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Skeletal stability of maxillary advancement with and without a mandibular reduction in the cleft lip and palate patient

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Abstract. The stability of surgical maxillary advancement in a consecutive series of patients with cleft lip and palate who underwent Le Fort I osteotomy with and without simultaneous mandibular setback surgery was evaluated. Preoperative, postoperative, and follow-up lateral cephalograms of 21 patients were assessed to compare differences in surgical movement and postoperative relapse between two groups: those who underwent maxillary surgery alone and those who underwent bimaxillary surgery. Differences in the number of patients who experienced relapse of <2 mm, 2–4 mm, and >4 mm between the groups were also compared. Mean advancement of the cleft maxilla was 5.5 mm in the maxilla only group and 3.6 mm in the bimaxillary group, with a mean horizontal relapse of 0.8 mm and 0.2 mm, respectively. Mean surgical movement in the vertical dimension was comparable in the two groups and the magnitude of vertical relapse was less than 0.4 mm overall. Approximately 80% of patients in both groups experienced horizontal relapse of less than 2 mm. There was no significant difference in the degree of postoperative relapse between those who had single-jaw surgery and those who had two-jaw surgery.

Key words: maxillary osteotomy; cleft; relapse; stability.

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Individuals with cleft lip and palate (CLP) deformities commonly present with varying degrees of maxillary hypoplasia, which becomes progressively apparent with development, as the cleft maxilla fails to maintain normal growth rates.[1] Patients with CLP therefore usually present with midfacial deficiency and class III skeletal and dental malocclusions. However, the severity of the final skeletal discrepancy depends not only on the hypoplasia intrinsic to the deformity and the iatrogenic effect of cleft palate repair on subsequent growth of the midface, but also on the underlying pattern of overall facial growth.[2,3] For CLP patients with maxillary hypoplasia and for whom orthognathic surgery is indicated, the basic procedure for surgical correction is the conventional Le Fort I maxillary osteotomy, although gradual lengthening of the

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maxilla by distraction osteogenesis may be considered if the skeletal discrepancy is severe.

It is well known that surgical movements to advance the maxilla are generally stable in non-cleft patients when stabilized with rigid fixation.[4–6] In contrast, it is generally accepted that cleft patients are predisposed to greater instability owing to factors related to the cleft deformity and the scarring from earlier surgical interventions aimed at achieving primary closure of the cleft structures. It has been reported in a systematic review that surgical advancement with a maxillary osteotomy in patients with CLP shows horizontal relapse of 1.5–2 mm or 25–30% after surgical movements of 5–6 mm.[7] However, the studies analyzed in that review included samples where data for patients who underwent maxillary surgery alone were combined with those who had simultaneous mandibular surgery, or it was not clarified otherwise. In studies that have examined the difference in stability of cleft maxillary advancement following single-jaw or two-jaw surgery, data have only been reported as mean changes in maxillary position or as a percentage of the surgical movement.[8–13]

The purpose of this study was to evaluate the outcome of surgical treatment in terms of skeletal stability in a cohort of patients with CLP who underwent correction either by maxillary advancement surgery alone or by bimaxillary surgery to determine any differences between the groups with respect to postoperative relapse.

Materials and methods

The oral and maxillofacial surgery unit database was used to identify patients with CLP who had undergone maxillary repositioning during the years 1999–2011. Inclusion criteria were those patients with a diagnosis of a repaired unilateral cleft lip and palate or cleft palate only, treated with a Le Fort I advancement osteotomy. Patients were excluded for any of the following reasons: diagnosis of isolated cleft lip, cleft lip and alveolus only, or bilateral cleft lip and palate; diagnosis of a craniofacial syndrome or anomaly; treatment by segmented maxillary surgery, maxillary distraction osteogenesis, or a staged orthognathic procedure.

A total of 103 patients were identified as having undergone a cleft-related maxillary osteotomy, of whom 46 met the inclusion criteria. Twenty-five of these 46 patients were excluded due to insufficient radiographic records, thus 21 patients with complete records were included in the study. The sample was divided into two groups: those treated by maxillary surgery alone ($n = 11$) and those treated by maxillomandibular surgery ($n = 10$), which involved a mandibular setback osteotomy. For the purposes of this study, a genioplasty was considered as an adjunctive procedure.

