Journal of Cranio-Maxillo-Facial Surgery 44 (2016) 413–420

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Major factors contributing to anterior and posterior relapse after intraoral vertical ramus osteotomy

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ARTICLE INFO

Article history:
Paper received 17 November 2015
Accepted 14 January 2016
Available online 23 January 2016

Keywords:
Intraoral vertical ramus osteotomy
Mandibular setback surgery
Posterior relapse
Stability

ABSTRACT

The aim of this retrospective cohort study was to investigate the factors contributing to mandibular relapse after intraoral vertical ramus osteotomy (IVRO) while controlling for possible confounders. Forty-seven patients who underwent bimaxillary surgery were divided into three groups according to the direction of horizontal mandibular relapse: a stable group (group S), a posterior relapse group (group P), and an anterior relapse group (group A). Lateral cephalograms were analysed 1 month before and at 7 days and 12 months after surgery. One month before surgery, the pogonion in group A was positioned about 13 mm more anteriorly than in group P ($P < 0.05$). Immediately after surgery, the mandibles in groups A and S had moved about 6 mm more posteriorly than in group P. At 12 months, both the mandibles (point B) and the maxillae (point A) had moved posteriorly in group P ($P < 0.05$). A multivariate linear regression analysis showed that the amount of setback was the one key factor predicting postoperative mandibular changes 12 months after IVRO. As the amount of setback decreased, mandibular posterior horizontal relapse increased after IVRO. These findings suggest that the amount of setback can be a key factor predicting postoperative mandibular relapse.

1. Introduction

Mandibular prognathism has been reported to have a relatively high prevalence in Asian populations (Lew et al., 1993). To treat adult patients with skeletal Class III malocclusion and mandibular prognathism, bimaxillary surgery is commonly performed; Le Fort I osteotomy, bilateral sagittal split ramus osteotomy (SSRO), and intraoral vertical ramus osteotomy (IVRO) are examples. Several factors contributing to postoperative mandibular anterior relapse have been reported after mandibular setback using SSRO, including the amount of setback, faulty pre-surgical orthodontics, method of fixation, and amount of bony contact (de Villa et al., 2005; Jakobsone et al., 2011; Moure et al., 2012; Paeng et al., 2012). Recent studies showed that mandibular anterior relapse after SSRO might be more greatly associated with the degree of intraoperative clockwise movement of the proximal segment than the amount of setback (Han et al., 2014; Yang and Hwang, 2014).

However, because the proximal and distal segments are not rigidly fixed immediately after IVRO, and patients who undergo IVRO are required to perform active physiotherapy (PT) with vertical elastics after intermaxillary fixation (IMF) for 2–4 weeks, the mandibular relapse pattern after IVRO is significantly different from that after SSRO (Jung et al., 2012). Previous studies reported that a considerable number of patients develop posterior mandibular relapse rather than anterior relapse 12 months after IVRO (Jung et al., 2013; Choi et al., 2015a, 2015b). Chen et al. reported that

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http://dx.doi.org/10.1016/j.jcms.2016.01.013
1010-5182/

the amount of setback was not associated with anterior mandibular relapse 2 years after IVRO; overbite, anterior facial height, mandibular length, and occlusal plane were weakly correlated with relapse (Chen et al., 2011). However, a problem arose in the data analyses of this study because of a failure to determine and control for collinearity between the variables. To our best knowledge, few studies have evaluated factors contributing to mandibular relapse after bimaxillary surgery with mandibular setback using IVRO while controlling for confounders.

The aim of this study was to investigate factors contributing to mandibular relapse after bimaxillary surgery with IVRO. The authors hypothesized that the amount of setback can be a major factor contributing to mandibular horizontal relapse. The specific aims of the study were to compare horizontal and vertical positional changes of skeletal and dental variables for 12 months after IVRO between skeletal Class III malocclusion cases with stable mandibular positioning, posterior mandibular relapse, and anterior mandibular relapse; and to determine the correlation between the amount of setback and horizontal relapse 12 months postoperatively while controlling for possible confounders.

2. Material and Methods

2.1. Study design/sample

This retrospective cohort study included adult patients who were diagnosed with skeletal Class III malocclusion and mandibular prognathism, and underwent mandibular setback surgery using IVRO between 2006 and 2013 at the Departments of Oral and Maxillofacial Surgery and Orthodontics, Yonsei Dental Hospital, Seoul, Korea.

