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Clinical Paper
TMJ Disorders

Counterclockwise maxillomandibular advancement surgery and disc repositioning: can condylar remodeling in the long-term follow-up be predicted?

L. R. Gomes[1], L. H. Cevidanes[2], M. R. Gomes[3], A. C. Ruellas[4], D. P. Ryan[5], B. Paniagua[6], L. M. Wolford[7], J. R. Gonçalves[1]

[1]Department of Orthodontics and Pediatric Dentistry, Araraquara School of Dentistry, Sao Paulo State University (UNESP), Araraquara, Sao Paulo, Brazil; [2]Department of Orthodontics and Pediatric Dentistry, School of Dentistry, University of Michigan, Ann Arbor, Michigan, USA; [3]Private practice, Salvador, Bahia, Brazil; [4]Department of Orthodontics, School of Dentistry, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil; [5]San Antonio School of Dentistry, University of Texas Health Science Center, San Antonio, Texas, USA; [6]Department of Psychiatry, School of Medicine, University of North Carolina, Chapel Hill, North Carolina, USA; [7]Departments of Oral and Maxillofacial Surgery and Orthodontics, Texas A&M University Health Science Center, Baylor College of Dentistry, Baylor University Medical Center, Dallas, Texas, USA

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Abstract. This study investigated predictive risk factors of condylar remodeling changes after counterclockwise maxillomandibular advancement (CCW-MMA) and disc repositioning surgery. Forty-one female patients (75 condyles) treated with CCW-MMA and disc repositioning had cone beam computed tomography (CBCT) scans taken pre-surgery, immediately after surgery, and at an average 16 months post-surgery. Pre- and post-surgical three-dimensional models were superimposed using automated voxel-based registration on the cranial base to evaluate condylar displacements after surgery. Regional registration was performed to assess condylar remodeling in the follow-up period. Three-dimensional cephalometrics, shape correspondence (SPHARM-PDM), and volume measurements were applied to quantify changes. Pearson product–moment correlations and multiple regression analysis were performed. Highly statistically significant correlation showed that older patients were more susceptible to overall condylar volume reduction following CCW-MMA and disc repositioning ($P \leq 0.001$). Weak but statistically significant correlations were observed between condylar remodeling changes in the follow-up period and pre-surgical facial characteristics, magnitude of the surgical procedure, and condylar displacement changes. After CCW-MMA and disc repositioning, the condyles moved mostly downwards and medially, and were rotated medially and counterclockwise; displacements in the opposite direction were correlated with a greater risk of condylar resorption. Moreover, positional changes with surgery were only weakly associated with remodeling in the follow-up period, suggesting that other risk factors may play a role in condylar resorption.

Key words: orthognathic surgery; mandibular condyle; cone beam computed tomography.

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Postoperative instability of counterclockwise maxillomandibular advancement (CCW-MMA) due to condylar displacement during the surgical procedure and/or subsequent long-term condylar resorption remains an area of concern[1,2]. Authors have suggested that condylar torque and altered condylar loading may lead to sagittal relapse and an anterior open bite[3,4].

There is disagreement in the current literature regarding treatment efficacy and the options for preventing degenerative condylar changes after bimaxillary surgical advancement. Although some investigators believe that orthognathic surgery alone reduces or eliminates temporomandibular joint (TMJ) dysfunction and symptoms[5–7], others have reported that performing orthognathic surgery in the presence of a TMJ disorder may cause further harmful effects to the TMJ[8,9].

Some studies have shown that the simultaneous surgical correction of coexisting dentofacial deformities and a TMJ pathology by repositioning and stabilizing the articular disc provides high-quality treatment outcomes for most patients[10–13]. On the other hand, specific condylar displacement changes during articular disc repositioning surgery have been investigated as a potential factor inducing condylar remodeling in the long-term follow-up[14]. Moreover, it has been reported that the degree of mandibular advancement performed may also contribute to skeletal relapse and condylar resorption[11]. Patients with pre-surgical TMJ symptoms requiring large mandibular advancement appear to be at increased risk[15,16].

The use of cone beam computed tomography (CBCT) and new three-dimensional (3D) tools allow for a comprehensive analysis of surgical and post-surgical skeletal changes. Such technologies have the potential to identify individual variability and highlight associations between structural changes and the stability of surgical correction[17,18].

