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Clinical Paper
Cleft Lip and Palate

# Transpalatal distraction osteogenesis prior to alveolar bone grafting in cleft lip and palate patients

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*K. M. El-Sayed, H. Khalil: Transpalatal distraction osteogenesis prior to alveolar bone grafting in cleft lip and palate patients. Int. J. Oral Maxillofac. Surg. 2010; 39: 761–766.* 

*Abstract.* Alveolar bone grafting is a standard method for treating alveolar cleft. To ensure the best outcome, improving the arch form as well as soft tissue quality in the area around the cleft is recommended. In this study, 11 patients who presented with alveolar cleft and collapsed maxillary arch were treated in the following sequence: transpalatal distraction osteogenesis followed by soft tissue surgery in some cases and by cancellous bone graft. In all cases, transpalatal distraction osteogenesis successfully corrected the transverse maxillary deficiency. One case showed a complete loss of the bone graft. Other minor complications were reported but they did not affect the final outcome.

Key words: cleft lip and palate; alveolar cleft; distraction osteogenesis; transpalatal distraction; cancellous bone graft; maxillary collapse.

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Bone grafting of the alveolar cleft is an integral part of rehabilitation of patients with cleft lip and palate deformities. The benefits and goals of this procedure include stabilization of the maxillary arch, elimination of oronasal fistulae, creation of bony support for subsequent tooth eruption and dental implant placement, and reconstruction of the hypoplastic pyriform aperture[4,16].

Collapse of the maxillary minor segment is one of the most common features in patients with repaired unilateral cleft lip/palate[13]. To achieve a high success rate in grafting these defects, optimizing maxillary arch alignment before graft placement is recommended. This usually involves transverse maxillary expansion[4]. Several techniques have been recommended for improving the arch form before grafting. These include orthodontic maxillary expansion, two stage Le Fort I osteotomy, rapid maxillary expansion, and surgically assisted rapid maxillary expansion. Generally, non-surgical expansion is indicated in patients under the age of 12 years and is associated with complications when used in skeletally mature patients[12]. Recurrence of the collapse and alveolar bone effects are among the reported complications[8,12,17].

Transverse maxillary expansion with a bone-borne transpalatal distractor has been used with favourable results in congenital and acquired transverse maxillary deficiency[9,10,19]. Most of the published data on transpalatal distraction osteogenesis relate to series applied in non-congenital defects or case reports applied in congenital cases[10]. The authors' aim was to evaluate the outcome of palatal expansion by bone-borne transpalatal distraction in collapsed maxillary arch and its influence on the success of subsequent alveolar cleft grafting in cleft lip and palate patients.

## Patients and methods

From 2002 to 2007, 11 patients with different forms of alveolar cleft were included in this study (3 females and 8 males). The age of the patients at the time of presentation ranged from 15 to 28 years

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(mean 19.7 years). The patients were treated with transpalatal distraction osteogenesis, then optional soft tissue improvement, followed by alveolar bone grafting.

The inclusion criteria were: unrepaired unilateral or bilateral alveolar cleft; no previous attempt at alveolar bone grafting; no previous active orthodontic treatment; unilateral or bilateral collapsed maxillary arch with skeletal cross bite that could not be corrected by non-surgical expansion as indicated by the treating orthodontist; erupted canine at the time of presentation.

## Treatment protocol

Maxillary expansion was carried out using a bone-borne transpalatal distractor (Surgi-Tec, Bruges, Belgium). After 5–7 latency days, expansion was achieved at a rate of 0.33–0.66 mm per day until the required transverse maxillary width was reached. The device was retained for 4 months for consolidation and removed under local anaesthesia. After the first 2 months of the consolidation period, the soft tissue on the buccal side of the maxilla was evaluated. In case of inadequate soft tissue mucosa to cover the subsequent bone graft, vestibuloplasty was performed. 2 months after removal of the distractor, grafting of the alveolar cleft was carried out with an iliac cancellous bone graft.

