grafting unsatisfying.[3]

Distraction osteogenesis (DO) was developed for application in the craniofacial region.[4] Several indications for alveolar transport DO exist. A very wide alveolar cleft may preclude a bone graft if soft tissue and alveolar bone are deficient. A patient who had a previous failed bone graft may be considered for transport DO to achieve the goals of standard alveolar cleft surgery. Older patients who have not been treated for their alveolar cleft defect may be candidates for transport DO to narrow the defect and thus require minimal secondary grafting.[1]

Bone-bone, bone-tooth and tooth-tooth types of distraction devices have been used based on the anatomic

characteristics of the distraction site and operator experience. Bone- bone and bone-tooth devices are firmly fixed so there is no need to take into account their side effect on teeth used for fixation as seen in tooth-tooth type.[5,6]

Rachmiel et al,[7] stated that alveolar bone transportation by distraction osteogenesis towards the defect using a bone-borne distractor followed by closure of the residual small defect by bone grafting three months later facilitating the repair of large defects.

Kahlon et al,[8] described a simplified technique for bridging wide alveolar cleft defects using a modified intraoral custom made tooth and bone borne maxillary distractor. The technique developed a new strategy of anterior transportation of a posterior segment for closing a larger alveolar cleft that cannot be closed with an autogenous bone graft.

So until now there are many controversies about many distraction devices which could be used for alveolar cleft repair, each has some advantages and disadvantages in performing this task.

In attempting to solve these controversies in repairing the alveolar cleft the hypothesis of this study was to compare the use of a bone borne distractor versus a tooth and bone borne distractor in repair of unilateral alveolar clefts.

## 2. MATERIALS AND METHODS

Sixteen patients with unilateral alveolar clefts were included in this study and divided randomly into two equal groups (8 patients each) according to the type of distractor. The patient's age ranged between (12– 25) years. The parents or corresponding relatives were informed and signed the written consents to participate in this study. The study protocol was reviewed and approved by Research Ethics Committee (REC) of Faculty of Dentistry, Tanta University.

Careful extra oral and intraoral clinical examinations were performed to determine the main chief complaint and also to evaluate the stability of maxillary segments, presence of old scar, asymmetry of the alar base, presence of oronasal fistula, the width of the alveolar cleft, the presence of erupting teeth in the cleft, vitality and mobility of the teeth in the transported segment.

Panoramic radiographs were done for all patients to examine; the presence and position of supernumerary teeth, the inclination of anchorage tooth and transported teeth, the size of the cleft side, the presence or absence of permanent lateral incisor and canine, the site of horizontal maxillary and interdental osteotomy and the anatomic position of the dental roots. Also Computed Tomography (CT) scans were done for all patients to show the anatomic position of both maxillary segments in axial and 3D planes and to measure local bone mineral density.

Study casts were done for all patients to record the size of the cleft, the maxillary dental arch dimensions and compare them with the postoperative casts.

In all patients the surgery was done on 2 stages: **Stage 1**: Cleft repair with segment transport distraction osteogenesis. **Stage 2**: distractor removal and cleft grafting.

The patients were divided into two equal groups according to the type of distractor used, ***Group I***: in which the bone-borne distractor (Liou cleft distractor) was used for alveolar cleft repair. **Group II:** A custom made hybrid distractor was used for segment transport. Separators were placed with respect to the canine, premolars and to the first molar and sufficient spaces were created. Bands for the respective teeth were made. An alginate impression of the maxillary arch was obtained. The bands were transferred to the impression and then poured with stone to obtain a working cast. In the laboratory, the modified Hyrax device was made on the cast with bands on one side and soldered miniplates on the other side. Out of the four Hyrax device extensions: two extensions were soldered to the two surgical miniplates that contain at least two holes and the remaining two extensions were soldered to orthodontic bands on the 1st or 2nd premolar and first molar respectively. The miniplate soldered to the wire extension had two or three holes, one of which was soldered to the wire extension and the others was set free for placement of the monocortical screws on both the transported disk and the fixed segment, figure (1).

