Three-dimensional quantitative assessment of surgical stability and condylar displacement changes after counterclockwise maxillomandibular advancement surgery: Effect of simultaneous articular disc repositioning

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Introduction: In this study, we quantitatively assessed 3-dimensional condylar displacement during counterclockwise maxillomandibular advancement surgery (CMMA) with or without articular disc repositioning, focusing on surgical stability in the follow-up period. **Methods:** The 79 patients treated with CMMA had cone-beam computed tomography scans taken before surgery, immediately after surgery, and, on average, 15 months postsurgery. We divided the 142 condyles into 3 groups: group 1 (n = 105), condyles of patients diagnosed with symptomatic presurgical temporomandibular joint articular disc displacement who had articular disc repositioning concomitantly with CMMA; group 2 (n = 23), condyles of patients with clinical verification of presurgical articular disc displacement who had only CMMA; and group 3 (n = 14), condyles of patients with healthy temporomandibular joints who had CMMA. Presurgical and postsurgical 3-dimensional models were superimposed using voxel-based registration on the cranial base. Three-dimensional cephalometrics and shape correspondence were applied to assess surgical and postsurgical displacement changes. **Results:** Immediately after surgery, the condyles moved mostly backward and medially and experienced lateral yaw, medial roll, and upward pitch in the 3 groups. Condyles in group 1 showed downward displacement, whereas the condyles moved upward in groups 2 and 3 ($P \leq 0.001$). Although condylar displacement changes occurred in the 3 groups, the overall surgical procedure appeared to be fairly stable, particularly for groups 1 and 3. Group 2 had the greatest amount of relapse ($P \leq 0.05$). **Conclusions:** CMMA has been shown to be a stable procedure for patients with healthy temporomandibular joints and for those who had simultaneous articular disc repositioning surgery. (Am J Orthod Dentofacial Orthop 2018;154:221-33)

Counterclockwise maxillomandibular advancement surgery (CMMA) has often been used to treat hyperdivergent skeletal Class II patients. This surgical technique was developed as an effective means to achieve optimal functional and esthetic outcomes in patients with high occlusal plane facial deformities.[1,2]

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However, skeletal relapse after that orthognathic surgery has been a major issue because of problems related to the stretching of suprahyoid, pterygoid, and masseter muscles, as well as adverse effects on the temporomandibular joints (TMJs).[1-3] Clinical concerns have been raised regarding the influence of suboptimal intraoperative positioning of the proximal segments: ie, condylar torque, which may be associated with progressive condylar resorption[4-6] and subsequent postoperative relapse.[7]

CMMA has been described as a stable procedure for patients with healthy TMJs.[8] However, controversial opinions surround the appropriate treatment plan for those with preexisting TMJ disorders who need such orthognathic surgery for correcting jaw deformities and malocclusions.[8,9]

Some authors have suggested that orthognathic surgery alone may reduce or eliminate TMJ dysfunction and symptoms,[10,11] whereas others have reported damaging effects to the condyles from such surgery when there is internal derangement of the TMJs.[12,13] For instance, after mandibular advancement, it may happen from muscular activity, which causes the discs to remain displaced as the condyles assume a superoposterior position in the fossae by an increase in mechanical loading.[8,9]

Some studies have shown that concomitant surgical correction of dentofacial deformities and TMJ disorders by repositioning and stabilizing the articular disc using the Mitek anchor technique (Mitek Products, Westwood, Mass) provides great treatment outcomes for most patients concerning functional, esthetic, and psychological aspects.[8,14,15] Contrariwise, specific condylar displacement changes during articular disc repositioning surgery might be investigated as potential factors inducing condylar remodeling in the long-term follow-up, because of the condylar loading alteration.[16] The current literature is still not clear about the best treatment option for preventing degenerative condylar changes after bimaxillary surgical advancement.[15]

Cone-beam computed tomography (CBCT) has been used for assessing condylar changes and surgical relapse. However, most previous studies have measured longitudinal changes by using 2-dimensional tools, which are susceptible to errors in determining corresponding landmark positions when bone remodeling occurs. Accurate quantitative 3-dimensional (3D) image techniques are now available, giving clinicians a new imaging modality to evaluate postoperative skeletal relapse as well as positional and dimensional condylar changes.[7,15,17-19]

The aim of this study was to quantitatively assess 3D condylar displacement changes during CMMA with or without articular disc repositioning, focusing on surgical stability in the follow-up period.

Table I. Definition of landmarks used for 3D cephalometric analysis

Anatomic landmark	*Symbol*	*Definition*
Nasion	N	Anterior point on the frontonasal suture in the midsagittal plane
Sella	S	Midpoint at the posterior wall of sella turcica, obtained by projection of the geometric center of sella passing through nasion
Subspinale	A	Deepest point on the anterior contour of the maxillary alveolar process in the midsagittal plane
Supramentale	B	Deepest point on the anterior contour of the mandibular alveolar process in the midsagittal plane
Menton	Me	Lowest point on the lower border of the mandibular symphysis in the midsagittal plane
Gonion	Go	Midpoint at the angle of the mandible, obtained by the mean distance between the right and left sides

MATERIAL AND METHODS

This retrospective study sample was composed of CBCT scans and clinical records from patients who had CMMA by the same surgeon (L.M.W.). Inclusion criteria were (1) osteotomies performed and stabilized with rigid internal fixation; (2) female patients at least 15 years old and male patients at least 17 years old; (3) patients with no TMJ abnormalities and with TMJ disc displacement assessed in clinical examinations and on magnetic resonance imaging interpreted by 2 experienced and calibrated doctors (L.M.W. and J.R.G.); and (4) CBCT scans acquired at 3 time points: before surgery (T1), immediately after surgery (T2), and at least 6 months postsurgery (T3). The exclusion criteria were patients with (1) craniofacial syndromes, (2) systemic degenerative conditions, (3) severe facial asymmetry, (4) previous TMJ surgery, and (5) previous arthroscopy, arthrocentesis, or viscosupplementation.

Records from 226 subjects consecutively treated from October 2008 to January 2011 were evaluated. One hundred nine patients were excluded for having undergone total prostheses of the TMJ. Thirty-eight patients were excluded for not having CBCT scans at all 3 time points (12 had TMJ articular disc repositioning surgery using the Mitek anchor technique (Mitek Products, Westwood, Mass),[14] and the other 26 had no TMJ intervention). Therefore, 79 patients matched the inclusion criteria for this study.