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Leading Clinical Paper
Distraction Osteogenesis

Trans-sinusal maxillary distraction for correction of midfacial hypoplasia: long-term clinical results

N. Nadjmi[1], F. Schutyser[2], R. Van Erum[3]

[1]Department of Cranio-Maxillofacial Surgery, Eeuwfeestkliniek, Harmoniestraat 68, B-2018 Antwerpen, Belgium; [2]Medical Image Computing (Radiology – ESAT\PSI), Faculties of Medicine and Engineering, University Hospital Gasthuisberg, Herestraat 49, B-3000 Leuven, Belgium; [3]Private Practice Orthodontist, Consultant Orthodontist, Cleft Lip Palate Team, Antwerpen, Belgium

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Abstract. Maxillary distraction osteogenesis is indicated in severe angle class III malocclusions, and severe maxillary hypoplasia among some cleft patients and other craniofacial deformities. Twenty patients, aged 8–48 years (mean 17.8 ± 10.5 SD) with maxillary and midfacial hypoplasia were treated. The follow-up period was 13–65 months (mean 35 ± 16.3 SD). A trans-sinusal maxillary distractor was placed intraorally at each side of the maxilla. The distraction vector was predicted using specialist software, and was transferred to the patients using stereolithographic models and individual templates. A (high) Le Fort I type osteotomy was performed. The amount of activation varied from 8 to 17.5 mm (mean 13.1 ± 2.9 SD). Soft and hard tissue formation resulted in complete healing across the distraction gaps. The distractors are almost completely submerged, and can be left in place as long as necessary to avoid relapse. Wit's appraisal was used to measure the stability of the long-term distraction results. Results up to 5 years after distraction showed considerable maxillary advancement with long-term stability. Ongoing growth of the facial skeleton must be considered when distraction osteogenesis is chosen in growing patients.

Key words: midfacial hypoplasia; maxillary sinus; midface; cleft lip and palate; bone tissue; image-guided therapy; surgery simulation; distraction osteogenesis.

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A possible treatment for patients suffering from maxillary hypoplasia or midface deficiency is maxillary distraction. This can be indicated in severe angle class III malocclusions, and severe maxillary hypoplasia among cleft patients and other craniofacial deformities. Primary cleft lip and palate (CLP) repair in infancy and early childhood often results in deficient maxillary growth in the sagittal direction[11]. This can lead to pronounced maxillary hypoplasia at a young age[17]. Conventional treatment by Le Fort I type osteotomy proved to be difficult with unstable long-term results in CLP patients. Scarring from previous operations hampers mobilization of the maxilla, and relapse is more significant and frequent in cleft patients than non-cleft patients[17]. Although there are no conclusive data on any differences in terms of surgical relapse, velopharyngeal function and speech between cleft maxillary osteotomy and distraction, distraction osteogenesis tends to be preferred to conventional osteotomy for younger CLP patients with more severe deformities[2].

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Attempts to treat Class III malocclusions through the use of maxillary protracting appliances and chin caps are described, with conflicting opinions about the treatment results[10,18]. Maxillary distraction osteogenesis using an external device (Delaire facial mask) with dental anchorage showed significant dentoalveolar compensation[17]. The rigid external distraction system of Polley and Figueroa (RED II, KLS Martin Tüttlingen, Germany) permits easy device application and removal, and multidirectional movement. This device has produced satisfactory clinical results, superior to those of face-mask protraction[10], but both reverse headgear and rigid external distraction apparatus are cumbersome and highly visible[17]. In external maxillary distraction, the distraction hardware is rigidly fixed to the cranium and projects in the frontofacial midline, thus limiting oronasal airway access[25].

A low-profile, intraoral distraction device, used in an experimental study by Weinzweig et al. [21] was successful in midface distraction at the Le Fort I level, but the distraction cylinder protruded through the buccal mucosa and had to be delivered through a skin incision in the nasolabial fold area. A subcutaneous distraction device (Zurich Maxillary Distractor, KLS Martin Tüttlingen, Germany) placed in the malar region was clinically evaluated[8,23]. One distractor is installed at the left and one at the right hand side of the patient. There was difficulty in installing this pair of distractors with parallel axes to allow maximum distraction length. The distraction often resulted in a rotational more than a gliding movement, causing loss of distraction distance at the level of occlusion[8]. Delaire masks were used up to 1 year as a retention device to stabilize the results[8,23]. A recent study showed that the maxilla in young cleft patients can be lengthened successfully using intraoral distraction devices (Zurich Maxillary Distractor) with long-term stability. There was less control of the vector of lengthening in relation to the extraoral devices, and three-dimensional correction could not be achieved. With this type of distractor, the distraction length is limited to a maximum of 15 mm[15].