This study investigated whether age, pre-surgical antero-posterior and vertical facial characteristics, and the magnitude of the surgical procedure and/or condylar displacement changes may predict condylar remodeling after CCW-MMA and disc repositioning surgery.

Materials and methods

De-identified CBCT scans from 41 female patients presenting with disc displacement and TMJ osteoarthritis (OA), who underwent CCW-MMA associated with disc repositioning surgery, were included in this study (Fig. 1). Patients were operated on consecutively by the same surgeon (LMW), using rigid internal fixation. Articular disc displacement was assessed by clinical examination and magnetic resonance imaging (MRI) interpreted by two experienced and calibrated doctors (LMW and JRG). Diagnostic criteria for temporomandibular disorders were used to identify TMJ OA[19].

The current study utilized CBCT images obtained before surgery (T1), immediately after surgery (3–9 days) (T2), and at an average 16 months post-surgery (T3). Archives from patients presenting with craniofacial syndromes, systemic degenerative conditions such as rheumatoid arthritis, or who had undergone a previous TMJ intervention were excluded.

A total of 82 condyles were analyzed. Seven condyles were excluded due to a history of previous arthroplasty. The final sample was composed of 75 condyles. All patients signed an informed consent form for hospital admission, surgical procedures, and release of information for research purposes. This study was approved by the university institutional review board and was performed in compliance with the Declaration of Helsinki.

Surgical technique

The TMJ and orthognathic surgeries were performed concomitantly, beginning with the TMJ surgery. Articular disc repositioning surgery was performed using the Mitek anchor technique (Mitek Products, Inc., Westwood, MA, USA). The CCW-MMA technique was then performed beginning with the bilateral mandibular sagittal split osteotomies with counterclockwise rotation and stabilization; one bone plate was positioned in the posterior body area and two to three bicortical 2-mm diameter screws were placed in the ascending ramus on each side. The maxillary osteotomies were then performed for counterclockwise rotation and stabilized with four bone plates using 2-mm diameter screws and bone grafting when indicated. A detailed description of the surgical procedure has been published previously[10].

Image acquisition and 3D analysis

CBCT images were obtained using a 17 × 23 cm extended field of view protocol, with a scan time of 17.8 s and isotropic voxel size of 0.3 mm (i-Cat CBCT,

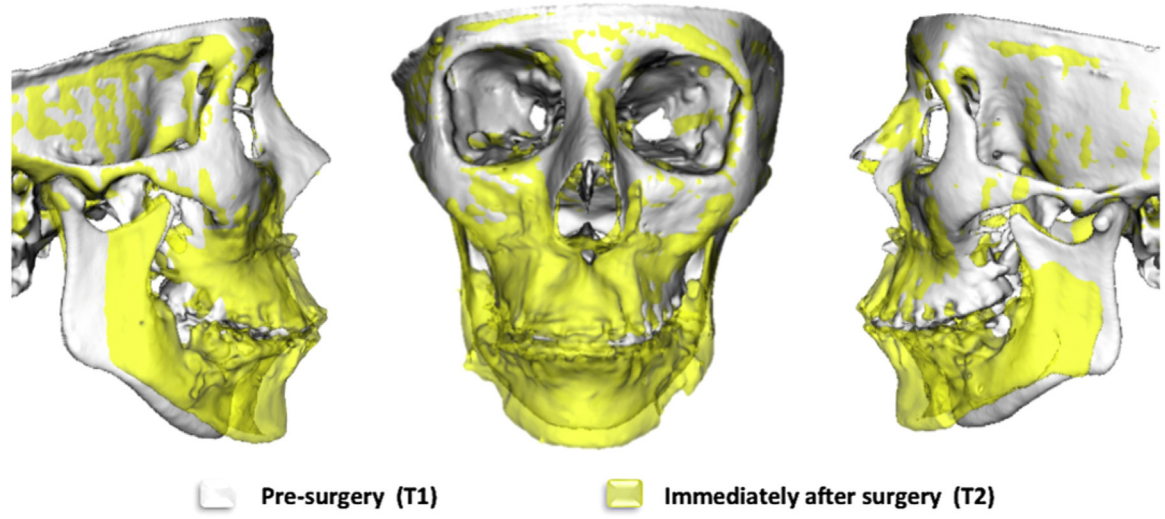

Fig. 1. All patients underwent counterclockwise maxillomandibular advancement surgery. Images obtained from a randomly selected patient. The amount of surgical movement differed from one patient to another.

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