# Transport distraction osteogenesis for closure of alveolar clefts – A clinical experience.

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***Abstract***

***Treatment of an alveolar defect in a case of cleft lip and palate remains an onerous task to cleft surgeons. Alveolar bone grafting using autogenous bone grafts, has unanimously remained the treatment of choice for closure of alveolar defect in almost all cleft centers around the world. However, this treatment option is far from ideal. The success rate of alveolar bone grafting exponentially decreases with the increase in the size of the defect. Complications like graft resorption, wound dehiscence and recurrence of fistulae make alveolar bone grafting unpredictable for large defects. Management of soft tissues in an alveolar cleft defect poses an equally arduous challenge. Closure of soft tissues under too much tension almost always gives way to wound dehiscence. The principles of distraction osteogenesis have been exploited in treating osseous defects in orthopedics and maxillofacial***

***surgeries. It would seem prudent to incorporate this phenomenon in treating alveolar clefts too. In this article we have described our clinical experience in using this novel technique of transport distraction osteogenesis in treating alveolar cleft defects and have reported four of our cases with their clinical outcomes.***

## Introduction

In the comprehensive care of cleft patients, closure of alveolar defects plays a salient role in the treatment algorithm. This procedure was initially described by Schmid [1] in 1950 and later by Boyne and Sands[2,3] in 1971 where they used autogenous bone grafts to fill the alveolar defect. The objectives were to maintain bony continuity in the alveolus, closing the oro nasal fistula, to provide bone support to the alar base and allow for canine or lateral incisor eruption or orthodontic movement[3]. The technique described by Boyne and Sands was met with widespread appraisal and their principles of secondary bone grafting using autogenous bone grafts have been incorporated by most of the cleft centers throughout the world. However, this method is associated with several shortcomings which include, the presence of a donor site, chances of graft failure and furthermore, in case of large clefts, soft tissue deficiency and closure of flaps under tension can lead to wound dehiscence[4].

Since its description by Liou et al[5], the use of the principles of transport distraction osteogenesis for closure of alveolar defects is becoming increasingly popular due to its predictable and stable results over the conventional bone grafting techniques[4].The demerits of this procedure include irritation and hygiene problems due to the distractor, controlling the vector of the transport segment along the curvature of the alveolus and necrosis of teeth or the transport disc, all of which can be avoided with meticulous surgical planning and proper patient counseling[6].In this case series, we present our clinical experience of using transport distraction osteogenesis for closure of alveolar defects.

## Materials and Methods

Informed consent was obtained from all the patients. A standard operative procedure was performed for all the four patients. Before the surgery, orthodontic treatment was initiated to level the arches and an interdental space was made for the planned osteotomy cut. Pre-operative planning included orthopantamographs, intraoral periapical X-rays and occlusal films for estimating the defect and planning the osteotomies. A stainless-steel wire was attached to the brackets on the teeth to guide the transport segment along the curvature of the alveolar arch. A vestibular incision was made on the lesser segment and a mucoperiosteal flap was reflected to expose the lateral bone surface. Two osteotomy cuts were made to separate the transport disc for distraction. First, the interdental vertical osteotomy cut was made from the interdental crest till the level of the planned horizontal cut. The second was the horizontal cut which extended from the vertical cut to the edge of the alveolus medially. The horizontal cut was made around 5 mm above the apices of the teeth to preserve their vitality[7]. Osteotomies were performed with preservation of the crestal and palatal mucosal attachment to the osteomized bone disc. One arm of the customized transport distractor was connected to the transport disc and the second arm to the posterior stable bone using 1.5 mm screws (Figure 1) (Figure 2.1 and 2.2)

The Distractor was activated to ensure appropriate movement of the transport disc. The mucosal flaps were closed with the activation arm of the distractor extending in the buccal vestibule.

**Distraction Schedule**

Latent Phase: 7 days

Distraction rate: 0.5mm x 2 per day

Duration: Variable (till the transport disc reached the docking site)

Consolidation: 3 months

The distractor was kept in place for stabilization till the completion of the consolidation phase.

**Results**

| Sr No | Pateint Age | Gender | Cleft type | Size of defect | Successful closure of defect | Complications |
|---|---|---|---|---|---|---|
| 1 | 14yrs | Female | bilateral | 25mm (14mm on the right & 11mm on the left) | Distraction done on the right side till the midline. | Difficulty in controlling the vector of transport disc |
| 2 | 16yrs | Female | Unilateral | 12mm | complete closure of the defect till the mucosal cover of the tissues approximated | None Gingivo-perioplasty done at the time of distractor removal |
| 3 | 21yrs | Female | Unilateral | 14mm | complete closure of the defect till the mucosal cover of the tissues approximated | None Gingivo-perioplasty done at the time of distractor removal |
| 4 | 14yrs | Male | Bilateral | 10mm on the right side and 8mm on the left | Distraction done on the right side Nil Due to | Hardware failure at the bone-screw interface |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | hardware failure, the procedure was aborted | |

Table 1.1: Results of all cases in tabular format

In this review, we have reported the results of four of our cases.

