

Transantral distraction devices in correction of severe maxillary deformity in cleft patients

Shokhruh Shokirov, Konrad Wangerin

SUMMARY

Maxillary advancement by Le Fort I osteotomy in cleft patients has an average relapse of about 40-60 percent. With extraoral distraction devices it is possible to obtain an almost unlimited advancement of the upper jaw. Due to the social problems the retention period is normally reduced to some months. A relapse of 10-25 % can be seen in these cases. Le Fort I internal distraction osteogenesis offers an alternative to one-step orthognathic advancement, with advantages of gradual lengthening through scar and earlier treatment in growing patients. The objective of this study was to present our experience in the treatment of maxillary deficiency in cleft patients using transantral internal distraction devices. The distraction procedure was successfully accomplished in seventeen patients. For all the seventeen patients maxillary distraction device designed by Konrad Wangerin was used. The distraction distances were 8 to 24 mm. Preoperative, postoperative, and follow-up (12 and 24 months) lateral cephalogram measurements were compared including angular and linear changes. A good new bone was found that was formed in distraction pitch between lines of osteotomy. After distraction of median facial zone, occlusion and profile of soft tissues were considerably improved. All patients after postoperative time required final orthodontic treatment and their final occlusal relationships were satisfactory. The transantral distraction device is a new option for the treatment of severe maxillary hypoplasia in cleft patients.

Key words: cleft lip and palate patient, distraction osteogenesis, cleft maxillary distraction.

INTRODUCTION

The primary cleft lip and palate repair performed during infancy and early childhood improves the facial appearance, speech, and deglutition, but these early surgical interventions cause an impairment of maxillary growth, producing secondary deformities of the jaw and malocclusion. In 20-25% of patients, orthodontic treatment alone is not sufficient and surgical correction of the class III malocclusion is required [2, 4]. Patients with severe cleft maxillary deficiency are difficult to treat with standard surgical orthognathic surgery. Treatment of severe maxillary hypoplasia with conventional Le Fort I maxillary advancement, especially in patients with orofacial cleft, has been unstable. Although rigid internal

fixation and bone grafting have greatly improved the postoperative stability of orthognathic surgery, the soft-tissue scar restriction and the poor quality of skeletal bone available for rigid internal fixation still make the relapse rate in these patients as high as 40 to 60 percent [5, 7].

The technique of distraction osteogenesis has provided wholly new ideas and methods for the correction of this kind of deformity. The first report of successful midface advancement by gradual distraction cleft patient by Cohen et al. and his associates dramatically changed the concepts of craniofacial reconstruction and especially in cleft patients with presenting severe maxillary hypoplasia [2]. An external adjustable rigid distraction device for midface distraction has been used with satisfactory results [3, 8]. The experience gained with external distractors in various applications has aided the development of internal distraction devices in the field of maxillofacial distraction osteogenesis, particularly in the maxillary and midface regions [1, 3, 4, 8, 10, 11].

¹Tashkent Medical Academy

²Department of Maxillofacial Surgery, Marienhospital, Stuttgart, Germany

Shokhruh Shokirov¹ – Ph.D.

Konrad Wangerin² – Prof., Dr. med., Dr. med. dent., Dr. h. c.

Address correspondence to Dr. Konrad Wangerin,
Böheimstraße 37, D 70199 Stuttgart, Germany
E-mail address: mkg@vinzenz.de

The objective of this study was to present our experience in the treatment of maxillary deficiency in cleft patients using transantral internal distraction devices.

PATIENTS AND METHODS

Seventeen patients (13 males and 4 females) with severe cleft maxillary hypoplasia (a negative overjet of 8 mm or more) were treated between January of 2003 and July 2009. Age at the time of surgery ranged from 13 to 35 years. The types of cleft lip and palate deformity of the patients were as follows: unilateral cleft lip and palate 6 patients, bilateral cleft lip and palate 7 patients and cleft palate alone 4 patients.

