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Change in condylar position in posterior bending osteotomy minimizing condylar torque in BSSRO for facial asymmetry

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ABSTRACT

During the correction of an asymmetric mandible with sagittal split ramus osteotomy (SSRO), bony interference between the proximal and distal segments inevitably occurs. This results in positional change of the condyle. In order to avoid this, a posterior bending osteotomy (PBO) has been introduced. This is an additional vertical osteotomy posterior to the second molar after SSRO. To investigate the change in condylar position after SSRO with PBO, 22 patients with facial asymmetry were enrolled and divided into two groups based on the surgical method used to remove the bony interference after SSRO: PBO ($n = 13$) and the grinding method ($n = 9$). Each group was subdivided into large and small bony interference groups by estimating the volume of bony interference with simulation surgery. Condylar displacement was evaluated by three-dimensional superimposition and the amount of condylar displacement was calculated. The positional changes of the condyles were variable in each patient. When comparing patients with large bony interference in the PBO and grinding groups, the condyles were significantly inwardly rotated in the grinding group ($p < 0.05$). The grinding method can be used to remove small bony interferences with tolerable condylar torque. However, PBO would be beneficial in correcting large bony interferences while minimizing condylar torque.

1. Introduction

Facial asymmetry is one of the most common complaints of patients undergoing orthognathic surgery, and is largely influenced by the asymmetry of the mandible rather than of the maxilla (Cheong and Lo, 2011). Asymmetric mandibles exhibit different lengths and angulation between the right and left ascending rami and the bodies of the mandible. Consequently, the mandibular arch is deviated and displaced laterally to one side, while the volumetric difference between the sides increases the asymmetrical appearance. While condyles with overgrowth result in elongated or hyperplastic mandibles, condyles with undergrowth or degenerative change can cause a shortening of the ramus and a retruded mandibular position on the affected side.

Conventional sagittal split ramus osteotomy (SSRO) has usually been used to correct mandibular asymmetry. After the establishment of optimal occlusion by adjusting the mandibular distal segment with the maxillary occlusion, bony interferences between the proximal and distal segments are inevitable in cases of mandibular asymmetry because of yawing and/or shifting movements of the distal segments, which can lead to condylar displacement.

To prevent condylar displacement, the proximal and distal segments should be passively positioned during the application of internal fixation devices (Ellis, 2007; Kang et al., 2010). In cases of mandibular yawing movement, the posterior end of the distal segment usually collides with the lingual surface of the proximal segment on the deviated side, while a gap between the proximal and distal segments is present posteriorly on the non-deviated side (Fig. 1A-b) (Yoshida et al., 2001; Ellis, 2007; Kang et al., 2010). Posterior collision between the two segments on the deviated side produces an anterior bony gap between the anterior end of the proximal segment and the buccal surface of the distal segment (Fig. 1A-b). If the anterior gap is closed by manual force without the removal of the bony interference at the posterior part in SSRO, the condyle may be displaced to the lateral side (Fig. 1A-c). This condylar displacement can be worsened by forced adaptation between the segments with a bone clamp or lag screws (Ellis, 2007). In contrast to the anterior gap, a posterior gap on the non-deviated side will not cause any clinically relevant condylar displacement in most cases, particularly when the anterior part of the proximal segment has adequate bony contact with the distal segment

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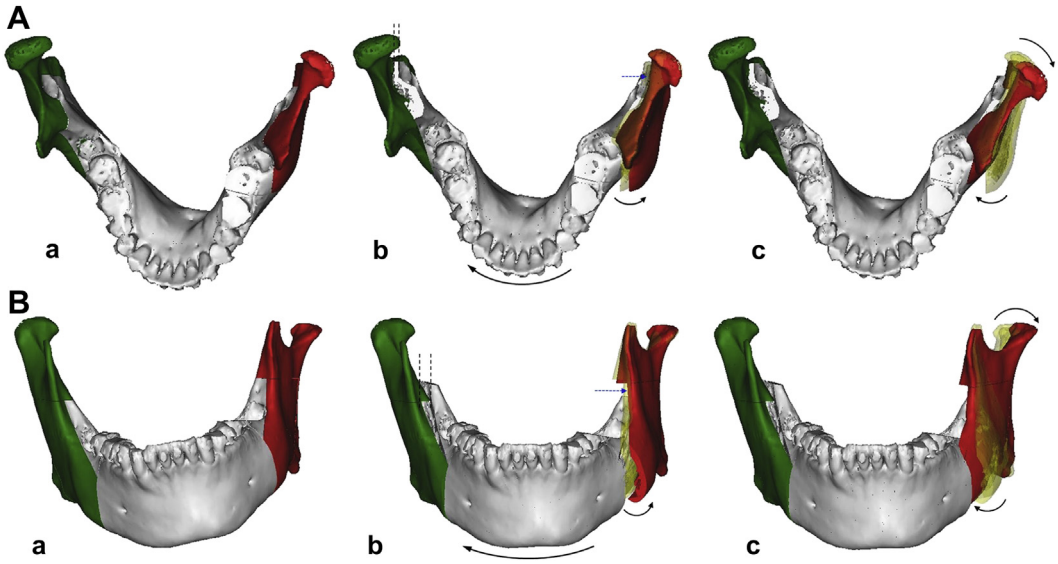