## Transpalatal distraction osteogenesis surgery

A mucoperiosteal flap was elevated through a gingival incision extending from the distal margin of the ipsilateral first molar to the cleft side. The incision began around the cleft to the other side of the premaxilla. In unilateral cases, the incision continued to the other side of the cleft until it reached the canine on the opposite side. In bilateral cleft, the same incision was used bilaterally as well as elevation of the mucosa over the premaxilla. Osteotomy of the maxillary buccal bone and lateral nasal bone were performed high, away from the roots of the teeth and just below the zygoma. It extended from the lateral nasal wall to the pterygomaxillary fissure without disjunction. The maxillary segment was tested for movement to ensure distraction was possible. In unilateral collapse, the osteotomy stopped at the cleft edge, while in bilateral cases osteotomy was carried out on both sides of the maxilla leaving the premaxilla bone untouched.

After osteotomy, the nasal mucosa was elevated and sutured if possible. In some cases, this was difficult or impossible because of the severe overlap of the premaxilla and the lateral segments. The distractor was then placed in the palate opposite the first premolars with no mucosal incision. The distractor was secured in the palatal bone with a 5–7 mm transmucosal screw. If possible, the oral mucosa on the buccal side was sutured over the defect closing the cleft with soft tissue only.

## Alveolar bone grafting

In all cases, bone graft was harvested from the anterior iliac crest through a medial approach with minimal incision. Only cancellous bone chips were harvested. The bone graft was condensed and placed into the reopened cleft. Palatal fistula, if present, was closed at this stage. Soft tissues closure was easy because of the previous distraction and soft tissue procedures. Figure 1 is an example of the sequence of treatment in a unilateral alveolar cleft with unilateral collapsed maxilla.

For each patient, study models were taken prior to distraction and immediately after distractor removal. The maxillary arch width was calculated at three points: canines, first premolars and first molars. The mark point for each tooth was determined by two intersecting lines, a gingival margin line and a line at the midpoint of the mesiodistal width of the tooth. The mean and standard deviation of the inter-arch distance and the percentage of arch width growth were calculated for each of these three points in each cast. Paired *t* tests were calculated for each of these points to assess the significance of maxillary arch width expansion. To assess bone formation in the cleft area, a periapical and orthopantomogram were taken before and 6 months after grafting. Patients were followed clinically for wound dehiscence, development of infection, persistence of oronasal fistulae, partial or complete loss of the graft, tipping of the maxillary segments and donor side morbidity.

## Results

Of the surgical cases, 5 patients presented with bilateral cleft and 6 with unilateral cleft. All patients had had their cleft lip and palate closed early in life and no previous attempt had been made at alveolar cleft closure or grafting. At the time of distraction, the permanent canines of all patients had erupted.

There were no intra-operative complications such as malfracturing or excessive bleeding. In two cases, it was difficult to place the distractor in the first premolar area as the distance was too small to accommodate the smallest available distractor. In these cases, the distractor was initially placed more posteriorly during the first week of active distraction. Another distractor was placed at the first premolar level to achieve more anterior distraction. Patient data are given in Table 1. The pre- and post-distraction

*Table 1*. Patient data.

| Patient | Age | Sex | Type of cleft | Pre-distraction vestibuloplasy | Minor graft loss | Total graft loss | Palatal fistula remained | Donor site morbidity | Failure of distraction | Distractor looseness |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 22 | Male | Bilateral | Mucosal graft vestibuloplasty | No | No | No | No | No | No |
| 2 | 20 | Male | Unilateral | No | No | No | No | No | No | No |
| 3 | 19 | male | Bilateral | No | No | No | No | No | No | Yes |
| 4 | 21 | Male | Bilateral | No | yes | No | No | No | No | No |
| 5 | 28 | Male | Unilateral | Scar release-z-plasty | No | No | No | No | No | No |
| 6 | 23 | Female | Unilateral | No | No | Yes | Yes | No | No | Yes |
| 7 | 15 | Male | Unilateral | No | No | No | No | No | No | No |
| 8 | 16 | Female | Bilateral | No | No | No | No | No | No | No |
| 9 | 19 | Male | Bilateral | No | No | No | No | No | No | No |
| 10 | 16 | Female | Unilateral | Mucosal graft vestibuloplasty | No | No | No | No | No | No |
| 11 | 18 | Male | Unilateral | No | Yes | No | No | No | No | No |