All had undergone primary lip and palate repair in infancy and early childhood, and all had previously been treated by secondary bone grafting of the alveolus and maxilla between the ages of 8 and 11 years.

Outcome analysis was based on clinical examinations, photographs, and cephalometric measurements pre- and postoperatively. After 1-3 years patients were asked to come for reexamination. For all the seventeen patients maxillary distraction device designed by Konrad Wangerin [12] was used (Fig. 1)

The criteria for patient selection included patients older than 12 years of age who had maxillary hypoplasia with class III relationships and a negative overjet of 8 mm or more. Other considerations for inclusion included cleft patients with severe palatal and pharyngeal scarring, pharyngeal flaps, and airway obstruction, and patients who had failed traditional maxillary advancement with orthognathic surgery (there were 2 cases with such result).

Surgical Techniques and Osteotomy

All patients underwent Le Fort I osteotomy and application of a transantral distraction device (Fig. 2.). The size of the device can be changed with the screwdriver by extending the blunt spike, which will be stuck into the bony rear wall of the sinus. The straight three-hole miniplate, fixed onto the front border of the distraction cylinder, is fixating the device onto the piriform aperture. The angled miniplate is fixed on the canine fossa of the mobile maxilla to push it forward. Intraoperative distraction will be performed by anticlockwise rotation of the distraction screw. The angled extension piece causes transmucosal activation in the maxillary floor of the mouth and may be removed after distraction is complete [12].

Calculation of vector of distraction was performed. A complete osteotomy for in each patient included pterygomaxillary disjunction and septal

disjunction and careful medial sinus wall separation. The maxilla was mobilized just enough to ensure that the skeletal osteotomy had been completed. Access and adaption of the distraction device was performed, followed by the monocortical fixation of the distractors device and wound closure. The fixation of the devices above the osteotomy line is performed by a pin in the pterygoid bone and a miniplate paranasally. Traditional aggressive down fracturing was not performed. Radiographic control may help to obtain parallelism.

Distraction Protocol

After a 5-day latency period transantral distraction was performed at a rate of 1 mm per day for 8 to 24 days, according to the patients degree of deformity. The distraction vector was controlled forward and slightly downward. The amount of distraction was measured at the osteotomy line on the basis of preoperative and postoperative cephalograms. The activation pins, laying in the upper vestibule, are pulled off at the end of the distraction period. After a 8- to 12- months consolidation period, the distraction devices were removed.

Cephalometric Evaluation

The preoperative and postoperative lateral cephalometric radiographs were utilized for analysis (Fig. 3). Lateral cephalograms were taken preoperatively (T1), after distraction (T2), and after 1 year (T3) and 2 years (T4) of follow-up. Cephalometric measurements concerning skeletal and dental relationships were taken, and the results were compared after 1 and 2 years of follow-up (Table). The cephalometric analysis included four sets of measurements:

- Skeletal maxillary: SNA: Angle S-N-A: sagittal position of maxillary alveolar process relative to the anterior cranial base; maxillary length (Co-A).
- ANB – Angle A-N-B: sagittal position of mandibular alveolar process relative to the maxillary alveolar process and anterior cranial base.
- Dental relationship: upper I to Sn (sellanasion); overjet.
- Soft tissue: Upper lip protrusion mm, nasolabial angle, Gl'-Sn'-pog (glabella-subnasalpogonion).

