Magnetic resonance imaging evaluation of articular disk position after orthognathic surgery with or without concomitant disk repositioning: a retrospective study

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Objective. The aim of this study was to compare the outcomes of 2 surgical treatment options: one for correction of class II malocclusion skeletal deformity and one for pre-existing temporomandibular joint (TMJ) disorders requiring orthognathic surgery (OS) for correction of dentofacial deformity.

Study Design. This retrospective study evaluated *patients* who underwent OS with maxillomandibular advancement (MMA) with or without concomitant TMJ surgery for articular disk repositioning (ADR). Patients were divided into 2 groups: group I (MMA) was treated with OS only (18 patients); and group II (MMA-ADR) was treated with OS and concomitant ADR (19 patients). The sample consisted of 74 TMJs (mean patient age 29.86 years).

Results. In group I, 38.5% of the disks that were originally in normal position became displaced after OS, and 33.3% of displaced disks with reduction became nonreducing after OS. In group II, 78.9% of disks exhibited normal position in the final evaluation, and 97.3% of patients showed improved disk position after surgery. There was significant symptom improvement in all patients in group II, but no significant improvement in group I.

Conclusions. OS with ADR appears to produce stable and beneficial results in improving symptoms in patients with displaced disk and TMJ pain. (Oral Surg Oral Med Oral Pathol Oral Radiol 2021;131:276−285)

The temporomandibular joints (TMJs) are the foundation for mandibular position, facial growth and development, function, occlusion, and facial balance of the lower jaw. If the TMJs are not stable and healthy (nonpathologic), patients requiring orthognathic surgery may have unsatisfactory outcomes relative to function, aesthetics, occlusion, skeletal stability, and pain.[1]

It is common for TMJ disorders/pathology (TMDP) and dentofacial deformities to coexist.[1,2] Most of the time, orthognathic surgery alone is an acceptable option in patients with healthy TMJs, and it is rare that these patients require additional surgery. However, on occasion, TMDP may be the causative factor for the jaw deformity or may have developed as a result of jaw deformity, or the 2 entities may develop independently of each other.[2] The most common TMDPs that can adversely affect jaw position and orthognathic surgical outcomes include (1) articular disk displacement, (2) adolescent internal condylar resorption, (3) reactive arthritis, (4) active condylar hyperplasia, (5) ankylosis, (6) congenital deformation or absence of the TMJ, (7) connective tissue and autoimmune diseases, and (8) other end-stage TMDP.[2]

These TMDPs are often associated with dentofacial deformities, malocclusion, TMJ pain, headaches, myofascial pain, jaw function impairment, ear symptoms, and sleep apnea, among others. Patients with these conditions could benefit from corrective surgical intervention, including TMJ and orthognathic surgeries. Many clinicians may have difficulty identifying the presence of a TMDP and selecting the proper treatment for that condition. An accurate diagnosis and an appropriate surgical intervention for a specific TMDP should provide highly predictable and stable results.[1]

There is still controversy regarding the ideal management of patients with pre-existing TMDP requiring

Statement of Clinical Relevance

To determine the ideal management of patients with pre-existing temporomandibular joint (TMJ) disorders who require orthognathic surgery, with bimaxillary advancement, counterclockwise rotation, with or without concomitant TMJ disk repositioning, it is necessary to investigate the spatial position of the disk by using magnetic resonance imaging.

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orthognathic surgery. Some authors state that the deformity can be corrected only with conventional orthognathic surgery, whereas other advocate surgical management in conjunction with the correction of the dentofacial deformity.[3]

Proper evaluation of the TMJs, especially in the presence of TMDP, requires magnetic resonance imaging (MRI). Its use is indicated to confirm the stage of internal derangement of a TMJ disk, irregularity of the articular surface, changes in the size and structure of the mandibular condyle, and condition of the masticatory muscles.[4]

The purpose of this study was to investigate the spatial position of the articular disk, before and after orthognathic surgery, by using MRI, in patients submitted to bimaxillary surgical advancement (maxillomandibular advancement [MMA]) with counterclockwise rotation, with or without concomitant TMJ surgical disk repositioning. The specific aims of the study were to (1) evaluate if the disk position was preserved or altered after surgery and (2) compare the groups with regard to symptoms before and after surgery.

