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Relapse related to pushing and rebounding action in maxillary anterior downgraft with mandibular setback surgery

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ABSTRACT

Purpose: Maxillary downgraft (MD) and mandibular setback (MS) are problematic procedures in terms of postoperative stability. While the amount of intraoperative clockwise rotation (CWR) of the proximal segment (PS) after MS combined with MD has a positive correlation with the amount of MD, mandibular relapse after MS with MD in relation to intraoperative CWR of the PS has not been reported. Moreover, the effect of mandibular relapse on maxillary stability after MS with MD remains unclear. The purpose of this study is to evaluate mandibular and maxillary stability after MS with MD in relation to intraoperative CWR of the PS and amount of MD.
Materials and Methods: The study included 57 patients who underwent bimaxillary orthognathic surgery. Patients were classified into two groups according to whether MD was performed or not performed: Group I had 2 mm or more MD; and Group II had less than 2 mm MD including vertical impaction or no vertical changes. The amount of surgical movement and postoperative relapse were cephalometrically evaluated and statistically analyzed.
Results: There was no significant difference in MS between Groups I and II, however, the vertical movement of the maxilla was different significantly ($p < 0.001$). In Group I, the intraoperative CWR and postoperative CCWR of the PS was greater than that of Group II ($p = 0.010$; $p < 0.001$, respectively). Consequently, the anterior relapse of the mandible was greater in Group I than in Group II despite the same amount of MS in Groups I and II. In Group I, with direct bone contact using Le Fort I inclined osteotomy, vertical relapse at point A showed no statistical correlation with anterior relapse at point B, while the vertical and horizontal dental relapse at U1 showed significant correlations with anterior relapse at point B ($r = -0.403$, $p = 0.030$; $r = 0.581$, $p < 0.001$, respectively).
Conclusion: For more stable results, Le Fort I inclined osteotomy is recommended to obtain direct bone contact when moving the maxilla inferiorly. The PS must also be fixed while maintaining vertical bone step to prevent CWR.

1. Introduction

Mandibular prognathism is a common dentofacial deformity in patients that frequently requires orthognathic surgery (Mah et al., 2017), and mandibular setback (MS) surgery is one of the most unstable orthognathic procedures (Proffit et al., 2007). Maxillary downgraft (MD) is an inevitable movement when there is vertical deficiency and insufficient incisal showing, and also has a large postoperative relapse rate (Proffit et al., 2007).

Several factors for skeletal relapse after MS have been reported, including preoperative orthodontic treatment to obtain a stable occlusion, amount of MS, soft tissue tension and postoperative scarring, fixation method, duration of intermaxillary fixation, condylar displacement, and positional change of the tongue (Rodriguez and Gonzalez, 1996; Chou et al., 2005; Kim et al., 2007, 2015; Proffit et al., 2007; Mucedero et al., 2008; Moure et al., 2012; Paeng et al., 2012; Lee et al., 2015). Intraoperative clockwise rotation (CWR) of the proximal segment (PS) is the main factor after MS using bilateral sagittal split ramus osteotomy (BSSRO) (Franco et al., 1989; Komori

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et al., 1989; Politi et al., 2004; Cho, 2007; Kim et al., 2007; Proffit et al., 2007; Yang and Hwang, 2014). In our previous study, we reported that CWR of the PS is caused by an operator avoiding the vertical bone step in the mandibular inferior border, and CWR improves bone contact between the PS and the distal segment (DS). The formation of vertical bone steps after repositioning the DS to the final occlusion was the most predictable factor for CWR of the PS, and it was significantly correlated with the amount of MD and MS (Yang and Hwang, 2014). However, there have been no reports on the occurrence of intraoperative CWR of the PS due to MD and resultant postoperative anterior relapse of the mandible.

The following factors have been suggested as contributing factors to instability after MD: inadequate stabilization, inappropriate and/or lack of bone grafting, and increased masticatory bite forces (Wardrop and Wolford, 1989). Bilateral coronoidotomy, pterygomasseteric myotomy, and the use of a bite-opening appliance before surgery have been proposed as surgical methods to adapt muscles to an increased length (Ellis et al., 1989). Rigid fixation and interpositional bone grafts with hydroxyapatite or autogenous bone are effective at increasing stability (Persson et al., 1986; Ellis et al., 1989; Wardrop and Wolford, 1989; de Mol van Otterloo et al., 1996; Proffit et al., 2007). In our previous paper, we reported on Le Fort I inclined osteotomy, which can cause direct bone contact without a bone gap despite MD (Yang and Hwang, 2012).

Le Fort I inclined osteotomy improves stability following MD. However, there have been no reports on the effects of mandibular anterosuperior relapse on postoperative stability of the maxilla when MS and MD coexist. The purpose of this study was to evaluate mandibular and maxillary stability after MS with MD in relation to intraoperative CWR of the PS and the amount of MD.

2. Materials and Methods

2.1. Patients

A total of 57 skeletal class III patients (male:female = 31:26, mean age = 22.5 years) who underwent bimaxillary orthognathic surgery (Le Fort I osteotomy with/without MD and BSSRO for MS) at Seoul National University Dental Hospital and who were followed-up for 1 year were selected for this study. All patients had pre- and post-operative orthodontic treatment. This study was approved by the institutional review board (CRI10035).