RESULTS

All 17 patients with cleft lip and palate after cheilo- and uranoplasty had several deformities of

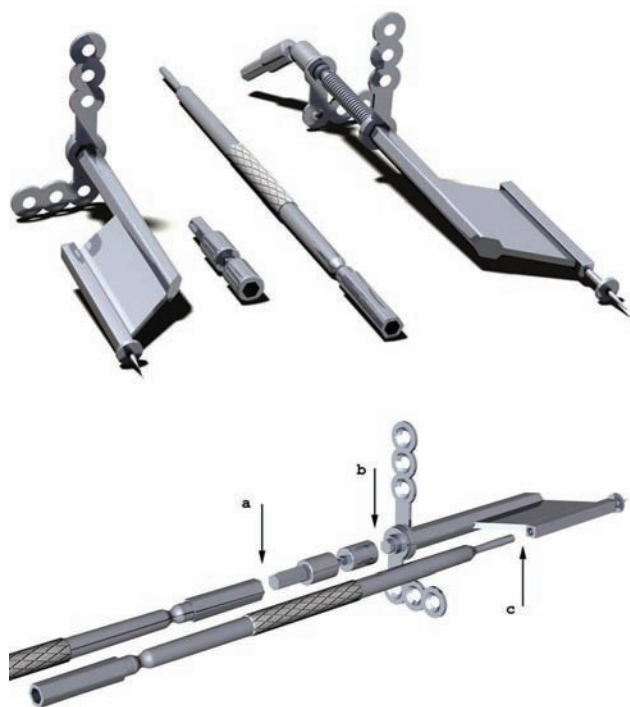


Fig. 1. Transantral distraction device designed by Konrad Wangerin

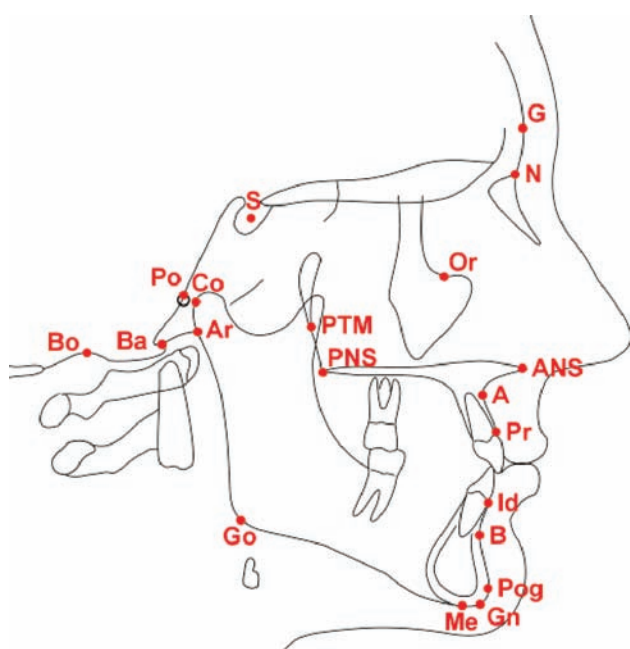
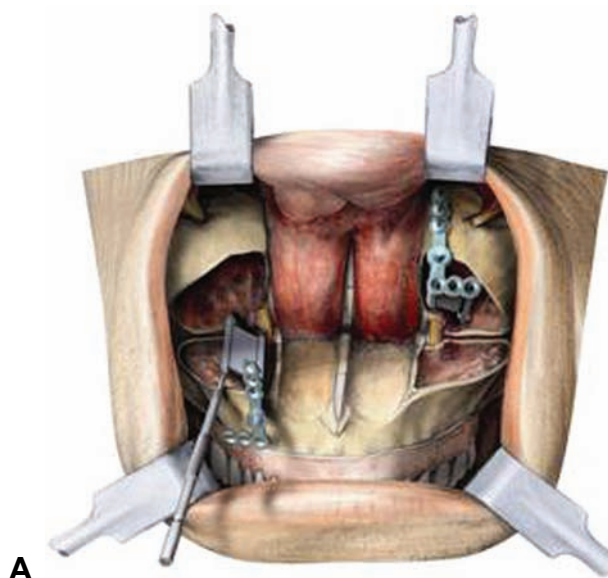
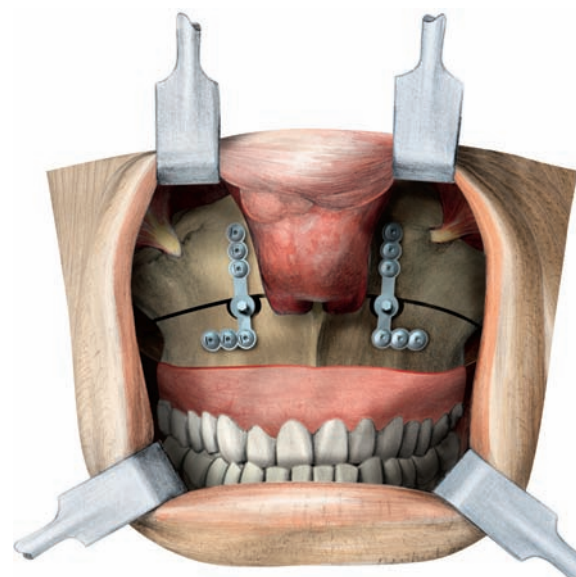