**Figure (1): Liou cleft distractor (left).modified Hyrax distractor (right).**

**The surgical technique of stage I (distraction)**

The maxillary alveolar bony segment was exposed by a vestibular incision. The palatal attached mucoperiosteum was minimally reflected in the area of the papilla between the 2nd premolar and 1st molar, enough to provide access for an osteotome. The horizontal osteotomy was extended from the cleft site up to the 1st molar area about 5 to 10 mm above the dental roots to avoid injury of the roots. The vertical osteotomy was done between the second premolar and the first molar in the cleft side. The segment was completely mobilized by using a thin osteotome in order to finish the cuts in the vertical segment both buccally and palatally. After that the distractor was fixed with titanium screws. the distractor must be activated to check any resistance before wound closure, figures (2&3).[9]

**Distraction protocol:** Following a latency period of 5 to 7 days, the activation period was initiated at a rate of 1mm a day followed by a consolidation period of 12 weeks. The activation process was continued until the end of the alveolar cleft come in contact with each other, as it was detected by radiographic evaluation.[10]

All patients in both groups were followed up to 3 months postoperatively Clinically to evaluate wound healing, mobility and vitality of the teeth in the transport segment. Radiologically**:** to ensure the correct position of the distractor and the osteotomy sites and evaluate the new bone formation at the distracted segment. Cast analysis**:** Dental casts had been made at 3rd months and 6th months for measurement of relapse postoperatively and compared them with the preoperative one.

**Stage II surgery (Distractor removal and alveolar cleft grafting)**

After consolidation period the distractor was removed surgically through intraoral incision which designed to allow grafting the remaining cleft site at the same time using autogenous chin bone graft, figure (4).

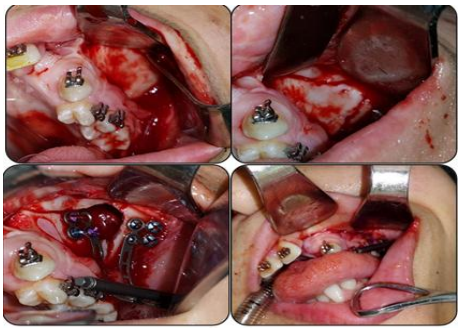

**Figure (2): Surgical technique of stage I (distraction) in Group I.**

**Figure (3): Surgical technique of stage I (distraction) in Group II.**

**Figure (4): Alveolar cleft grafting after distractor. removal at the same time.**

The routine postoperative care and instructions including broad spectrum antibiotics, non-steroidal anti-inflammatory drug for pain relief, soft diet, maintaining good oral hygiene were explained to the patients and their relatives.

The patients were followed up for 6 months postoperatively both Clinically to evaluate the wound healing, infection and postoperative edema and pain, and radiographically to determine the graft incorporation at the follow up periods (1st, 3rd and 6th month) and Axial CT scans were done for each patients at the follow up period (immediately and 6th months postoperatively) to assess and measure local bone mineral density at each follow up interval.

Statistical analysis was done using SPSS program (SPSS Inc. Released 2008. SPSS statistics for Windows, Version 17.0. Chicago: SPSS Inc). P value was calculated and data was collected & tabulated.

## RESULTS

**Stage I (distraction)**

***a- Clinically***: the wound healing process was progressed uneventfully in both groups without major complications

In comparing the pre and postoperative width of the cleft at 3 months postoperatively, there was a difference with statistical significance at P-value 0.007 and 0.001 in group I and II respectively, table (1).

In comparing the amount of relapse in the regenerate area at the different observation periods 3 and 6 months between both groups were statistically significant (P-value = 0.018*) in favor to group I. No significant differences in the vitality and mobility of teeth in both groups.

**Table (1): Showed significant difference in the width of the cleft side in both groups.**

| | G1 | | | G2 | | |
|---|---|---|---|---|---|---|
| | **Preoperative** | **After 1 month** | **After 3 months** | **preoperative** | **After 1 month** | **After 3 months** |
| **Range** | 13-30 | 2-17 | 3-17 | 13-25 | 4-15 | 4-15 |
| **Mean ± S. D** | 18.625±7.386 | 10.28±5.08 | 10.38±5.07 | 15.625±3.998 | 7.75±3.11 | 7.75±3.11 |
| **T test** | - | 9.944 | 9.945 | - | 16.545 | 16.545 |
| **P-value** | - | 0.007* | 0.007* | - | 0.001* | 0.001* |

**Figure (5): Preoperative and one month postoperative intraoral photographs of patient No 1 group 1 showing the decrease in the width of alveolar cleft after the end of the distraction period.**

**Figure (6): Preoperative and one month postoperative intraoral photographs of patients No 2 group II showing formation of regenerate area between first molar and second premolar.**

***b) Radiographically:*** There was a change in inclination of the transported segment when comparing the preoperative measures and the postoperative measures at one and three months postoperatively without statistical significance in group I (P-value 0.816) and was statistically significant in group II (P-value=0.001*).