MATERIAL AND METHODS

Patients who underwent surgery between May 2008 and July 2014 for correction of a skeletal deformity, specifically class II malocclusion and high occlusal plane angle, were included. All patients had to satisfy all of the following inclusion criteria: (1) preoperative dentofacial deformity treated with maxillomandibular advancement surgery with counterclockwise rotation; (2) preoperative MRIs; and (3) postoperative MRIs obtained at least 6 months after surgery. Patients were excluded from the study if they had (1) phenotypic expression of craniofacial syndromes; (2) class III malocclusion; (3) previous TMJ or maxillomandibular surgery; and (4) incomplete records or unwillingness to participate in the study.

Three experienced surgeons who had the same technical training for this procedure evaluated all of the MRIs.

Variables and data collection methods

The predictor variable of this study was the treatment performed (standard or experimental study group). Patients were divided into 2 groups: group I (MMA) was treated with orthognathic surgery only; and group II (MMA-ADR) was treated with orthognathic surgery and concomitant articular disk repositioning surgery. Group I consisted of patients without TMJ symptoms, with or without disk displacement. Group II consisted of patients with TMJ disk displacement and TMJ symptoms (pain and/or limited mandibular movement), indicating internal joint pathology. Patients from group II had moderate to severe pain, limitation of mouth opening, no response to conservative treatment (physical therapy, medications, and splint therapy). Orthognathic surgery included standard BSSO and Le Fort I osteotomies,[5] counterclockwise rotation, and internal rigid fixation: The maxilla was stabilized with 4 bone plates and at least 4 screws of 2 mm diameter each, and the sagittal split osteotomies were fixed with 1 or 2 bone plates, followed by 2 or 3 bicortical positional 2-mm screws in the retromolar region on each side.[6,7]

In group II, articular disk repositioning was performed before MMA, with a mini-anchor (Mitek Anchor; Mitek Products Inc., Westwook, MA) technique and an endaural approach, as described by Wolford et al.[8]

The main outcome variable of this study was the disk position. To analyze this variable, bilateral sagittal MRIs of the TMJs, with the subject in occlusion and maximal jaw-opening positions, were obtained to assess disk displacement before and after surgery. All MRI procedures followed a common acquisition protocol that consisted of 1.5-T images (Signa; General Electric, Milwaukee, WI); a dual surface coil; T1 and T2 weighting; 2-mm (oblique sagittal) and 1.5-mm (oblique coronal) slices; and a field of view that comprised the entire condyle in both closed-mouth and maximal incisal opening positions.

The images were magnified (200%) and displayed on a computer screen by using a commercially available imaging software program (OSIRIS; UIN/HCUG, Geneva, Switzerland).

Three calibrated oral surgeons, with extensive experience in the field of TMDP diagnosis and surgical treatment, evaluated the MRIs. Because the presence of an anchor gives away what treatment group the subject was in, the surgeons were blinded to the age, gender, and symptoms of each subject, and the results of one examiner's analysis of disk position were not seen or assessed by any other examiner. The evaluation was done randomly and nonsequentially and repeated 9 times for each subject at different times over several weeks.

The imaging assessment criteria classified the diagnosis into 3 categories (normal, disk displacement with reduction, and disk displacement without reduction), in accordance with the intermediate zone (IZ) criteria described by Orsini et al.[9] Disk position was considered to be normal if the IZ was located between the anterosuperior aspect of the condyle and the posteroinferior aspect of the articular eminence in the midline or above the line joining the centers of 2 imaginary circles, which were fitted to these structures (Figures 1A and 1B). These circles were positioned to closely approximate the condyle and the eminence outlines. Conversely, disk position was regarded as "anterior disk displacement" when the posterior band was located anterior to the line (Figure 1C). Disk positions, assessed in both open- and closed-mouth