Fig. 3. Reference landmarks used for the cephalometric analysis

- A-point (Point A) – subspinale, ss;
- ANS – anterior nasal spine;
- B-point (Point B) – supramentale, sm;
- Co – condyion
- G – glabella;
- N, Na – nasion;
- Or – orbitale;
- Pog, P, Pg – pogonion;
- PNS – posterior nasal spine;
- PTM, Pterygomaxillare – pterygomaxillary fissure;
- S – sella;
- Sn – subnasale;
- Gn' – soft tissue gnathion.



A



B

Fig. 2. A – fitting the transantral distractor, whose rear spike is extended with the screwdriver in accordance with the depth of the maxilla and inserted into the bony rear wall of the maxillary sinus lateral to the neurovascular bundle. B – the mobile maxilla is folded up and with the aid of the angled miniplates is fixed on the lateral upper border of the osteotomy near the canine fossa.

maxilla as degree of severity in the form of dimension of maxilla sizes, reposition of upper jaw, disturbance of bite in sagittal, vertical and transversal planes, discrepancy of dentition. The maxillary retrusion was manifested mainly by reduced maxillary length (Co-A), decreased SNA angle, and a negative overjet (Table).

The distraction procedure was successfully accomplished in seventeen patients. In all patients, the average maxillary advancement was 13 mm (11 mm on the left side and 10 mm on the right; 8 to 24 mm). There were no cases of surgical morbidity, dental injury, infection or gingival injury in any of the 17 patients. None of the patients required a blood



Fig. 4. Lateral cephalograms. The patient at 17 years old. (Above, left) Preoperative view. (Above, right) Immediately after Le Fort osteotomy. (Below, left). Six months postoperatively. (Below, right). 12 months postoperatively

transfusion. There were no complications from bleeding or infection and no complications of either bony, dental, or soft-tissue viability in any of the maxillary segments. The follow-up period ranged from 1 year to 3 years. All patients underwent the distraction process uneventfully. There were no problems with wearing the device and no problems with maintenance of the intraoral splint throughout

the active and retention phases of distraction.

The preoperative and post treatment cephalometric measurements and the cephalometric changes are presented in Table.

The maxillary movement was demonstrated by the increased SNA angle and maxillary length (Co-A) (Table). The mean maxillary anterior movement, as measured by dental overjet, was 14.7 mm, and the

Table. Cephalometric Values before Distraction, after Distraction, and at 1- and 2-year Follow-Up (n=17 patients)