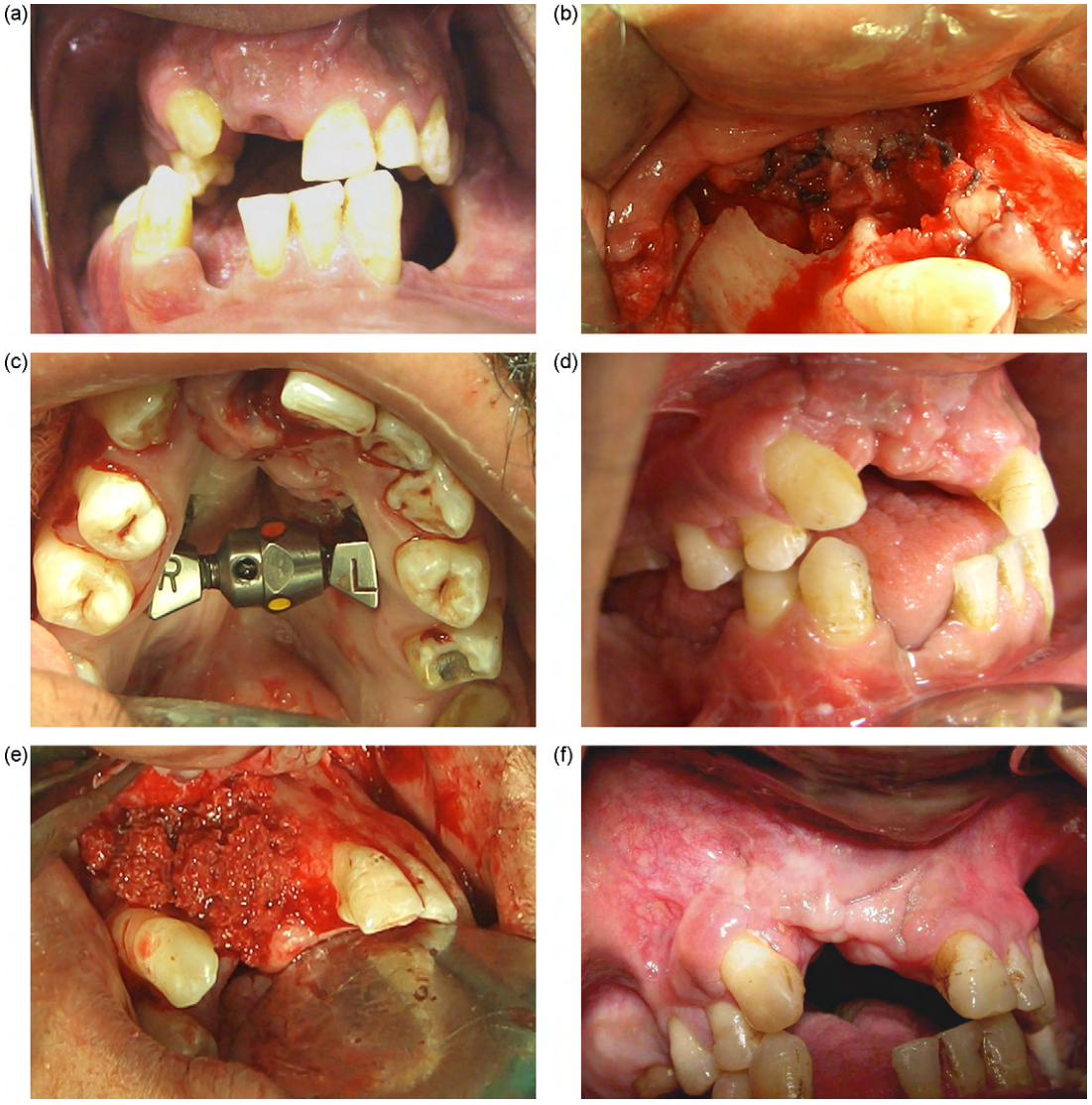


*Fig. 1*. (a) Preoperative alveolar cleft with unilateral asymmetry of the maxilla. (b) Operative (distraction) photograph showing lateral osteotomy and sutured nasal mucosa during insertion of the distractor. (c) Transpalatal distraction osteogenesis in place in the first premolar area. (d) Occlusion and soft tissue healing after removal of the distractor and before grafting. (e) Second surgery with cancellous bone graft in the defect. (f) Post-grafting showing healed cleft site.

casts were measured twice by the same investigator to ensure measurement accuracy. Paired *t* tests showed no significant differences between the first and second measurements. The mean inter-arch distance and standard deviation at the canines, first premolars and first molars are shown in Table 2. In all cases, transpalatal distraction osteogenesis successfully corrected maxillary collapse and cross bite. *t* tests showed high significance between the pre- and post-distraction inter-arch distances for all measured points. The percentage of arch width improvement was more at the canine (37%), followed by the first premolars (35%) and the first molars (27%).

There were no intra-distraction complications such as infection, infraorbital nerve damage or teeth looseness. Device-related problems occurred in two cases, patients experienced looseness of the distractor dur-

*Table 2*. Pre- and post-transpalatal distraction osteogenesis cast measurements.

| | Pre-distraction | After distraction | Percentage of expansion | *t* test probability |
|---|---|---|---|---|
| Canine–canine mean | 19.27 | 25.81 | 37.3% | Highly significant |
| SD | 4.54 | 4.42 | | |
| 1st premolar–1st premolar mean | 19 | 25 | 34.6% | Highly significant |
| SD | 3.76 | 3.49 | | |
| 1st molar–1st molar | 28.636 | 36.18182 | 27.2% | Highly significant |
| SD | 3.500 | 3.1565 | | |

