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High oblique sagittal split osteotomy of the mandible: assessment of the positions of the mandibular condyles after orthognathic surgery based on cone-beam tomography

R. Kuehle[a], M. Berger[a], D. Saure[b], J. Hoffmann[a], R. Seeberger[a,*]

[a] *Department of Oral and Maxillofacial Surgery, University Hospital Heidelberg, Im Neuenheimer Feld 400, 69120 Heidelberg, Germany*
[b] *Institute of Medical Biometrics and Informatics University of Heidelberg, Germany*

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Abstract

High oblique sagittal split osteotomy is an orthognathic technique to move the mandible. Our aim was to evaluate changes in the position of the condyle in the glenoid fossa and its angulation before and after high oblique sagittal split osteotomy (HSSO). Fifty patients (32 women and 18 men, mean age 26.3 (SD 7.4) years) had cone-beam computed tomographyic (CT) scans before operation, immediately postoperatively, and before removal of the osteosynthesis nine months postoperatively. The images were analysed to look for changes in the sagittal, coronal, and axial positions of the condyles. Twenty-four patients with class II malocclusion had a mean (SD) mandibular advancement of 6.51 (2.41) mm, and 26 patients with class III malocclusion had a mean (SD) mandibular setback of 4.16 (2.77) mm. The joint space increased significantly ($p < 0.05$) relative to baseline immediately postoperatively, but there was no significant increase at the nine-month follow-up. The changes in position in the sagittal, coronal, and axial planes were comparable. Despite there being a short proximal joint-bearing segment, the results indicate that this technique allows free-hand condylar positioning into the fossa safely without any clinically relevant dislocations.

Keywords: Orthognathic surgery; Cranio-mandibular-joint; Bilateral sagittal split osteotomy; Mandibular condyle position

Introduction

There have been many innovations in orthognatic surgery since Obwegeser introduced the bilateral sagittal split osteotomy (BSSO) in 1959.[1] Since then there have been several modifications to the standard BSSO technique, including those introduced by Hunsuck in 1968 and by Epker in 1977.[2,3] To date, this method remains the most commonly used technique by most maxillofacial surgeons during orthognathic surgery of the mandible, but it was developed at a time when ridged osteosynthesis was unavailable, and therefore extensive bony contact was vital to achieve stable results. However, effects on the course of the inferior alveolar nerve in the body of the mandible, and consequent numbness of the lower lip and chin, were and remain a major drawback. The reported risk of permanent numbness of the lower lip after BSSO varies between 11.7% and 24%.[4–7]

The current availability of stable, ridged osteosynthesis has led to the development of transoral short osteotomy techniques that involve the ascending ramus of the mandible and so avoid damage to the inferior alveolar nerve. The so-called high sagittal split osteotomy (HSSO) was described in this journal by Seeberger et al. in 2013.[8] Compared with the BSSO, injuries to the lower alveolar nerve are less common with HSSO, the exposed bony surface is smaller, and the osteotomy is completed without the risk of a "bad split".[6,7,9]

* Corresponding author at: Department of Oral and Maxillofacial Surgery, University Hospital Heidelberg, Im Neuenheimer Feld 400, 69120 Heidelberg, Germany.
E-mail address: robin.seeberger@me.com (R. Seeberger).

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One major drawback of a short osteotomy, however, involves concerns about bony healing and the condylar position as a result of the reduced bony contact and poor handling of the short proximal segment. We present a clinical evaluation of HSSO, which we made by evaluating the position of the proximal segment with cone-beam computed tomography (CT). Condylar positioning devices were omitted to simplify the technique, as the reliability of cone-beam CT for the evaluation of condylar changes has been described previously.[10,11]

Patients and Methods

Orthognathic operations were followed by examination of a consecutive, retrospective, cone-beam CT analysis, as all our orthognathic patients have routine cone-beam CT scans. We included 32 women and 18 men, mean age 26.3 (SD 7.4) years with skeletal class II (n = 24) or class III (n = 26) malocclusion. All patients had HSSO to reposition the mandible during bimaxillary surgery. Patients with a history of orthognathic surgery to the jaws, trauma to the mandibular joint, degenerative joint disease, or large anatomical deviations were excluded from the study. Data were collected after informed consent had been obtained from all patients, together with approval from the ethics committee of the University Hospital of Heidelberg (S-131/2009).