The inclusion criteria for the study were as follows: age >18 years, presence of skeletal Class III dentofacial deformities with an ANB angle (the angle formed by point A, the nasion, and point B) < 0°, a bimaxillary surgery requirement (one-piece Le Fort I osteotomy and bilateral IVRO), and a conventional orthognathic surgery requirement with pre- and postsurgical orthodontics. The exclusion criteria were as follows: history of orthognathic surgery; an existing medical, physical, or mental condition that could impair healing; presence of syndromic craniofacial deformities such as a cleft lip and palate; significant menton deviation of >4 mm from the facial midline; a single-jaw surgery requirement; a surgery-first approach requirement; and unavailability or an incomplete series of identifiable lateral cephalograms.

The relapse pattern after IVRO was the primary predictor variable in this study. The study sample was divided into three groups according to the direction of horizontal mandibular relapse based on point B [(+), anterior; (−), posterior]: a stable group (group S) including patients with relapse amounts from −2.0 mm to 2.0 mm, a posterior relapse group (group P) including patients with a relapse amount <−2.0 mm, and an anterior relapse group (group A) including patients with a relapse amount >2.0 mm. All patients underwent pre- and postsurgical orthodontic treatment in the Department of Orthodontics, Yonsei Dental Hospital, Seoul, Korea.

This study conformed to the tenets of the Declaration of Helsinki on medical protocols and ethics and was approved by the Institutional Review Board of Yonsei Dental Hospital (IRB No. 2-201500035).

2.2. Surgical and orthognathic treatment

All patients underwent one-piece Le Fort I osteotomy. Rigid internal fixation with titanium miniplates or self-reinforced biodegradable poly-70L/30DL-lactide (BioSorb FX; CONMED LINVATEC Biomaterials, Utica, NY, USA) was used to stabilize the maxilla after one-piece Le Fort I osteotomy. After drilling and tapping, four L-shaped plates with monocortical bone screws 2.0 mm in diameter were placed bilaterally in the canine fossa and zygomatic buttress. Informed consent for using self-reinforced biodegradable miniplates and screws was obtained from the patients before surgery.

Each patient underwent mandibular setback surgery using bilateral IVRO. A conventional double-sliding osteotomy was performed using a round oscillating saw to simplify the angle at the antelingular prominence, and the saw blade was directed anterosuperiorly toward the sigmoid notch.

Maxillomandibular fixation (MMF) was maintained for 2 weeks after surgery. After MMF, patients were given instructions regarding active PT using intermaxillary vertical elastics to prevent an open bite event immediately after surgery and to ensure sound postoperative rehabilitation (Jung et al., 2012; Choi et al., 2015a, 2015b). During PT, the postoperative splint was used as guidance for mandibular tooth positioning. When a maximum mouth opening (MMO) of at least 30 mm was obtained after 1–2 weeks of PT, the splint was removed. PT was continued until an adequate (more than 40 mm) range of jaw movement and stable occlusion were achieved (Jung et al., 2012). Postoperative management was the same for all three groups.

2.3. Data collection methods

Skeletal and dental changes after surgery were evaluated with lateral cephalograms taken 1 month before surgery (T1), within 7 days after surgery (T2), and 12 months after surgery (T3). Surgical change was defined as T2 minus T1 and postoperative change was defined as T3 minus T2. The lateral cephalograms were traced using V-ceph 5.5 (Osstem, Seoul, Korea) by an examiner. All reference planes were transferred from the T1 to T3 time points according to the sella–nasion (SN) plane superimposition.

For the cephalometric measurements, an X–Y coordinate system was constructed. The X-axis originated at N and formed an angle of 7° upward from the SN plane (Fig. 1). The Y-axis was defined as the line perpendicular to the X-axis and passing through S. The positions of the landmarks were recorded as linear measurements in relation to the X- and Y-axes.

This study identified seven angular and 12 linear cephalometric measurements. The seven angular measurements included the angle between the lines connecting S, N, and point A (SNA); the angle between lines connecting S, N, and point B (SNB); the angle between the SN and occlusal planes (SN–OP); the angle between the SN and mandibular planes (SN–MP); the angle between the SN plane and upper central incisor (U1–SN); the angle between the mandibular plane and lower central incisor (IMPA); and the interincisal angle between the upper and lower central incisor inclinations.

The 12 linear measurements included horizontal distances from point A, point B, the pogonion (Pog), and the menton (Me) to the Y-axis; and vertical distances from point A, point B, Pog, Me, the tip of the upper central incisor (U1); and the mesiobuccal cusp tip of the upper first molar (U6) to the X-axis. Overjet and overbite were also included in this study.

2.4. Reliability

Reproducibility was determined by comparing measurements obtained from original examinations with those obtained from repeated examinations. All measurements were repeated by the same examiner after 2 weeks. The method error was calculated using the intraclass correlation coefficient (ICC), which was