Fig. 1. The effect of forced proximal segment positioning without removal of the bony interference. The condyle is displaced laterally if the anterior gap on the deviated side is closed by force without removing the bony interference. A, Effect of yawing correction on the positions of the proximal and distal segments; B, Effect of canting correction on the positions of the proximal and distal segments. (a, After osteotomy; b, After positional change in the distal segment; c, After forced positioning of the proximal segment).

through the use of positional screws at the posterior bone gap area for increased fixation. However, slight to mild condylar changes can occur during condylar guidance and rigid fixation. A similar situation can also be caused during the correction of occlusal canting (Fig. 1B).

Condylar displacement during SSRO has a significant impact on early postoperative relapse and temporomandibular joint (TMJ) dysfunctions, such as TMJ pain, clicking sounds, disc displacement, and condylar resorption (Hackney et al., 1989; Ellis and Hinton, 1991; Ellis, 1994; Harris et al., 1999; Yoshida et al., 2001; Baek et al., 2006; Angle et al., 2007; Ueki et al., 2008; Kang et al., 2010). Condylar displacement should therefore be avoided or minimized as much as possible during SSRO. Several surgical techniques have been introduced, the most common method being grinding the bone interference on the lingual surface of the proximal segment (Ellis, 2007). Another approach is to maintain the anterior gap between the proximal and distal segments using a bent titanium plate (Ueki et al., 2001, 2008) or a bone graft at the area of the anterior gap (Kang et al., 2010). The other surgical approach is a shortening of the osteotomy at the posterior part of the distal segment, which involves the short lingual osteotomy technique (Hunsuck, 1968; Wolford et al., 1987) and the distal cutting technique in addition to conventional SSRO (Kim et al., 2002). Even though the rear part of the mandibular canal is not typically included in the distal segment in either technique, in severe mandibular asymmetry, the bony interferences cannot be fully removed because part of the distal segment between the mandibular canal and the second molar can collide with the proximal segment.

As a solution to this problem, an additional vertical osteotomy of the distal segment just behind the terminal molar, which is able to remove almost all bony interferences even in cases of severe asymmetry, was introduced (Fig. 2) (Epker et al., 1999; Ellis, 2007). The vertical osteotomy can be performed fully after the lateralization of the inferior alveolar nerve or partially, except at the mandibular canal, using a fissure bur or saw. In cases of partial osteotomy, a greenstick fracture is induced with force applied lingually with or without an osteotome (Epker et al., 1999; Ellis, 2007). This technique has some problems. There is an increased potential for damage to the inferior alveolar or lingual nerve with the use of a bur or saw. In addition, the lateralization of the inferior alveolar nerve can cause nerve damage. The lingual insertion and twisting of an instrument may detach the lingual periosteum, which makes the posterior segment to free bone. In addition, a partial osteotomy, except at the area of the inferior alveolar nerve, is insufficient for manual greenstick fracture because there is thick cortical bone at the lingual side of the inferior alveolar nerve. The use of a piezoelectric bone cutting device can be a good alternative to the fissure bur or saw in order to avoid damage to the soft tissue (Fig. 3A) (Vercellotti et al., 2001; Metzger et al., 2006; Stübinger

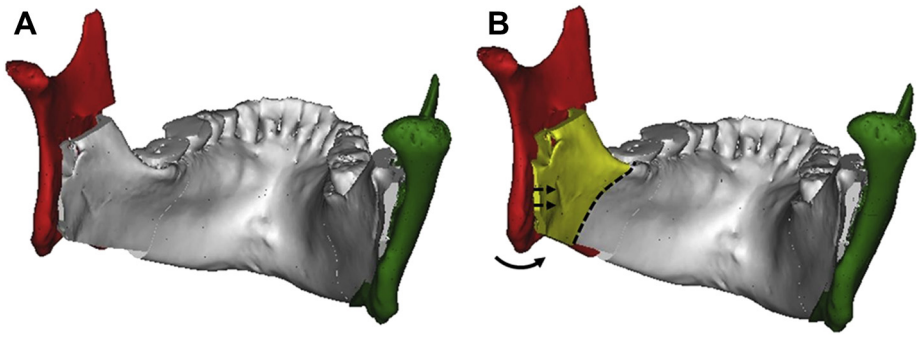

Fig. 2. Posterior illustration of PBO. Additional osteotomy of the distal segment posterior to the last molar after SSRO. The PBO segment is turned inward to passively align the proximal and distal segments. A, After SSRO; B, After PBO.