Variables	(n=17)				P
	Preoperatively T-1	Immediately after distraction T-2	1 years after distraction T-3	2 years after distraction T-4	
SNA (degrees)	72.3±3.4	83.1±3.1	82.0±3.3	82.0±3.1	*
ANB (degrees)	-4.3±0,9	5.0±1,2	3.9±1.3	3.7±1.3	*
Upper 1 to SN, degrees	94.1±2.2	102.8±1.8	102.3±1.8	102.2±1.8	*
Overjet, mm	-11.8±3.5	2.9±1.4	2.6±1.7	2.5±0.8	*
Maxillary length Co-A, mm	82.3±2.6	103.8±2.4	102.6±2.1	102.6±2.0	*
Upper lip protrusion, mm	-5.6±2.2	1.1±1.3	1.0±1.3	0.9±1.2	*
Nasolabial angle (degrees)	89.0±2.2	105.0±2.3	103.3±2.8	103.1±2.6	*
GI'-Sn'-Pog' (degrees)	3.0±1.2	13.5±1.3	13.0±1.4	13.0±1.4	*

* T1 versus T2, T1 versus T3, T1 versus T4: p<0.05

occlusion changed from class III to class I with slight overcorrection. Cephalometric analysis showed that the SNA angle was between 69.5 degrees and 78.0 degrees, with an average of 72.3±3.4 degrees preoperatively, 83.1±3.1 degrees immediately after distraction, 82.0±3.3 degrees 12 months postoperatively, and 82.0±3.1 degrees in the 24 months postoperative period. ANB angle advancement in negative side -4.3±0,9 degrees responds to dentition correlation by Angle III class. The ANB values (in degrees) were as follows: preoperative -4.3±0,9; immediately after distraction 5.0±1,2; and follow-up (>1 and 2 years) 3.9±1.3 and 3.7±1.3. There was associated improvement in facial convexity, as demonstrated by the increased GI'-Sn'-Pog' angle. The increased nasolabial angle increased was due to the maxillary support to the base of the nose, and there was greater aesthetic balance between the nose and the upper lip. Control cephalometric measurements performed in 12 and 24 months showed stable position of maxilla (Fig. 4).

In all seventeen patients after 10-12 months retention phase distraction device removal was performed. A good new bone was found that was formed in distraction pitch between lines of osteotomy. The surface of a new bone was a little lower than the surface of surrounding normal bones but had rigid structure. In 5 of 17 patients for maxilla stabilization autobone plasty from iliac crest was used and fixed with titanic miniplates. All the surgical procedures were combined with orthodontic treatment.

The cephalometric measurements for the skeletal and dental relationships were compared after 1 and 2 years and revealed satisfying stability (Table). In 24 months maxilla position and occlusion became stable in all patients, no apparent relapse followed.

DISCUSSION

It is known that 25 to 70 percent of all patients born with cleft lip and palate will require maxillary advancement to correct the maxillary hypoplasia and improve aesthetic facial proportion. In the treatment of hypoplastic cleft palate with conventional Le Fort I osteotomy and major advancement, the extreme discrepancies make stabilization difficult, and the added effect of palatal scarring can result in significant post surgical relapse [5, 7]. On the other hand, distraction osteogenesis provides an alternative method for maxillary advancement in patients with a great tendency to relapse, such as cleft palate patients. McCarthy et al. introduced the clinical use of distraction osteogenesis on membranous bone in 1992 with mandibular distraction [6]. Figueroa and Polley used a rigid external distraction device to treat maxillary deficiency [3]. Molina et al. suggested an incomplete Le Fort I osteotomy for a face-mask appliance with an intraoral dental splint [8]. However, Swennen et al. subsequently reported significant dentoalveolar changes with this method and recommended a complete osteotomy [11]. Other surgeons have modified the procedure further, preferring bone-borne wires or plates and screws over a dental splint [8, 9].

In our center an internal device is preferred over an external device because the device is hidden and better tolerated by the patients [10, 12]. The internal distraction device has potential benefits, such as elimination of the skin scarring caused by translation of transcutaneous fixation pins, improved patient acceptance during the fixation or consolidation period because there is no external component. Compared with the conventional surgical method, the distraction osteogenesis technique can move the maxilla

for more distance. A continuous distraction force not only facilitates bone formation in the distraction gap but also promotes soft-tissue proliferation, this can greatly lower the soft-tissue scar restriction and increase postoperative stability, will have a less negative effect on the patients velopharyngeal closure.