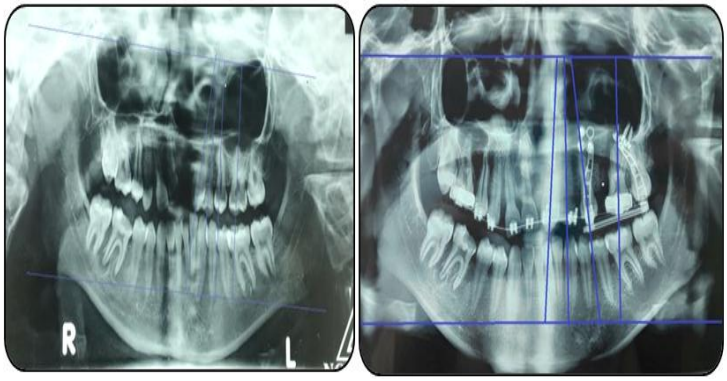


**Figure (7): Preoperative and 3 month postoperative panoramic photo radiograph of the patient No 1 group I showing the regenerate area and decrease in the size of the alveolar cleft.**

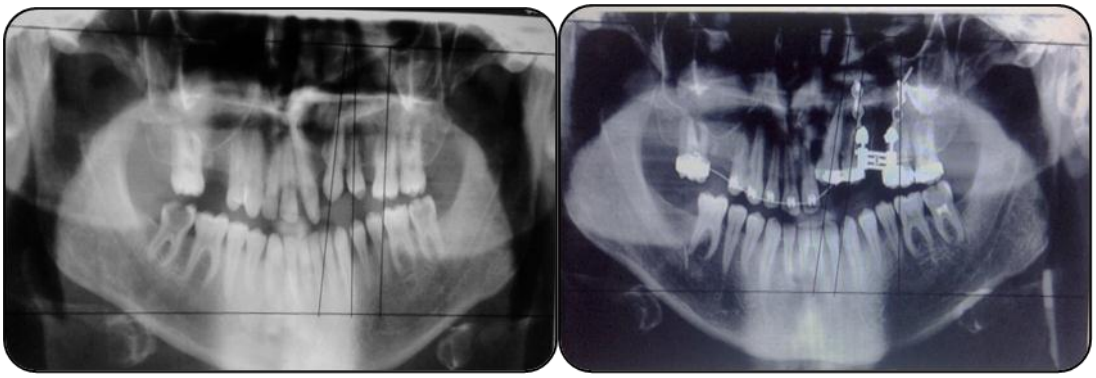

**Figure (8): Preoperative and 3 month postoperative panoramic photo radiograph of the patient No 1 group I showing the regenerate area and decrease in the size of the alveolar cleft.**

***c) Cast analysis:*** the differences of the width of the cleft side between the preoperative measures and the postoperative measures at 3 months were statistically significant in both groups. Figure (9).

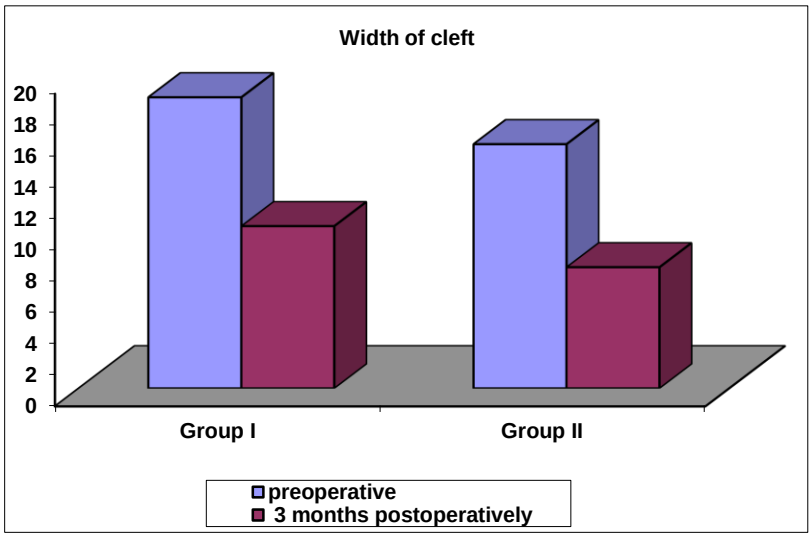


**Figure (9): the differences of the width of the cleft side.**

**Stage II (alveolar cleft grafting)**

- Clinically**:** Graft resorption and recurrence of fistula occurred in only 1 case of group II.
- Radiographically: The differences of the density of the grafted bone between the first month and six months postoperatively were statistically significant in both groups as P-value 0.001 and 0.001 in group I and Group II respectively.