Two cases were of unilateral alveolar cleft.

In both these cases pre-surgical orthodontics was done to align the maxillary arch and tilt the root of the first premolar to make space for the osteotomy cut. The orthodontic arch wire was used for guiding the vector of the transport disc. Distraction was done till the transport segment approximated the docking site at the premaxilla (Figure 3.1 - 3.4).

Gingivoperioplasty was planned at the time of distractor removal after the completion of consolidation.

The other 2 cases were of bilateral cleft.

Presurgical orthodontics was done to align the arches. A stainless-steel wire was fixed to the brackets to guide the transport disc along the alveolar arch.

It was planned that the transport segments from both the sides would meet at the premaxilla at the completion of the distraction. However, simultaneous bilateral distraction appeared unsuitable since the guide wire required stability from the contralateral side to guide the transport segment along the arch.

In the first case of bilateral distraction we managed to distract the transport disc till the midline. However, we had difficulty in controlling the vector. The transport disc met the premaxilla at 45 degrees and was collapsed palatally. This was rather a minor setback as we could correct it with orthodontic treatment after consolidation.

The patient was planned for contralateral side transport distraction osteogenesis after the consolidation of the right side was completed.

In the other case of bilateral alveolar cleft, we experienced hardware failure at the screw bone interface due to which we had to abort the procedure. We believe that this was because of the maxillary bone being too hypoplastic to support the distractor. However, the subsequent healing after the removal of the distractor was uneventful.

The patients were discharged on the 2$^{nd}$ to 4$^{th}$ post op day and were instructed to follow up on the 7$^{th}$ post op day when their care takers were taught to activate the distractor according to the schedule. Close follow up of the patients was kept during all the phases of the distraction.

None of our patients showed any signs of transport segment mobility after the distractor removal. We had no incidence of transport segment necrosis, loss of vitality of any teeth, infection or wound dehiscence.

**Discussion**

Bone is one of the biologically privileged tissues that has the capacity to regenerate. Distraction osteogenesis utilizes this sublime property for a myriad of reconstructive procedures. Alveolar defects being one of them.

The first reported case series of transport distraction for closure of alveolar defects was given by Liou et al[5]. They presented 11 cases where they had used this procedure for treating alveolar defects. Since then, transport distraction osteogenesis is gaining imperturbable popularity among cleft surgeons for treating alveolar defects[8,9,10].

In cases of large alveolar defect, autogenous bone grafting may have unpredictable results. Long et al [11], in a review of fifty-six patients observed that there was a significant co-relation between the width of the alveolar cleft and the success rate of secondary bone grafting using autogenous cancellous bone. They noted a drastic fall in the success of secondary autogenous bone grafting in clefts greater than 11.2mm with 19% of patients having no bony bridge between the segments. A similar inference was drawn by Hynes[12] in his study where he noted that alveolar clefts having a width greater than 10mm treated with autogenous bone grafting fell in Berglands[13] category Type III (<25% bone formation in realtion to the adjacent alveolar crest height) and Type IV(bone level below the roots of the adjacent tooth), measured when the canine had fully erupted. Hence, transport distraction osteogenesis provides a plausible treatment option for closure of alveolar defects of larger dimensions.

The soft tissues expand simultaneously due distraction osteogenesis which helps in reducing the size of the naso-alveolar fistula making the subsequent repair easy. The quality of bone achieved with distraction osteogenesis is superior to the bone regenerated after autogenous bone grafting as reported by Rachmeil et al making implant placement in the edentulous gap more favourable[14]. Many authors have described the use of endosseous implants after distraction osteogenesis for prosthetic rehabilitation and have reported successful results[8,15].

The age range in our case series was from 14years to 21 years. If these patients were treated by alveolar bone grafting, they would have been grouped into the stage of late secondary bone grafting[16]. However, the ideal age for transport distraction osteogenesis would be the same as that for alveolar bone grafting ie 8 -10 years (before the eruption of the canine)[5]. As suggested by Liou, the teeth that are transported along with the transport disc can be orthodontically retracted back to their previous position allowing the canine to erupt.