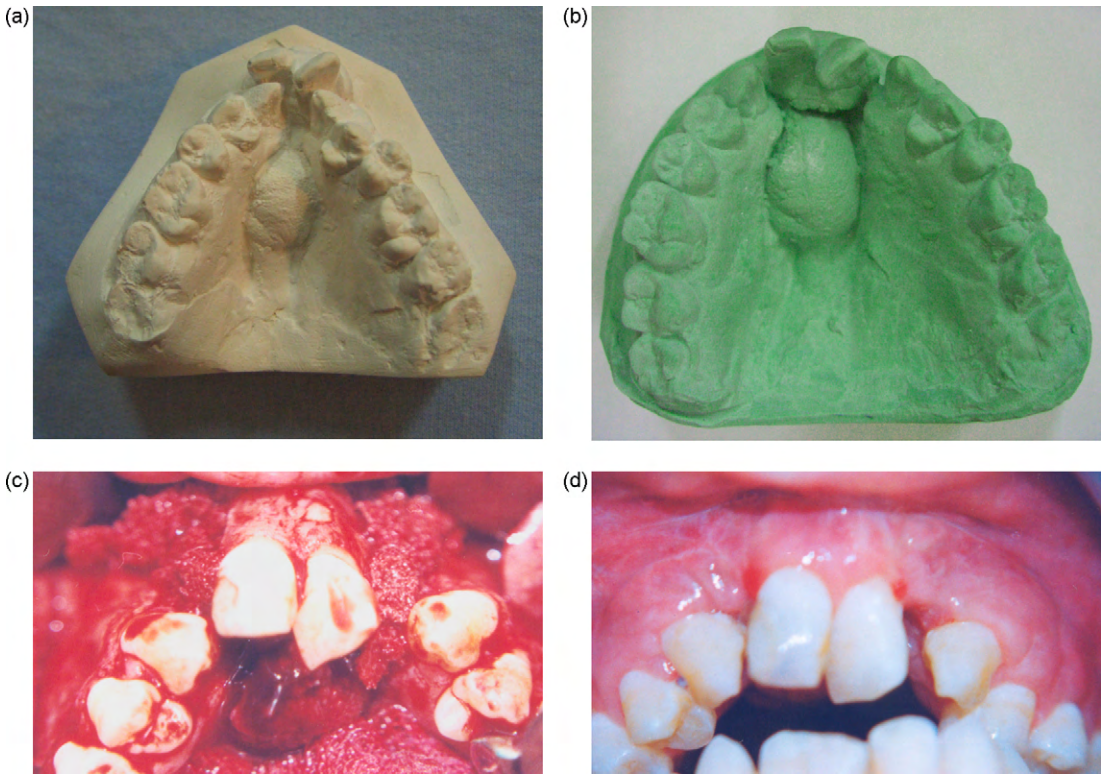


*Fig. 2*. (a) Preoperative dental cast of a patient with severe maxillary collapse and bilateral alveolar cleft. (b) Post-distraction dental cast with correction of the maxillary collapse. (c) Bilateral cancellous bone graft after transpalatal distraction osteogenesis proceeded with mucosal graft vestibuloplasty. (d) Appearance of the maxilla 1 month after bone grafting.

ing the second week, which required replacement and fixation of the distractor with two emergency screws under local anaesthesia. Distraction continued in a regular manner. Figure 2 shows the pre- and post-operative appearance of a bilateral alveolar cleft with severe bilateral collapse.

Soft tissue evaluation after transpalatal distraction osteogenesis showed that only 3 patients needed soft tissue improvement in preparation for grafting. Two of them received mucosal graft vestibuloplasty, the other was treated by scar release with z-plasty. Nasal mucosal suturing and palatal closure were facilitated by the previous transpalatal distraction osteogenesis. During bone grafting there was no difficulty in achieving a tension-free soft tissue closure to cover the graft in any of the cases. Graft failure was reported in one case with complete loss of the graft and persistence of the alveolar cleft. Two other cases showed partial bone loss, which did not influence the final outcome of the graft. There was no case of tooth looseness, tipping of the distracted segment or donor site morbidity. One case showed persistent palatal fistula. Radiographic analysis revealed osseous bridging of the former cleft in only 10 patients.

## Discussion

Secondary alveolar bone grafting has been established as the 'gold standard' for alveolar cleft reconstruction and has provided a foundational support in contemporary cleft management[3,18]. There are several objectives for alveolar cleft reconstruction, but uniting the cleft maxilla into one continuous arch is a universal goal in alveolar cleft management[4,6,7,21]. This is important for subsequent arch rehabilitation and before distraction osteogenesis to bring the maxilla forward.

To achieve a high success rate in alveolar cleft grafting, optimizing the hard and soft tissue status around the cleft is indicated[7]. This means that the soft tissues in the nasal side as well as oral mucosa should be closed to obtain perfect coverage of the graft. Hausamen & Schmelzeisen[6] stated that a standardized safe method to close the cleft alveolus is to use a double-layer technique. Correcting the collapsed maxilla before grafting also aids suturing of the nasal mucosa, which is not possible if the maxillary segments are severely collapsed. That was also the authors' clinical impression in many of the treated cases, in which nasal mucosa suturing was impossible or difficult due to overlapping of the bony segments.