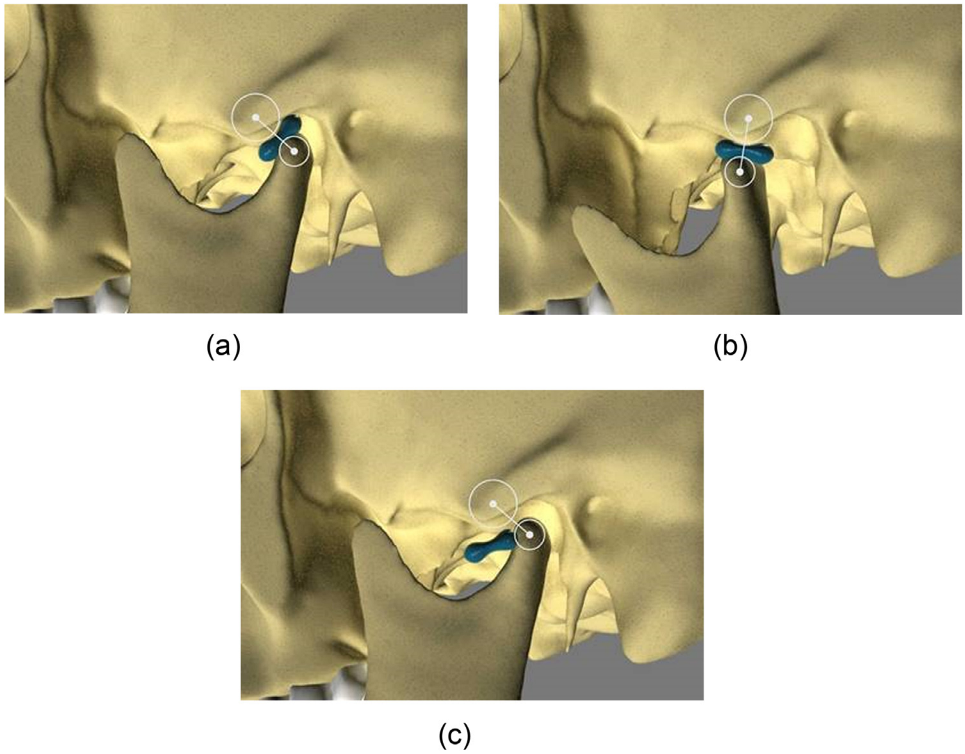


Fig. 1. Intermediate zone (IZ) criteria of disk location in relation to condyle and articular eminence. **A,** Closed-mouth position. **B,** Open-mouth position. **C,** Anterior disk displacement in closed-mouth position.

positions, were combined, and the final categorization of the joint disk status was formulated for each joint (e. g., normal, disk displacement with reduction, or disk displacement without reduction) (Figures 2−4).

Calibration was done by using 148 MRI scans (preoperative and postoperative) according to the aforementioned criteria. Each examiner evaluated the images 3 times, with a 1-week interval between assessments. Then, to assess intra- and interrater reliabilities, a kappa test was used, with any differences in interpretation being reconciled by means of consensus. Interexaminer agreement regarding interpretations of the diagnoses was adequate ($\kappa > 0.6$).

One examiner, who used a standardized form before and after surgery, performed all of the clinical evaluations in both TMJs. The secondary outcome variables for this study collected during anamnesis included age, gender, TMJ pain, facial pain, headaches, jaw function, diet, and disability, all of which were recorded by using a numerical visual analog scale (VAS), where 0 = normal and 10 = most abnormal; objective evaluations included maximal incisal opening (MIO), lateral excursions (left and right) without pain (measurements in millimeters), and TMJ noises (clicking, popping or crepitation). Occlusion was also evaluated in centric relation as well as in centric occlusion: class I, class II, or class III malocclusion was recorded in centric relation along with cross bites, open bites, and deep bites, among others.[1] Cephalometric changes in the occlusal plane and pogonion were recorded for all patients.

The research project that led to the present study was submitted to the Research Ethics Committee of the Federal University of Uberlândia in the Brazilian state of Minas Gerais (Proc. 277.827, CAAE: 10675813.3.0000.5152) and was duly reviewed and approved. This study followed all of the guidelines of the Declaration of Helsinki.

Data analyses

The unit of analysis considered for the disk position evaluation was the joint because the behavior of the left joint is not necessarily equal to that of the right joint in the same subject. Clinical evaluation of the patients was performed on an individual basis.