Controlling the vector of the transport segment along the arch was a precarious task. As Liou has advocated, we had used the arch wire to guide the transport disc along the arch. However, in one of our case the brackets on transport segment got dislodged from the arch wire leading to a palatal collapse of the segment. This was however a mild impediment rather than a complication since we could align the arch with orthodontics. Rachmiel et al[15]have reported a case in which they had used elastics attached to orthodontic implants on the palate to control the vector of the transport disc.

A case series by Mitsugi et al[8] have reported using the distractor in an open configuration and attaching one arm to docking site and the other to the transport disc. Closing the distractor during the distraction phase would achieve the desired distraction. This could be a plausible option for maintaining the vector of the transport distraction and avoiding the undesirable deviation towards the palatal side.

We experienced hardware failure in one of our cases. This was mainly due to the hypoplastic lesser segment which could not bear the load of the distractor.

Moreover, in all our cases, there was a considerable chance of encountering the roots of the teeth during screw fixation. Accommodating these shortcomings by using smaller screws and less number of screws lead to a decrease in the stability of the distractor. Ervedi et al[17] has reported an elegant solution to these problems by soldering the distractor to the orthodontic bands on the teeth on the transport segment, the osteotomy technique to separate the transport disc being the same.

Except in one case where we experienced hardware failure, we managed to close a considerable defect of the alveolus using transport distraction osteogenesis. However, all our cases required a second procedure, for closure of the residual defect. Nevertheless, in our opinion, these results were far superior than what we would have achieved using secondary alveolar bone grafting alone.

## Conclusion

We conclude that transport distraction osteogenesis is plausible adjuvant of secondary alveolar bone grafting in treating large alveolar cleft defects with stable and predictable results. The complication rates of this procedure are low if the surgical procedure is planned meticulously. The drawbacks of this procedure are the protracted treatment time and patient discomfort. However, the benefits outweigh the shortcomings if the treatment is planned well.

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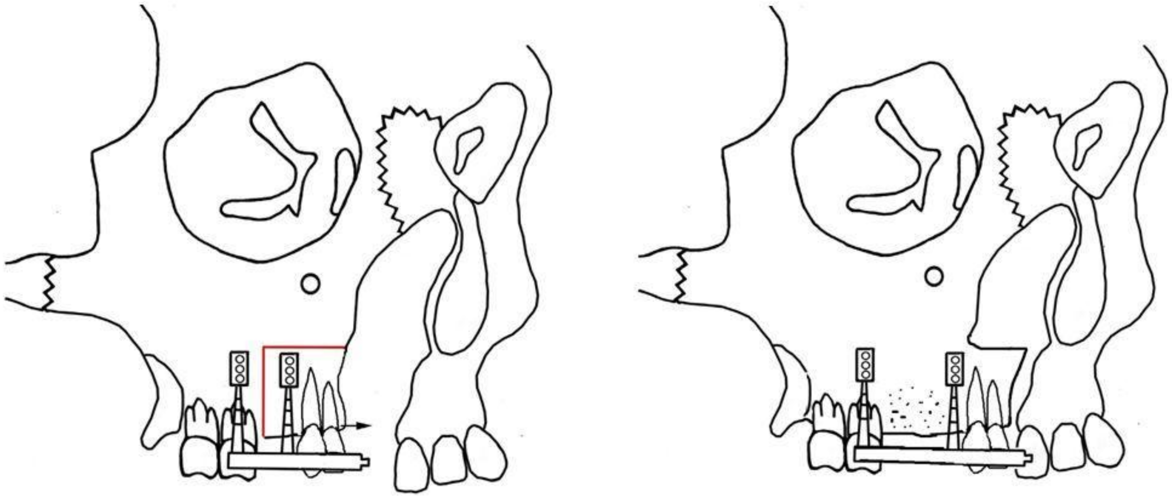

