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Soft tissue changes and skeletal stability after modified quadrangular Le Fort I osteotomy

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Abstract. The purpose of this study was to evaluate the soft tissue changes and skeletal stability of a modification of the Le Fort I osteotomy design – the modified quadrangular Le Fort I osteotomy (MQLI). Patients who had maxillary advancement and mandibular setback surgery for skeletal class III malocclusion with a midface deficiency were included. MQLI patients ($n = 20$) were compared to conventional Le Fort I osteotomy patients (LFI) ($n = 20$) using cephalometric radiographs taken preoperatively (T0), immediately postoperative (T1), and at >6 months postoperative (T2). Soft tissue radiographic changes of the cheek line and perinasal areas, and skeletal movements were analyzed. The basic skeletal characteristics and amount of maxillary and mandibular surgical change were similar in the two groups (group difference, $P > 0.05$). There was no significant difference between the two groups in terms of maxillary and mandibular skeletal stability. The cheek profile angle increased significantly after MQLI by 3.5° ($P < 0.05$), whereas LFI showed a 2.1° increase ($P > 0.05$). Overall, the soft tissue cheek outline moved significantly more anteriorly in MQLI, but the difference to LFI osteotomy did not reach statistical significance. MQLI could be an efficient and stable surgical method to improve maxillary and infraorbital hypoplasia without malar advancement, especially in Asian patients.

Key words: Le Fort I; quadrangular; maxillary osteotomy; cheek; skeletal class III.

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Since Axhausen (1934)[1] introduced maxillary advancement surgery using the Le Fort I osteotomy, this procedure and its modified forms have been applied in various situations. Axhausen's original concept of the Le Fort I osteotomy, the conventional Le Fort I osteotomy, osteotomized the maxilla 4–5 mm above the root tip of the maxillary molar and 4–7 mm above the base of the piriform rim. Kufner (1971)[2] proposed the quadrangular Le Fort II osteotomy, which was later modified by Keller and Sather (1987)[3] to correct midfacial deficiencies, achieving favourable aesthetic results. However, the conventional procedures had limited versatility and required an ideal anatomy. Consequently, Keller and Sather (1990)[4] modified the

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conventional Le Fort I osteotomy and proposed the quadrangular Le Fort I osteotomy. This method had indications and clinical outcomes that were quite similar to the quadrangular Le Fort II osteotomy, but its adaptability was greater and it could be applied even to cases with maxillary midline shift, significant vertical maxillary deficiency, and vertical excess.[4] A bilateral osteotomy was utilized that passed through the piriform aperture at the level of the infraorbital nerve and extended laterally just below the foramen to the tuberosity–pterygoid plate region posteriorly. An inferior step in the osteotomy was frequently necessary at the anterior margin of the maxillary buttress. This surgical procedure was applied to advance the maxilla and zygomatic complex without noticeable complications. Thus, the quadrangular Le Fort I osteotomy can be considered an acceptable method for the correction of dentoalveolar and infraorbital–zygomatic deficiencies. However, it entails certain technical difficulties because of the high osteotomy line and has disadvantages in relation to the correction of asymmetry and changing of the occlusal plane.

Some patients who have a maxillary deficiency with skeletal class III malocclusion show a flat or depressed paranasal profile without a protruded zygoma, especially patients in the Asian population. Although several surgical methods have been documented for improvement of the paranasal deficiency with or without maxillary osteotomy,[5,6] choosing the most appropriate surgical method remains a difficult decision.

We modified the quadrangular Le Fort I osteotomy for patients with a skeletal class III malocclusion with maxillary hypoplasia who do not require malar advancement. The osteotomy line of the modified quadrangular Le Fort I (MQLI) is comprised of an anterior quadrangular osteotomy and a posterior horizontal osteotomy. The aim of the current study was to evaluate the clinical outcomes of MQLI and to compare these with the outcomes of conventional Le Fort I osteotomy (LFI).