All patients were treated according to the management protocol for cleft patients within the unit. Patients underwent primary repair of the lip at 3 months of age and the palate at around 12–18 months to allow normal speech development. Secondary alveolar bone grafting with autogenous cancellous bone from the iliac crest was performed between 8 and 12 years of age, and was timed to coincide with the development and eruption of the maxillary permanent canine tooth. All patients received pre-surgical and post-surgical orthodontic treatment. Surgically-assisted rapid maxillary expansion and/or extraction of teeth were performed at the commencement of pre-surgical orthodontic treatment where necessary, depending on the requirements and planning of each individual case.

All patients were operated on by senior consultant oral and maxillofacial surgeons (AAH and JMS) using a standardized approach. A standard Le Fort I maxillary down-fracture osteotomy was performed, and the maxilla was repositioned passively into the planned occlusion and stabilized using four titanium 'L-shaped' miniplates. In all cases, interpositional grafting of the anterior and lateral bony walls of the maxilla was undertaken using either block corticocancellous bone from the iliac crest or local bone harvested from the operative sites for smaller defects. Postoperatively, intermaxillary elastics (5.5 oz, 3/16 in.) were placed at the completion of the surgical procedures and were used for 6 weeks. For those who underwent a bimaxillary procedure, standard simultaneous bilateral mandibular sagittal section osteotomies carried forward to the first molar region (and advancement genioplasties) were performed and secured with a single miniplate and screws bilaterally.

All patients had preoperative (T1) and postoperative (T2) lateral cephalograms, which were taken shortly before and after surgery. Follow-up lateral cephalograms (T3) were available at an average of 13.4 months following surgery in the maxilla only group and 13.0 months following surgery in the bimaxillary group. The cephalometric analysis used was a modification of the method described by Chua et al.[14] Changes in the position of maxillary skeletal landmarks were measured on coordinate axes with a horizontal reference line (X) constructed at 7° from the sella–nasion line and a vertical reference line (Y) drawn perpendicular to the horizontal reference line passing through sella (Fig. 1). The surgical movement (T1–T2) and postoperative relapse (T2–T3) of the anterior and posterior maxilla were measured as linear changes at A-point and posterior nasal spine (PNS), respectively, in the horizontal and vertical dimensions in relation to the X and Y reference lines. Anterior and inferior movements were indicated by positive values and posterior and superior movements were indicated by negative values. The surgical rotation and rotational relapse of the maxilla in relation to the cranial base were also assessed, as measured by changes in the angle of the palatal plane (anterior nasal spine (ANS)–PNS) relative to the sella–nasion line.

All radiographs were hand-traced longitudinally by one examiner (FXW) on high-quality acetate overlay sheets with transfer of anatomical landmarks from the preoperative radiograph to subsequent ones in order to minimize tracing error. To further improve the reliability of identifying maxillary landmarks, particularly those distorted by the cleft deformity and those subject to change as a result of surgical alteration or postoperative bony remodelling, a method of constructing a template of the maxilla based on the outline of internal palatal structures constructed from the preoperative radiograph was used for superimposing on the maxilla in subsequent radiographs. The overall superimposition of sequential radiographs was performed using the method of anatomical best fit on the anterior cranial base structures and the anterior wall of sella turcica. The tracings were scanned into a computer and landmarks were digitized using cephalometric software (Quick Ceph Studio version 3.0.8; Quick Ceph Systems, San Diego, CA, USA).

The reliability and error of cephalometric measurements were calculated based on repeated tracings of 30 lateral cephalograms selected randomly from 15 patients and performed after a 2-week interval. The reliability of the two sets of measurements was evaluated by paired t-test with a 5% level of significance and revealed no significant difference for linear ($P = 0.54$) or angular measurements ($P = 0.26$). Dahlberg's formula was used to calculate the random error in tracing, and analysis showed a difference of 0.40 mm for linear measurements, which is within the