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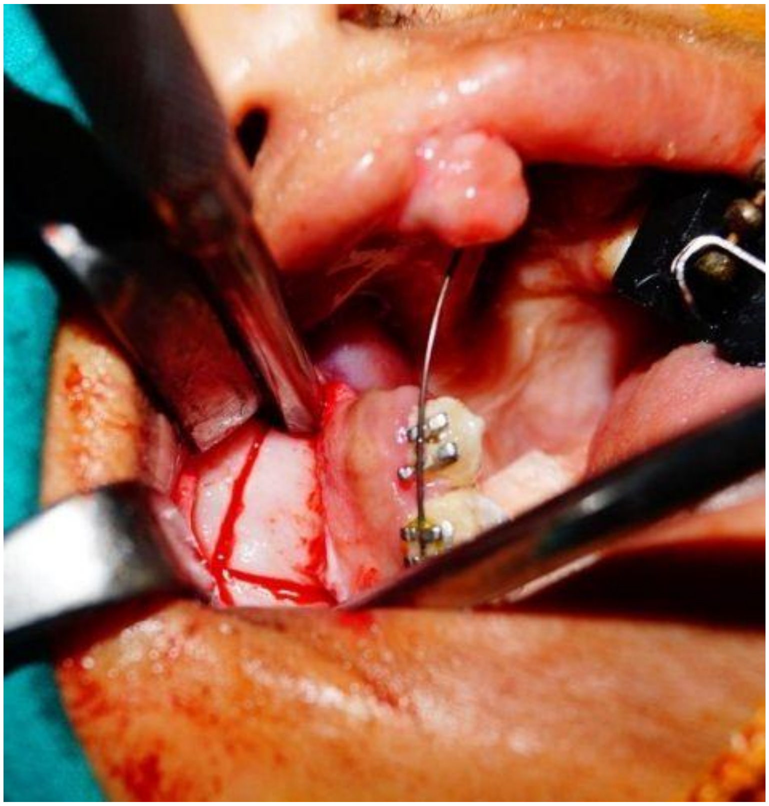

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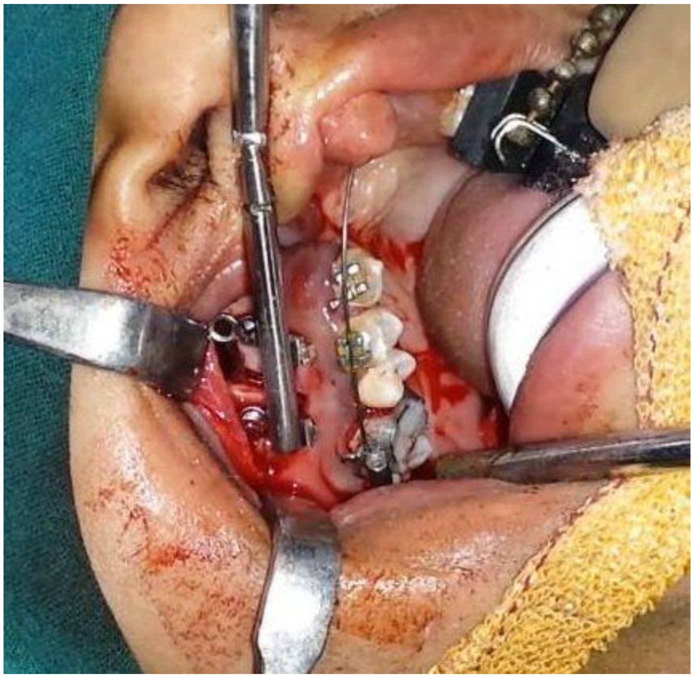

