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Clinical Paper
Cleft Lip and Palate

Mandibular effects of maxillary distraction osteogenesis in cleft lip and palate☆

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Abstract. Maxillary distraction osteogenesis (DO) is a reliable treatment for severe maxillary deficiency in cleft lip and palate (CLP). The objective was to analyze its long-term effects on the mandible. A retrospective study of 24 CLP treated with maxillary DO using the Polley and Figueroa technique was done; patients were followed for more than 4 years. Preoperative (T0), 6–12 months postoperative (T1), and ≥4 years postoperative (T2) cephalometric radiographs were evaluated. A classical cephalometric analysis was used to assess treatment stability, and a Procrustes superimposition method was used to assess local changes in the shape of the mandible. The mean age of patients at T0 was 15.4 ± 4.1 years. SNA increased at T1 and T2 ($P < 0.001$), with no significant relapse between T1 and T2, indicating stability at 1 year after treatment (T0 = 72.4 ± 5.3°; T1 = 81.3 ± 6.2°; T2 = 79.9 ± 6.1°). SNB, facial angle, gonial angle, and symphyseal angle remained stable. Long-term analysis of the mandible demonstrated a minimal counter-clockwise rotation of the body (mandibular plane = −0.2 ± 3.2°) and ramus (−0.6 ± 4.3°). Maxillary DO in CLP had no significant effect on the shape or rotation of the mandible. The maxillary advancement remained stable after 1 year.

Key words: cleft palate; cleft lip; growth; distraction; mandible; maxilla.

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Maxillary retrusion is a common problem affecting children with cleft lip and palate (CLP). The prevalence of this skeletal class III relationship requiring surgery has been estimated to be around 25%.[1,2] The aetiology is multifactorial, and includes the severity of the initial deformity and the iatrogenic effects of the primary surgical treatment. These patients were initially treated with conventional orthognathic surgery, but the introduction of distraction osteogenesis (DO)[3,4] allowed the cleft surgeon to treat severe maxillary hypoplasia with other modalities.[5,6]

Maxillary DO has been used successfully in CLP for many years. This reliable treatment of severe maxillary deficiency has been proven to have good long-term stability.[7–13] When this technique is used for significant maxillary advancement, some studies have reported a mandibular autorotation (clockwise), due to the forward and downward movement of the maxilla and/or due to the counter-clockwise rotation of the palatal plane, increasing the posterior vertical dimensions.[7,11,12,14,15] Despite this initial mandibular movement, to the best of our knowledge no published studies have focused directly on the long-term mandibular effects of maxillary DO in CLP.

The purpose of our study was to evaluate the long-term effects on the mandible of external maxillary DO in CLP. Specific aims were to evaluate the mandibular shape, rotation, and position. We hypothesized that the effects would be minimal.

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Materials and methods

This retrospective study reviewed cleft patients treated with maxillary DO in a paediatric cleft/craniofacial and plastic surgery unit. The cases of all complete CLP patients treated consecutively between January 2001 and January 2008 were reviewed. This research was carried out in accordance with the principles outlined in the Declaration of Helsinki.

The inclusion criteria were: complete unilateral CLP (UCLP) or complete bilateral CLP (BCLP) patients with severe maxillary hypoplasia and class III malocclusion (requiring a horizontal maxillary advancement $\geq$7 mm), operated on by the same surgeon with the same primary treatment protocol,[16] and distracted externally in accordance with the Polley and Figueroa technique.[17] Cephalometric radiographs taken preoperatively (T0), at 6–12 months postoperatively (T1), and more than 4 years postoperatively (T2) were required for the chart to be complete (Fig. 1). Patients with incomplete files, internal distraction patients, and syndromic cleft patients were excluded from the study.

Maxillary distraction osteogenesis technique

The maxillary DO was always carried out externally using the KLS Martin Rigid External Distraction system (RED; KLS Martin, Tuttlingen, Germany) or the Walter Lorenz Blue device (Walter Lorenz Surgical, Jacksonville, FL, USA). First, a custom-made intraoral orthodontic appliance was inserted preoperatively in each patient to link the maxillary skeleton to the distraction apparatus. The system consisted of a double arch (vestibular and palatal arch) and a transpalatal arch, all cemented with bands on the first permanent molars and the first primary molars or permanent premolars. Two external traction hooks were welded to the vestibular arch at the level of the lateral incisors, and were bent under and in front of the upper lip with the end of the hook ending at the level of the palatal plane.

