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Correlation between intraoperative proximal segment rotation and post-sagittal split ramus osteotomy relapse: a three-dimensional cone beam computed tomography study

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Abstract. This study evaluated the effects of proximal segment rotation and the extent of mandibular setback on post-sagittal split ramus osteotomy (SSRO) relapse using three-dimensional (3D) analysis. Thirty-one patients diagnosed with a skeletal class III malocclusion who underwent SSRO alone were enrolled in this study. The movements of the mandibular condyles were assessed using cone beam computed tomography (CBCT) and a 3D imaging program at ≤1 month before the operation (T0), 1 week after the operation (T1), and 6 months (T2) and 1 year (T3) postoperative. Yaw and roll were increased at T1 as compared to T0. However, the proximal segments reverted to their original positions between T2 and T3. There was a positive correlation between the extent of the posterior movement of the mandible and relapse at 6 months and 1 year postoperative. Although the proximal bone segments showed displacement in three dimensions at T1, they reverted to their original positions over time. In addition, although there was a positive correlation between the extent of the posterior movement of the mandible and the occurrence of post-surgical relapse at 6 months and 1 year post-surgery, the rotation of the proximal bone segment during surgery had no relationship with postoperative relapse.

Key words: SSRO; condyle position; CBCT; relapse; pitch; yaw; roll movement.

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Skeletal class III deformities can result from either mandibular prognathism or maxillary deficiency, or the simultaneous occurrence of both conditions[1,2]. The sagittal split ramus osteotomy (SSRO) for the correction of mandibular prognathism was first introduced in the 1950s by Trauner and Obwegeser and has been used widely since, as it enables an intraoral approach and promotes bone healing by providing a large overlap of bone segments[3–5]. Although the SSRO has been performed for decades, issues regarding postoperative stability and relapse continue to be raised, with many studies reporting on these issues.

Studies have reported long-term relapse rates of between 2.0% and 50.3%, even when rigid fixation was indicated for patients with mandibular prognathism post-orthognathic surgery. Factors affecting post-SSRO stability have been investigated in many studies. These factors include the stability of the occlusion due to preoperative orthodontic treatment, soft tissue tension around the mandible, the fixation method for the bone segments, duration of intermaxillary fixation (IMF), condyle displacement, a change in the position of the tongue due to mandibular retraction, and the activity of muscles such as the facial muscles, masticatory muscles, and suprahyoid muscles. Postoperative stability is reported to depend on the combined result of these factors[6–9].

The exact positioning of the proximal segment after surgery has also been reported to be an important contributing factor to postoperative stability. Komori et al. reported that skeletal relapse during the initial IMF was greatly affected by the surgical method, and that it could be resolved by maintaining the position of the proximal bone segment after surgery[10,11]. The position of the proximal bone segment and the extent of the posterior movement of the mandible have also been described as factors affecting post-surgical relapse[12–14]. In other studies, condyle displacement due to the rotation of the proximal bone segment and the extent of the posterior movement of the mandible have been reported as factors contributing to postoperative relapse[8,15]. Yang and Hwang reported that the clockwise rotation of the proximal bone segment during surgery was associated with postoperative relapse[2].

For decades, studies examining the extent of mandibular setback or the movement of the proximal segment, which affect postoperative relapse, have used two-dimensional (2D) radiography tools such as cephalograms. However, these studies are limited by the distortion of the superimposition of the anatomical structures, such as distortion in the horizontal/vertical plane[16].

Three rotational descriptors (pitch, roll, and yaw) are used to supplement the planar terms (anteroposterior, transverse, and vertical) in describing the orientation of the line of occlusion and the aesthetic line of the dentition[17,18]. Recent three-dimensional (3D) reconstructions have greatly contributed to the understanding of the forward, backward, transverse, and rotational movements of the distal segment of the mandible. The complex movements required for the surgical correction of dentofacial deformities clearly need to be assessed in 3D to improve postoperative stability and reduce symptoms of temporomandibular joint disorders after surgery[19,20].

Cone beam computed tomography (CBCT) is a recently developed technology that is used for 3D analyses of the craniofacial morphology and movement[21]. The use of this technology is associated with a lower radiation exposure and cost as compared to those of conventional computed tomography (CT) or magnetic resonance imaging. Many recent studies have reported that 3D CT analysis of patients receiving orthognathic surgery has good reliability and reproducibility[22–24].

This study evaluated the effects of proximal segment rotation and the extent of mandibular setback on post-SSRO relapse using 3D analysis.

Materials and methods

Subjects

This prospective study, performed between January 2011 and December 2014, examined the mandibles of 31 patients who underwent bilateral SSRO (BSSRO) alone for the correction of skeletal class III malocclusion at the Department of Oral and Maxillofacial Surgery of Kyung Hee University Dental Hospital. The BSSRO was performed by the same skilled surgeon, using semi-rigid fixation. The subject group consisted of 14 male and 17 female patients, who ranged in age from 18 to 35 years at the time of surgery. For all subjects, the difference in lateral movement between the left and right mandibles was noted to be less than 2 mm. Exclusion criteria included severe facial asymmetry, congenital malformations such as cleft lip or cleft palate, systemic diseases, history of trauma, and resorption of the mandibular condyle.

During the follow-up period, the patients did not experience any infections of the surgical wound, bone fragment instability, malunion, or malocclusion, and none of them showed significant relapse requiring revision surgery.

Surgical methods and materials

The BSSRO was performed according to the Obwegeser–Dal Pont method. With regard to internal fixation, miniplates and monocortical screws (Jeil Medical Corp., Seoul, South Korea) were used for all subjects. Three screws were used on each side of the mandible to fix the miniplate in place. Semi-rigid fixation was accomplished with a titanium miniplate at the anterior mandibular ramus.

The proximal segment was placed in the primary section by measuring three points from the orthodontic brackets of the maxilla to a point on the ascending ramus using a condylar repositioning ruler (Fig. 1). The distal segment was moved backwards, and semi-rigid fixation using one monocortical miniplate and three miniscrews per side was conducted after surgery. To prevent displacement of the proximal segment after mandible movement, the monocortical miniplate was fixed by maintaining the overlap distance between the segments. After locating a reference point on the ramus, three or more points on the maxillary orthodontic brackets were measured to this point before separation, so that the proximal segment could be fixed in its original location. Additionally, to prevent condylar displacement caused by bony interferences between the proximal and distal segments, an additional vertical osteotomy of the distal segment or grinding of the bone interference on the lingual surface of the proximal segment was performed. To stabilize the postoperative occlusion, approximately 5–7 days of IMF with an interocclusal splint was applied. Physiotherapy including mouth-opening exercises with orthodontic elastics was started after releasing the IMF, and was continued for 6 weeks. Postoperative orthodontic treatment was started 6–7 weeks after surgery.

Radiographic examination

The mandibular condyles were assessed by CBCT in panoramic mode within 1 month before the operation (T0), within 1 week after the operation (T1), and at 6 months (T2) and 1 year (T3) postoperative. The Alphard-Vega 3030 Dental CT system (Asahi Roentgen Ind. Co., Ltd, Kyoto, Japan) was used in this study. The patient's Frankfort horizontal plane was set parallel to the floor using a cepha-