A kappa test was used to assess intra- and interexaminer reliabilities in the MRI interpretation process. To compare changes between the pre- and postoperative phases, the McNemar-Bowker test was used. The χ^2 test was employed to check for any association between the groups in the pre- and postoperative phases. For descriptive assessment, relative and absolute evaluations were frequently used. The significance

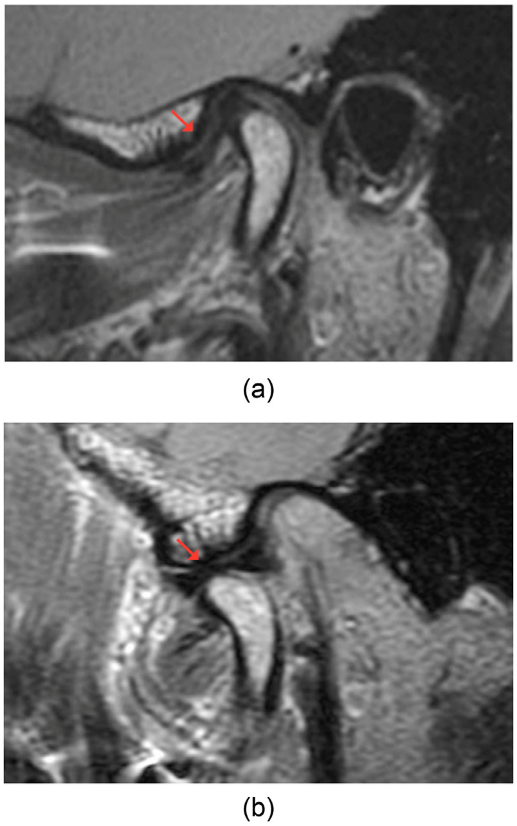


Fig. 2. Magnetic resonance imaging (MRI) scan of the same temporomandibular joint (TMJ) with the disk in normal position postoperatively. **A,** Closed-mouth position. **B,** Open-mouth position. Arrow points to the position of the disks.

level was 5%, and the statistical package used was R version 3.2.1.

RESULTS

From a total sample of 284 patients, only 37 patients (74 TMJs) met the inclusion criteria, mainly because many patients did not have postoperative MRIs or had refused to get one after surgery. There were 32 females and 5 males (mean age 29.86 years; range 15−50 years). Postoperative MRIs had been taken after a mean 16.2 months (range 6−51 months). Group I consisted of 18 patients with no identified TMJ clinical symptoms or abnormalities, although some of the MRIs showed changes in disk position. Group II consisted of 19 patients with TMJ disk displacement, pain, and limited mandibular movement.

The mean advancement of the pogonion was 13.72 mm (standard deviation [SD] = 5.77) for group I and 14.92 mm (SD = 5.31) for group II. The average counterclockwise rotation and change in the occlusal plane was 7.38 degrees (SD = 4.47) for group I and 7.76 degrees (SD = 4.24) for group II.

For group I, 13 joints (36%) demonstrated normal disk position, and 23 joints (64%) had disk displacement (15 reducing and 8 nonreducing) preoperatively, whereas in group II, 35 joints (92%) had anterior disk displacement, and 3 joints (8%) had a lateral displacement that was consider normal variation (Table I). After orthognathic/TMJ surgery, the postoperative disk position for group I showed that there was normal disk position in 12 joints (33%) and disk displacement in 24 joints (67%) (12 reducing and 12 nonreducing) (see Table I). For group II, 30 joints (79%) had normal disk position after surgery, 7 had displaced disk with reduction (18%), and 1 was nonreducing (3%). A statistically significant improvement in disk position after surgery was observed.