## 4. DISCUSSION

Alveolar clefts were commonly repaired by bone grafting procedures which became an integral part of the treatment of patients with unilateral or bilateral cleft lip and palate.[11] The effectiveness of distraction osteogenesis in maxillofacial surgery was well documented. In the dentoalveolar region, distraction osteogenesis allowed lengthening of bone and soft tissues with low incidence of relapse suggesting this procedure as an ideal mean of narrowing the broad alveolar cleft defect.[12]

The mean age was above 14 years to avoid damage of the developing teeth and impairing the eruption pattern in the osteotomized segment which is agreed with Vega et al,[15] who treated patients with average age of 20.4 years.

The selection of cases involved the unilateral alveolar cleft as in bilateral cases it was difficult to preserve the vascularity of the osteomotised segments and this matched with other studies who stated that in a large alveolar cleft the amount of tissue available for the advancement of the labial and palatal flaps may be inadequate for complete closure.[17]

The maxillary alveolar bony segment was exposed by a vestibular incision, while the attached gingiva covering the crest of the ridge from the maxillary first molar up to the canine was not reflected. The palatal attached mucoperiosteum was minimally reflected in the area of the papilla between the second premolar and first molar, this approach resulted in preservation of adequate blood supply to the osteotomized segment, ensuring the survival of the transport bone segment, moreover allowed wide access and adequate bone exposure and adaptation of the distractors. This minimally invasive surgical approach is inconsistent with the approach of Bousdras et al,[18] who used an intraoral sulcus incision and tunneling technique.

The patients in group I recorded easy activation of the distractor, while patients in group II recorded difficult activation of the distractor by themselves due to limited access and this problem was overcomed by explanation how to activate the distractors to the patient's relatives.

All patients reported difficulty of eating well in the side of distraction and maintaining good oral hygiene measures during the first two weeks of the follow up periods. We instructed the patients to eat soft food in the contralateral side with using of soft brush and mouth wash.

There were two important problems related to hybrid distractor. First, the transport segment was docked in a more superior position at the end of the distraction period. This undesirable movement also changed the inclination of the teeth in the transport segment and increased tooth tipping. Second, the bony defect on the nasal side of the alveolar cleft could not be completely closed, this is opposite to the finding of Kahlon et al,[8] who did not mention any of these problems.

The modified Hyrax offered insufficient support in a transversal direction, with risk of the segment orienting itself toward the palatal direction or in a superior direction. To overcome these problems we used a mini implant in the lower jaw to direct the transported disc in an inferior direction using orthodontic wires and elastics and we also used a transpalatal wires soldered to the

bands on the anchorage teeth bilaterally to avoid the palatal movement of the transported segment which was performed by Neha et al,[19] who used a transpalatal arch to connect the bilateral posterior segments and to reinforce the anchorage of the posterior segments.

The inclination changes of the transported segment showed significant changes in group II used a hybrid distractor, this proof that the first molar tooth could not give adequate support for transporting a segment that contains one or two teeth which disagree with the explanation of Henkel, et al,[20] who stated that first molar tooth could give adequate support and it may be necessary to include bony support in addition to the molar tooth anchorage when transporting a larger segment.

Relapse with DO of the transported segment was significant in both groups, it may resulted from the influence of the tension at the center of the fibrous zone in the healing callus. This explains the negative correlation between the rate of relapse and the density of the distracted bone. This can be overcomed by increasing the consolidation period more than 3 months and this is agreed with Neha et al,[21] who waited for another 4 weeks for remodeling, allowing a more consolidation time before removing the appliance and disagree with various authors have proposed different durations for the consolidation phase, such as Liou et al,[12] 1 week; Dolanmaz et al.[21] and Suzuki et al, 5 weeks.[22]

The distraction devices could not create compression at the docking site, due to excessive force from the distraction device resulting in superior movement of the transported segment especially in group II. The aim was to achieve a continuous arch form and close the alveolar cleft using corticocancellous chin bone graft and this matched with the explanation of Liou et al.[12] Chin bone was the ideal site as we needed a small amount of bone and thus eliminate all the complication result from harvesting the iliac crest as a graft and this agrees with Guerrero et al.[23]

Graft resorption and recurrence of oronasal fistula occurred in one case in group II, may be due to pre-existing gingivitis, suture failure, mucosal tear at a suture, while the reported graft failure and recurrence of the oronasal fistula in other studies ranged from 2% to 17%.[2]

## CONCLUSION

Tooth and bone-borne modified Hyrax proposed an innovative and inexpensive method for the reduction of an alveolar cleft defect in comparison to the bone borne Liou distractor.

The tooth and bone borne distractor has a limited distance 9 to 10 mm as compared to the bone borne Liou distractor which gave a distance from 11 to 13 mm.

There are a few disadvantages of the described distraction procedure for both groups, including long treatment periods, which require patient cooperation and close follow-up. In addition, the complete closure of the alveolar cleft without use of bone grafting seems to be difficult when using both types of distractors.

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