In the authors' previously published animal study the potential of using a trans-sinusal distractor for the correction of maxillary hypoplasia was discussed[14,16]. On the basis of those results a novel maxillary distractor has been designed with the following objectives. The device should be easy to apply, easy to activate and guarantee predictable results. It should be submerged to minimize social hindrance, and should allow normal function during the distraction and retention period. Correction of severe maxillary deficiency at a young age (6–8 years) should be possible, before the child may experience any psychosocial harm from its facial disharmony. Early results regarding the clinical applicability of this new maxillary distractor have

Table 1. Patient table with indication of age, diagnosis, sex, orthodontic treatment status and follow-up time

Case no.	Sex	Retention period	Diagnosis	Age (years)	Orthodontic treatment (yes/no)	Follow-up (months)
1	M	6	UCLP	19	Y	30
2	M	3	UCLP	21	Y	23
3	M	4	BCLP	18	Y	18
4	M	3	BCLP	22	Y	31
5	F	2.5	BCLP	9	Y	24
6	F	2.5	UCLP	10	N	20
7	F	4.5	UCLP	12	N	13
8	M	6	Trisomy 21	17	Y	29
9	M	6	BLCP	12	N	18
10	M	2	UCLP	10	N	30
11	F	6	UCLP	8	N	54
12	F	6.5	UCLP	15	Y	55
13	F	4	Treacher Collins	18	Y	19
14	M	3	BCLP	48	N	41
15	M	5	Class III	39	Y	54
16	F	3	UCLP	9	N	31
17	M	24*	Acromegaly	31	N	30
18	F	4	Class III	14	N	60
19	M	4.5	UCLP	14	N	55
20	F	3.5	BCLP	10	N	65

UCLP, unilateral cleft lip and palate; BCLP, bilateral cleft lip and palate.
* Patient lost for follow-up for 2 years.

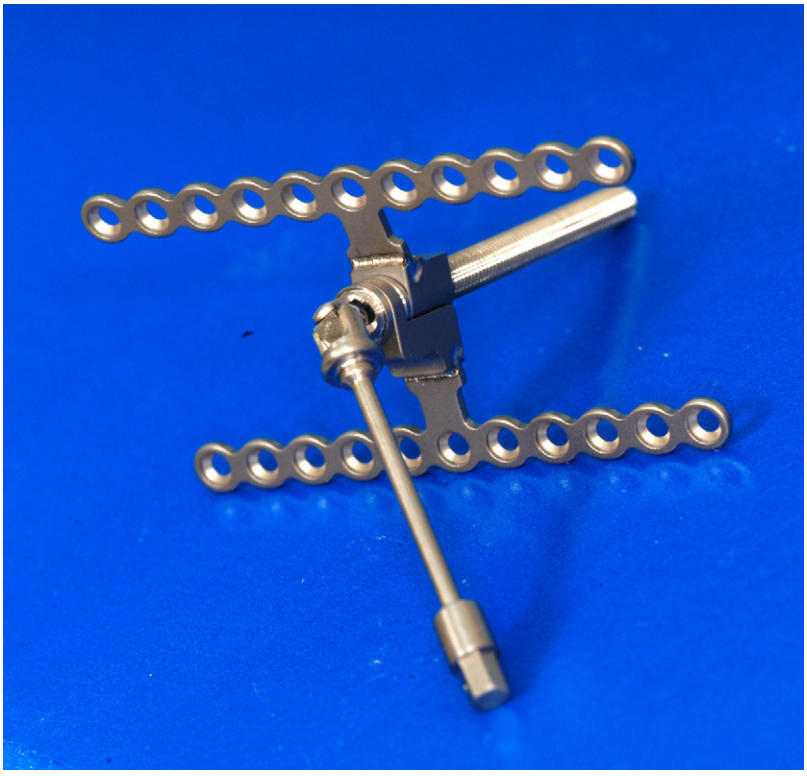

Fig. 1. The distractor consisted of two parts: an upper plate, and a lower plate holding the distraction screw. The distraction screw is placed inside the maxillary sinus, while the activation arm is brought into the oral cavity.