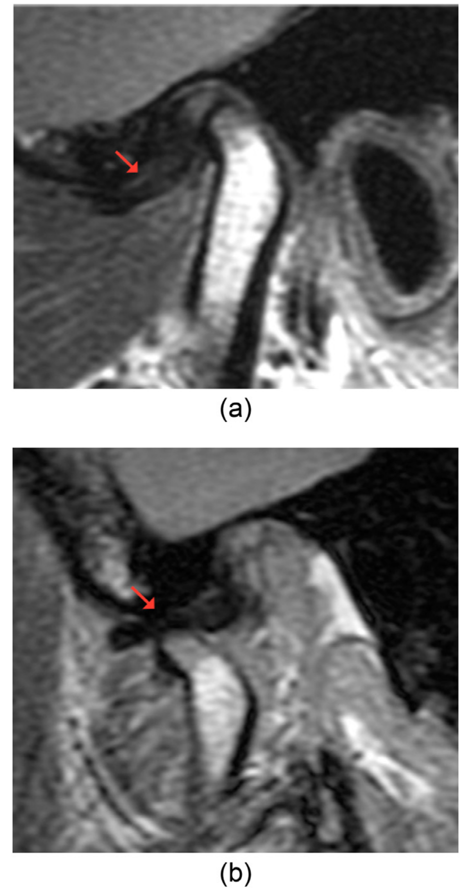
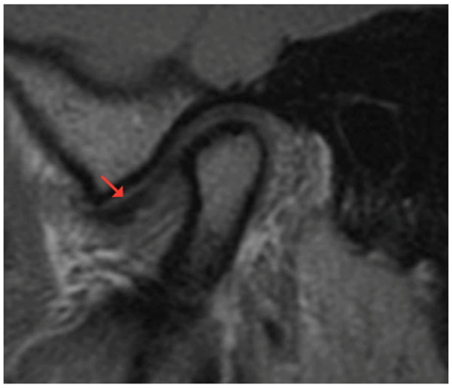
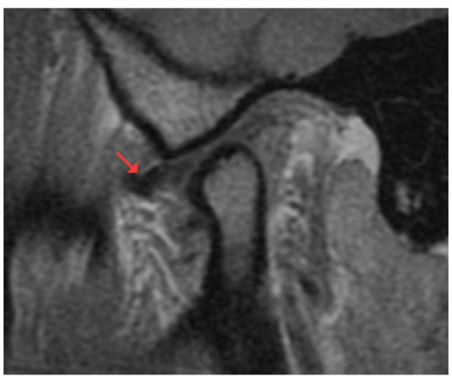


Fig. 3. Magnetic resonance imaging (MRI) scan of a temporomandibular joint (TMJ) with anterior disk displacement with reduction, preoperatively. **A,** Closed-mouth position. **B,** Open-mouth position. Arrow points to the position of the disks.

When comparing disk positions in the preoperative and postoperative phases, group I demonstrated that 36.1% of TMJs had normally positioned disks in the preoperative phase, 38.5% of disks were in normal position after surgery, and 33.3% of displaced disks with reduction had worsening of position (Table II), with a 50% increase in disks displaced without reduction (see Table I). However, changes in disk position were not statistically significant (*P* = .515) (Figures 5 and 6).



(a)



(b)

Fig. 4. Magnetic resonance imaging (MRI) scan of a temporomandibular joint (TMJ) with anterior disk displacement without reduction, preoperatively. **A,** Closed-mouth position. **B,** Open-mouth position. Arrow points to the position of the disks.

In group II, comparison of MRI scans of disk positions in the preoperative and postoperative phases showed that 97.3% of TMJs exhibited improved disk position. Of the TMJs that had exhibited disk displacement with reduction, 88.2% displayed normal position,

Table I. Preoperative and postoperative disk positions, according to the group

	Surgical procedure		*P value*
Preoperative disk position	*Group I − MMA*	*Group II − MMA-ADR*	
Normal	13 (36.1%)	3 (7.9%)	.006
DDWR	15 (41.7%)	17 (44.7%)	
DDWOR	8 (22.2%)	18 (47.4%)	
Postoperative disk position	*Group I − MMA*	*Group II − MMA-ADR*	
Normal	12 (33.3%)	30 (78.9%)	.005
DDWR	12 (33.3%)	7 (18.4%)	
DDWOR	12 (33.3%)	1 (2.6%)	

DDWR, disk displacement with reduction; *DDWOR,* disk displacement without reduction; *MMA,* maxillomandibular advancement with orthognathic surgery only; *MMA-ADR,* maxillomandibular advancement with articular disc repositioning surgery.

and no cases deteriorated after surgery. As for cases of disk displacement without reduction, 94.5% showed improvement in their condition: 66.7% showed normal position, and 27.8% showed displacement with reduction. Only 1 case in this group (5.6%) maintained disk displacement without reduction. Changes in group II were statistically significant (see Table II).