Correction of maxillary collapse can be achieved using several non-surgical methods but they have restrictions and drawbacks[4,8]. Suri & Taneja[17] summarize the drawbacks of non-surgical rapid maxillary expansion used in skeletally mature patients. Problems include: lateral tipping of posterior teeth; extrusion; periodontal membrane compression; buccal root resorption; alveolar bone bending; fenestration of the buccal cortex; palatal tissue necrosis; inability to open the mid-palatal suture; pain; and instability of the expansion. Mommaerts[12] noted that for patients over 14 years, corticotomies are essential to release the areas of resistance to expansion.

Surgically assisted rapid maxillary expansion (SARME) has been proposed to produce better treatment results in adults and to prevent complications by surgically releasing the closed sutures resisting the expansion forces[1,17,19]. SARME has recently been replaced by transpalatal distraction with superior results[5,9,11,19]. According to Mommaerts[12] conventional tooth-borne appliances produce greater loss of anchorage and more skeletal relapse

during and after expansion. Higher incidences of cortical fenestration and buccal root resorption are also observed with tooth-borne appliances compared with absolute bone-borne appliances. Application of the bone-borne distractor does not rely on complete dentition. Transpalatal distraction osteogenesis has been used extensively in the expansion of maxillary collapse in non-congenital defects[5,9,12,14]. Few reports have been published reporting transverse expansion of the maxilla using bone-borne transpalatal distraction osteogenesis in cleft lip and palate patients and most of these articles are case reports[10,11]. In the present study, transpalatal distraction osteogenesis successfully corrected maxillary collapse in all cases. The outcome of distraction of the maxilla was more effective in the canine region followed by the premolar region; the molar region was least successful. This agrees with the results of Pinto et al.[14] who reported expansion of $36 \pm 17\%$ at the canines, $32 \pm 14\%$ at the first premolars and $20 \pm 9\%$ at the first molars. The same finding was also reported by Günbay et al.[5]

Another possible application of distraction osteogenesis in cleft alveolus surgery is to use it in complete closure of the cleft or to reduce the gap needed to be grafted. This could be applied in cases with a normal arch form as the distractor is not flexible to move the segment anteriorly and expand the arch at the same time. A potential complication of this procedure is the prevention of complete approximation of the lateral segments resulting from premature contact at the narrow part of the cleft as the segments are being transported[11]. This technique could not be used in the present cases because of severe malalignment of the maxillary segments. Another sequence of treatment for such cases is to perform bone grafting, if possible, followed by distraction ontogenesis in order to benefit from the small gap between the bone edges. This requires osteotomizing a grafted bone that is already thin, which may cause further bone resorption.

The complications in this study did not differ from those of routine grafting procedures. The success rate of 91% is reasonable, considering how complicated the treated cases were. The reported success rate of alveolar bone grafting is 81–90%, when grafting is performed at the optimal time (8–11 years of age and before canine eruption)[4,6]. Patients in this series were grafted after the eruption of the permanent canines and at an older age. It is known that grafts carried out after canine eruption adversely influence the success rate[2,15]. There is a significant association between the monthly increase in age at bone grafting and poor outcome in children with unilateral cleft lip and palate[20]. The relatively high success rate of alveolar bone grafting in this report, considering the patients' age, complexity of the defect and grafting after canine eruption, could be attributed to the procedures used to optimize the recipient site.

One objection to the present technique is that transpalatal distraction osteogenesis will widen the gap between the bone edges, making soft tissue closure more challenging. The authors found no difficulties in closing the soft tissues without tension either on the nasal or oral sides. In the first operation during transpalatal distraction osteogenesis insertion, an attempt was made to suture and unite the soft tissue around the cleft at least on the buccal side; it helped in distracting and lengthening the soft tissues during bone distraction. The authors find that the treatment protocol reported here is a logical and successful way to treat complicated alveolar cleft with a reasonable success rate.

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## Competing interests

None declared.

## Ethical approval

Not required.

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