Patients were classified into two groups according to the amount of MD: Group I had 2 mm or more MD (n = 29; male:female 17:12; mean age 22.7 years), and Group II had less than 2 mm MD including vertical impaction or no vertical changes (n = 28; male:female 14:14; mean age 22.4 years).

2.2. Surgical procedure

Bimaxillary surgeries were performed by one oral and maxillofacial surgeon. In patients with MD, Le Fort I inclined osteotomy was performed to increase the bony height at the piriform aperture area to obtain direct bone contact at this area after downward movement of the maxilla, as described in our previous report (Yang and Hwang, 2012), while conventional Le Fort I osteotomy was performed in patients without MD. When there was a bone gap at the piriform aperture area despite Le Fort I inclined osteotomy, autogenous bone graft was performed to fill the bone gap. This technique resulted in sufficient bone resistance against postoperative occlusal force at the piriform aperture area to provide postoperative maxillary stability. The osteotomized maxillary segment was stabilized using four miniplates at the piriform aperture and zygomatic buttress area on both sides. All patients underwent modified BSSRO according to Obwegeser-Dal Pont's method (Dal Pont, 1961) for mandibular setback. The masseter muscle was not fully stripped, while the medial pterygoid muscle was fully stripped from the PS. After removing the intersegmental bone interference, the PS was manually guided to obtain an anterior-superior directed condylar position with regard to the glenoid fossa. One miniplate was used for fixation at each side. No intermaxillary fixation was used immediately following the operation, and light triangular guiding elastics were applied for 4–5 weeks after surgery.

2.3. Cephalometric analysis

To measure surgical changes and to evaluate postoperative stability, lateral cephalograms of each patient were obtained in the maximum intercuspal position at a magnification ratio of 1.1:1 prior to surgery (T0), immediately postoperatively (T1), and at 1-year follow up (T2). Cephalometric analysis was carried out according to the superposition technique. Each cephalogram was traced on acetate paper. Nine cephalometric reference points (sella (S), nasion (N), point A (A), point B (B), tip of upper central incisor (U1), mesiobuccal cusp of upper first molar (U6), articulare (Ar), menton (Me), and gonion (Go)) were determined on the lateral cephalogram at T0 and were transferred to lateral cephalograms at T1 and T2 (Fig. 1). An X–Y coordinate system was established (Fig. 1) in which the X axis (SN7) was constructed by rotating S–N downward by 7°, and the Y axis (=SN7v) was constructed on N perpendicular to SN7.

Methodical errors for each reference point were calculated using the Dahlberg formula: $S^2 = \Sigma d^2/2n$ (d, difference between remeasured values; n, number of double measurements). The maximum error of all reference points was 0.220 mm horizontal and 0.172 mm vertical (Table 1).

Six angular and seven linear parameters were analyzed. The linear parameters were Av (vertical measurement, A to X axis), Ah (horizontal measurement, A to Y axis), Bv, Bh, U1v, U1h, and U6v. The angular parameters were SNA, SNB, SN-U1, occlusal plane angle

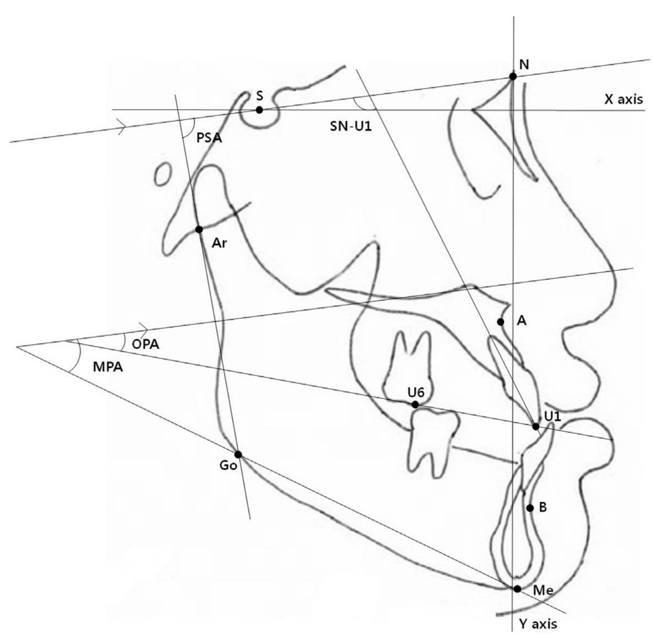

Fig. 1. Determination of landmarks used in cephalometric analysis and in angular and linear measurements. S, sella; N, nasion; A, point A; B, point B; Me, menton; Go, gonion; Ar, articulare; U1, tip of upper central incisor; U6, mesiobuccal cusp of upper first molar; X axis (SN7), line drawn 7° to sella-nasion line; Y axis (SN7v), line on nasion, perpendicular to x-axis; OPA, occlusal plane angle; MPA, mandibular plane angle; PSA, proximal segment angle.

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