Advancement of the maxilla in all seventeen patients with severe maxillary hypoplasia using distraction osteogenesis with an intraoral distraction device has been performed successfully. In the present study, the distraction length was between 8 and 24 mm, with an average distraction length of 13 mm. In all of patients, forward distraction was performed after the secondary bone grafting. It took place between the ages of 9 and 12 years. It is preferable to connect the distraction device to one intact segment of maxilla rather than to two (in unilateral cleft) or three (in bilateral cleft) segments of bone, for better control of movement and better bone healing. After distraction of median facial zone,

occlusion and profile of soft tissues were considerably improved. All patients after postoperative time required final orthodontic treatment and their final occlusal relationships were satisfactory.

CONCLUSIONS

Distraction osteogenesis is a principally new method for correction of secondary maxilla deformities. Its use for patients with severe secondary deformities of jaws permits gradual maxilla advancement in necessary position due to stimulation of osteogenesis.

The results of this study show that the upper jaw in cleft patients can be lengthened successfully using transantral internal distraction device with long-term stability. The advantage of maxillary distraction lies in the positive soft-tissue changes of increased nasal projection, normalized nasolabial angle, and a more prominent upper lip.

REFERENCES

1. Cho BC, Kyung HM. Distraction osteogenesis of the hypoplastic midface using a rigid external distraction system: the results of a one- to six-year follow-up. *Plast Reconstr Surg* 2006; 118:1201-12.
2. Cohen SR, Burstein FD, Stewart MB, Rathburn MA. Maxillary-midface distraction in children with cleft lip and palate: a preliminary report. *Plast Reconstr Surg* 1997;99:1421-8.
3. Figueroa AA, Polley JW, Ko EW. Maxillary distraction for the management of cleft maxillary hypoplasia with a rigid external distraction system. *Semin Orthod* 1999;5: 46-51.
4. Harada K, Baba Y, Ohyama K, Omura K. Soft tissue profile changes of the midface in patients with cleft lip and palate following maxillary distraction osteogenesis: A preliminary study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002;94:673-7.
5. Hoffman GR, Brennan PA. The skeletal stability of one-piece Le Fort 1 osteotomy to advance the maxilla; Part 2. The influence of uncontrollable clinical variables. *Br J Oral Maxillofac Surg* 2004;42:226-30.
6. McCarthy JG, Schreiber J, Karp N, Thorne CH, Grayson BH. Lengthening the human mandible by gradual distraction. *Plast Reconstr Surg* 1992;89:1-8.
7. Minami K, Mori Y, Tae-Geon K, Shimizu H, Ohtani M, Yura Y. Maxillary distraction osteogenesis in cleft lip and palate patients with skeletal anchorage *Cleft Palate Craniofac J* 2007;44:137-41.
8. Molina F, Ortiz Monasterio F, de la Paz Aguilar M, Barrera J. Maxillary distraction: Aesthetic and functional benefits in cleft lip-palate and prognathic patients during mixed dentition. *Plast Reconstr Surg* 1998;101:951.
9. Rachmiel A, Aizenbud D, Peled M. Distraction Osteogenesis in Maxillary Deficiency Using a Rigid External Distraction Device. *Plast Reconstr Surg* 2006; 117:2399-406.
10. Shokirov Sh., Wangerin K., Kretschmer W. Intraoral distraction devices in correction of maxillary deformity in cleft patients. In: Актуальные вопросы хирургии: Сб. науч. тр. Омск; 2008, с.55-56.
11. Swennen G, Colle F, De Mey A, Malevez C. Maxillary distraction in cleft lip palate patients: A review of six cases. *Cleft Palate Craniofac J* 1999;10:117-22.
12. Wangerin K. Our concept of intraoral distraction. *Stomatologie* 2005; 102:79-87.

Received: 30 09 2010

Accepted for publishing: 30 03 2011