Materials and methods

This retrospective investigation reviewed patients who had undergone bimaxillary surgery for a midfacial deficiency and mandibular prognathism between April 2009 and November 2011 at the authors' affiliated hospital. To compare the skeletal stability and soft tissue changes of MQLI and LFI, patients with a post-traumatic deformity, or craniofacial deformities such as cleft lip and palate, were excluded from the study. We included patients with skeletal class III malocclusion and maxillary and infraorbital hypoplasia with normal zygomatic prominence, which was determined by clinical examination. All patients had a bilateral sagittal split ramus osteotomy with LFI or MQLI. A total of 40 patients were recruited. Patients were divided into two groups of 20 patients each. Lateral cephalometric radiographs were taken preoperatively (T0), postoperatively (T1), and at >6 months postoperatively (T2) to analyze skeletal and soft tissue movements for each group of patients. This study was approved by the institutional review board of the study hospital.

Surgical procedure

The osteotomy lines of the quadrangular Le Fort I osteotomy, LFI, and MQLI are shown in Fig. 1. For LFI, we osteotomized the maxilla 4–5 mm above the root tip of the maxillary molar and 4–7 mm above the base of the piriform rim.[1] For MQLI, the posterior horizontal osteotomy was the same as that of the LFI, and the anterior horizontal osteotomy was located inferior to the orbital rim and at the level of the inferior turbinate, but not extended to the zygomatic buttress. The position of the vertical osteotomy was lateral to the maxillary first molar and inferior orbital foramen, connecting the two horizontal osteotomies (see Fig. 2). The osteotomized maxilla was fixed rigidly with four miniplates.

Cephalometric analysis

The reference lines and points used in this study are shown in Fig. 3. The lateral cephalograms were digitized by one observer using VCeph 6.0 (Osstem, Seoul, Korea). The traced cephalograms were overlapped at points S (sella), N (nasion), Po (porion), and Or (orbitale). The horizontal reference line was the Frankfort horizontal (FH) plane and the vertical reference plane was the line perpendicular to the FH plane passing through the Po point. Angular measurements (FH to NA, FH to NB, and ANB) and the horizontal (x) and vertical (y) positions of the ANS, PNS, A point, and B point were measured. Point CP was defined as the most anterosuperior point on the osteotomy line in the maxillary anterior area, as shown on the lateral cephalogram. Point C0 was at the intersection of the soft tissue outline of the cheek (the cheek line) and horizontal reference plane (FH plane). Points C1–C5 were defined as points of intersection of the cheek line and the lines drawn parallel and inferior to the FH plane at 5-mm intervals, beginning with point C1 positioned 15 mm below the FH plane. The measured values for points C1–C5 were horizontal distances from the vertical reference line.

Statistical analysis

The surgical changes (T0–T1) and postoperative changes (T1–T2) in the linear and angular measurements were evaluated statistically. Differences between time points (T0–T1 or T1–T2) in each group were tested with the Wilcoxon signed ranks test. Inter-group differences were analyzed with the Mann–Whitney U-test. The data were analyzed using SPSS version 12.0 for Windows

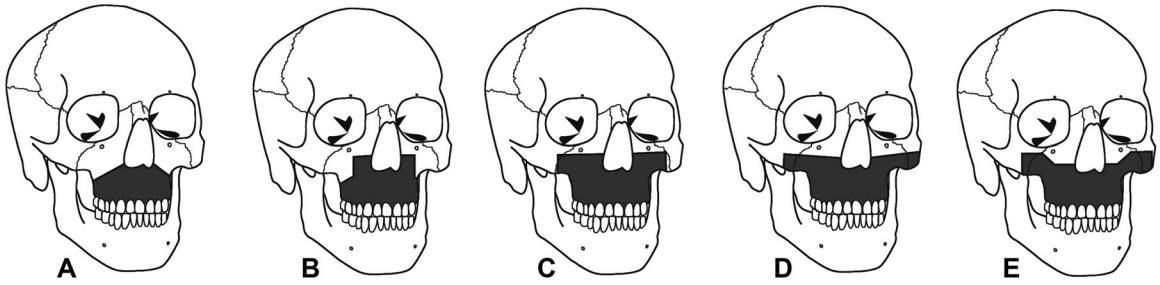

Fig. 1. Osteotomy lines for variations of the Le Fort I osteotomy. (A) Conventional Le Fort I osteotomy (Axhausen 1934).[1] (B) Modified quadrangular Le Fort I osteotomy used in the present study. (C) Quadrangular Le Fort I osteotomy (Keller and Sather, 1990).[4] (D) Modified Le Fort I (maxillary–zygomatic) osteotomy (Abubaker and Sotereanos, 1991).[8] (E) Extended Le Fort I osteotomy (Nørholt et al., 1996).[9]