Each HSSO was done as described by Seeberger et al. in 2013 and as shown in Fig. 1.[8,12] After positioning of the distal (tooth-bearing) segment of the mandible into a regular class I occlusion, the proximal (condyle bearing) segment was positioned free-hand without positioning devices.

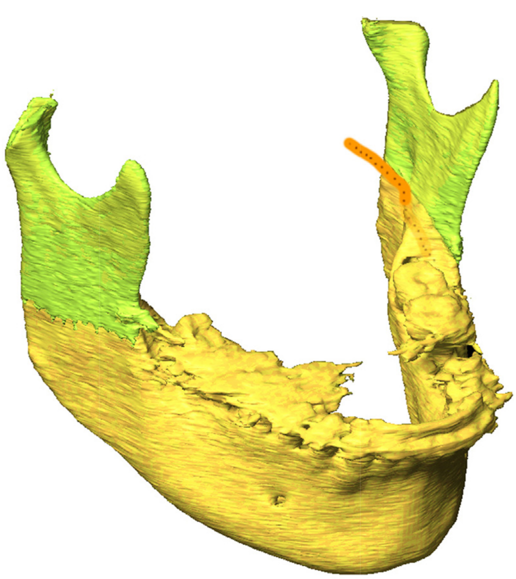

Fig. 1. The high oblique sagittal split osteotomy starts above the entry of the inferior alveolar nerve (orange) and ends within the ascending mandibular ramus without touching the course of the nerve. The proximal joint-bearing segments are shown in green.

Osteosynthesis was achieved using titanium miniplates (Modus 2.0; Medartis, Basel, Switzerland) that were fixed in place with four monocortical screws for each segment. Orthodontic treatment was restarted 2–4 weeks postoperatively. The osteosynthesis material was removed nine months postoperatively (250 (73) days).

Each patient had three cone-beam CT scans with a Gallileos Comfort plus system (Sirona Dental Systems GmbH, Bensheim, Germany). The specifications of the cone-beam CT machine included a spherical volume with a diameter of 15.4 cm, edge length of 0.125 mm for each voxel, tube voltage of 98 kV, amperage of 3–6 mA tube current, and scanning time of 14 seconds. The first scan was done two weeks preoperatively, and during this scan the positions of the patient's occlusion and joint were fixed with an initial centric splint. The second scan was done 2–4 days postoperatively to evaluate the results. During this scan patients were fixed in the final occlusion splint. The third and final scan was done nine months postoperatively and after completion of the orthodontic treatment to control ossification before removal of the osteosynthesis. All patients stood upright, and were adjusted to the Frankfort horizontal plane (FH) during the scans.

Cone-beam CT data were analysed using Galaxis 3-dimensional imaging software (Sirona Dental Systems), which allows various reconstructive options (for example, multiplanar and 3-dimensional reconstructions). Cone-beam CT scans were examined in a standard pattern beginning with the definition of reference points and corresponding planes to allow reliable measurements of the condylar angulations. These points and planes included the most cranial points of the glenoid fossa in the coronal plane, the FH in the sagittal plane, and a multiplanar reconstructed line from the lower nasal spine to the most anterior part of the foramen magnum in the axial plane.

The angles of the proximal (condyle-bearing) segments were measured in the sagittal, coronal, and axial planes. The values of the three cone-beam CT images were then analysed for changes in the angulations from the preoperative to the postoperative positions, and at the long-term follow up. Fig. 2 shows the optimal measurements for the coronal plane. The position of the head of the mandible was calculated according to the method modified by Kim et al.[10] In a central sagittal condylar reconstruction, the cranial, anterior, and posterior joint spaces were measured as shown in Fig. 3. The mandibular sagittal shifts were calculated using a sagittal reconstruction of the ascending mandibular ramus. Postoperatively, the clearly visible edges of the osteotomy (Fig. 4) allowed exact measurements of the magnitudes of mandibular advancements and setbacks.

Statistical analyses were made with the help of SPSS software (version 16.0, SPSS Inc, Chicago, IL, USA). Given the exploratory nature of this study, no adjustments were made for multiple testing. Probabilities of less than 0.05 were accepted as significant. An analysis of variance (ANOVA) was used to detect differences in the primary endpoint of