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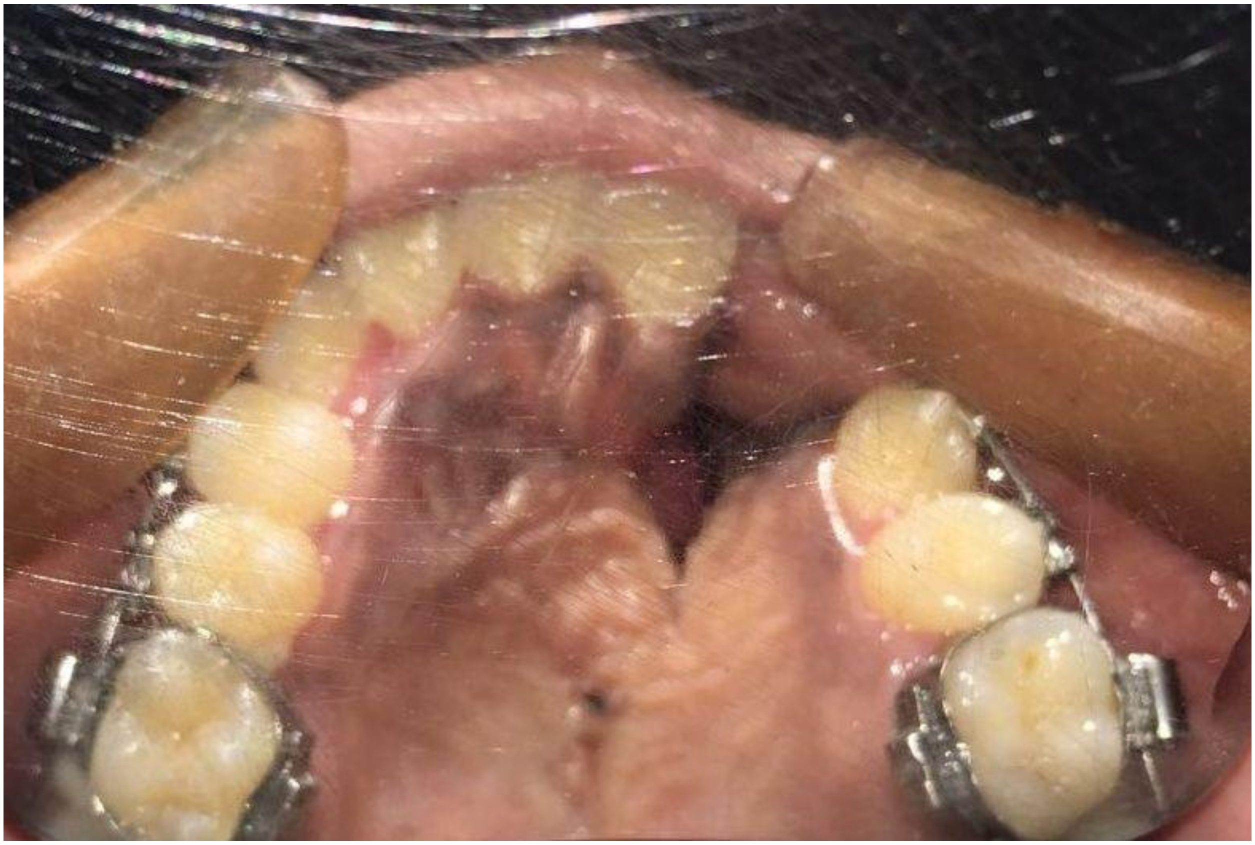

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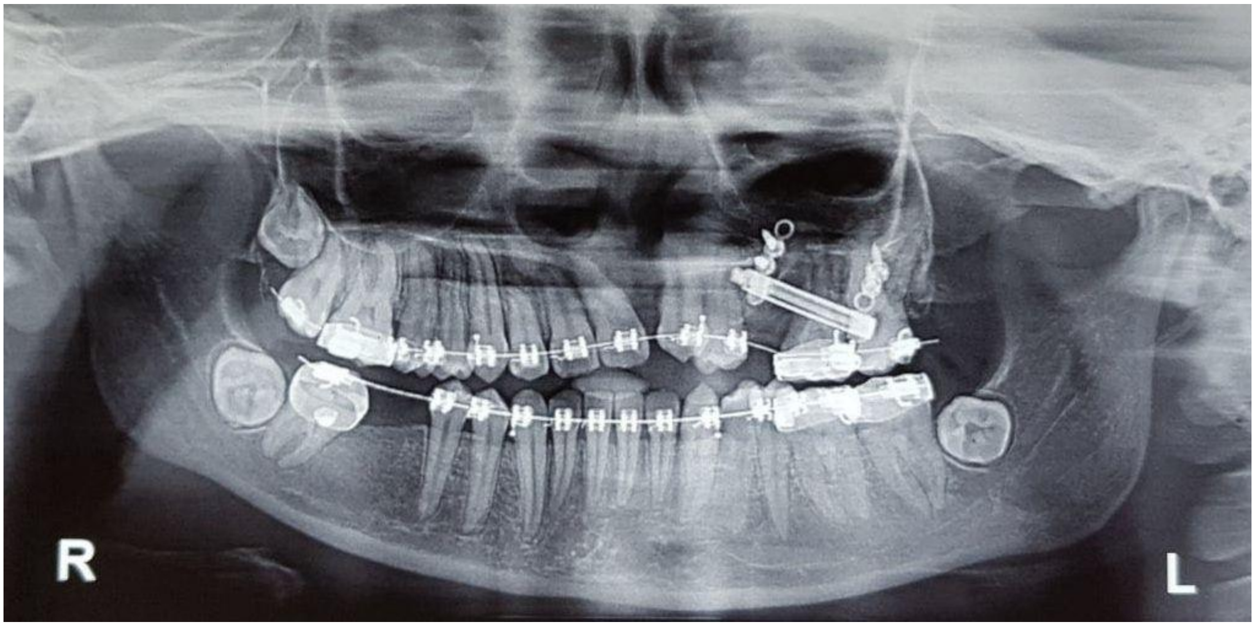


Figure 3.4: Post op OPG showing closure of alveolar defect and new bone formation in the region of distraction

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