Intraoperatively, a classical Le Fort I osteotomy was performed using a reciprocating saw. Pterygomaxillary disjunction and a maxillary down-fracture were performed to mobilize the maxilla. Although not always done by some authors,[18] the down-fracture is useful to properly release the scar adhesions. No intraoperative repositioning of the maxilla was performed, and no bone grafting or internal skeletal fixation was utilized. The halo of the RED device was then fixated after closure of the intraoral wound.

After a latency period of 3–4 days, the maxillary distraction was started at a rate of 1.5 mm per day. All patients had a straight uniplanar horizontal advancement. Patients were evaluated once per week during the activation phase until the required advancement was obtained. The overjet between the maxillary incisors and the decompensated mandibular incisors was used as the clinical guide to determine the end of distraction. For the consolidation phase, the system was left in place for 4–6 weeks. At the end of the consolidation period, the halo was removed and a removable orthodontic facemask with elastic traction was used as a retainer at night for a further 6 weeks. No orthodontic alignment was performed before the distraction. All of the orthodontic alignment and levelling was done after the consolidation phase.

Cephalometric analysis

The standardized lateral cephalometric radiographs analyzed for all patients enrolled in this study were taken shortly before the operation (T0) and postoperatively at 6–12 months (T1) and at more than 4 years (T2). A classical analysis was carried out using Procuste software 2007 (Procuste sarl, Caen, France). The bony landmarks used in this analysis included the following points: sella (S), basion (Ba), pterygoid (Pt), nasion (N), anterior nasal spine (ANS), posterior nasal spine (PNS), A-point (A), B-point (B), menton (Me), gnathion (Gn), gonion (Go), articulare (Ar), incisal edge and apex of the maxillary central incisor, incisal edge and apex of the mandibular central incisor, occlusal point (projection of the first maxillary premolar on the occlusal plane), distal of first maxillary molar, distal of first mandibular molar, porion (Po), orbitale (Or), and pogonion (Pog).

The angular measurements analyzed at T0, T1, and T2 were: SNA, SNB, ANB, Frankfort (Fr)–mandibular plane angle (FMA), facial angle of Ricketts (Fr/N–Pog), facial axis of Ricketts (Ba–N/Pt–Gn), occlusal plane–Fr angle (OP/Fr), inter-incisal angle, and superior incisor–Fr angle (Isup/Fr). The distance AoBo, representing the orthogonal projection of A-point and B-point on the occlusal plane, was also measured in millimetres (mm).

The Procrustes superimposition method[19–21] was then performed between T0 and T2 to evaluate the global morphological variations (Fig. 2). The superimposition was based only on the relatively stable cranial base points (N, S, Ba, Pt). This method allowed an analysis of the global changes in the maxillary and mandibular morphology and position, without introducing the size factor (eliminating the size differences between the radiographs). From these superposition images, the gonial angle (Ar–Go/Go–Me) and symphyseal angle (Go–Me/Me–B) were measured at T0 and T2 (Fig. 3). Rotations of the mandibular plane, ramus, and palatal plane were also calculated (Fig. 4). The value was negative when the rotation was counter-clockwise.

Statistical analysis

Statistical analysis of the data was performed using SPSS version 17.0 software (SPSS Inc., Chicago, IL, USA). All variables were divided into continuous and categorical variables; categorical

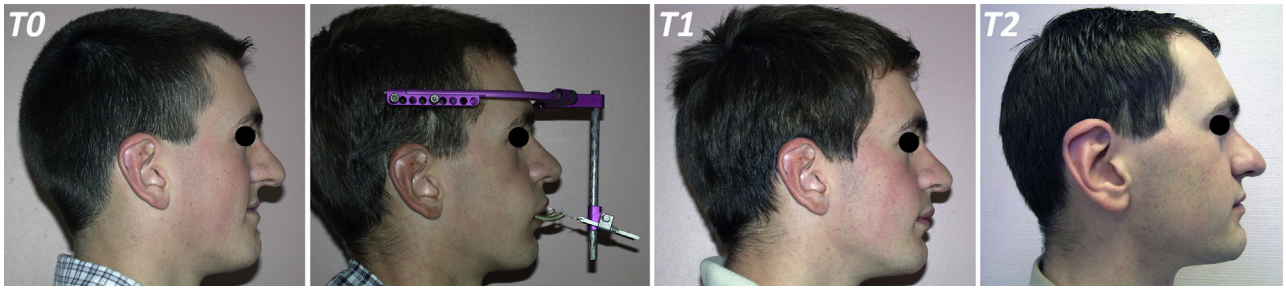

Fig. 1. Cleft lip and palate patient with severe maxillary hypoplasia preoperatively (T0), at 6–12 months post-distraction (T1), and more than 4 years post-distraction (T2).