A total of 26 patients (70.3%) had complete absence of postoperative TMJ pain, compared with only 9 (24.3%) preoperatively. A significant reduction of TMJ pain was observed in group II ($P = .001$). With regard to myofascial pain and/or headaches, 26 patients (70.3%) had myofascial pain and/or headaches preoperatively, and only 6 (16.2%) had these symptoms postoperatively. A significant reduction in the severity of myofascial pain and/or headaches and of myalgia was observed in group II ($P < .001$ and $P = .001$, respectively). With regard to jaw function, the median preoperative VAS score was 5, and the median postoperative score was 0 for group II, showing a significant difference ($P = .003$) and indicating an improvement in subjective assessment of postoperative jaw function (Table III).

For group I, the median lateral excursion values were as follows: left = 9 mm (preoperative) and 7.5 mm (postoperative); right = 9 mm (preoperative) and 6.5 mm (postoperative). For group II, the median lateral excursion values were as follows: left = 8 mm (preoperative) and 4.2 mm (postoperative); right = 10 mm (preoperative) and 4 mm (postoperative). The difference of lateral excursion of the pre- and postoperative values were statistically significant on both sides and for both groups ($P < .005$) (Table III).

With regard to TMJ sounds/noises, in group I, 11 patients (61.1%) had preoperative TMJ noises and 7 (38.9%) did not. In this group, only 1 subject had postoperative noise. However, no patients with joint noises in the preoperative phase presented with this sign postoperatively. In group II, 14 patients (73.6%) had preoperative TMJ noises, and 5 (26.4%) did not. After surgery, of the 14 patients who presented TMJ noises preoperatively, the symptoms persisted postoperatively only in 4; of the 5 patients who did not have TMJ noises, 3 had it in the postoperative period. A nonsignificant difference was observed for both groups (see Table II).

The initial occlusal plane was high in all patients, greater than or equal to 11 degrees° (16.3 degrees ± 2.4 degrees in group I and 15.4 degrees ± 2.3 degrees in group II). All patients had class II malocclusion with similar deformities. In addition, the alterations of the occlusal plane were similar between patients after surgery in group I (6.8 degrees ± 1 degrees) and in Group II (7.7 degrees ± 1.2 degrees) because all of them

Table II. Comparison of the disk positioning and TMJ sounds/noises, according to the group in the pre- and postoperative stages

Group I – MMA		*Postoperative disk position*			*P value*
		Normal	*DDWR*	*DDWOR*	
Preoperative disc position	Normal	8 (61.5%)	4 (26.7%)	–	.515
	DDWR	4 (30.8%)	6 (40.0%)	2 (25.0%)	
	DDWOR	1 (7.7%)	5 (33.3%)	6 (75.0%)	

Group I – MMA		*Postoperative TMJ sounds/noises*		*P value*
		No noise	*Noise*	
Preoperative TMJ sounds/noises	No noise	6 (85.7%)	1 (14.3%)	.389
	Noise	11 (100.0%)	-	

Group II – MMA-ADR		*Postoperative disk position*			*P value*
		Normal	*DDWR*	*DDWOR*	
Preoperative disk position	Normal	3 (100%)	15 (88.2%)	12 (66.7%)	<.001
	DDWR	–	2 (11.8%)	5 (27.8%)	
	DDWOR	–	–	1 (5.6%)	

Group II – MMA-ADR		*Postoperative TMJ sounds/noises*		*P value*
		No noise	*Noise*	
Preoperative TMJ sounds/noises	No noise	2 (40%)	3 (60%)	.305
	Noise	10 (71.4%)	4 (28.6%)	

DDWR, disk displacement with reduction; *DDWOR,* disk displacement without reduction; *MMA,* maxillomandibular advancement with orthognathic surgery only; *MMA-ADR,* maxillomandibular advancement with articular disk repositioning surgery; *TMJ,* temporomandibular joint.

underwent counter clockwise rotation of similar magnitude. The mean occlusal plane alteration was 8.64 degrees (9.6 degrees ± 2.7 degrees in group I and 7.7 degrees ± 2.3 degrees in group II).

DISCUSSION

The purpose of this study was to investigate the position of the TMJ articular disk before and after surgery in patients undergoing maxillomandibular advancement with counterclockwise rotation with or without concomitant TMJ surgical disk repositioning. In the group treated with orthognathic surgery and concomitant articular disk repositioning surgery, improved the position of the TMJ disk improved compared with the group treated with orthognathic surgery only (97.3% of group II patients showed improved disk position after surgery). In addition, there was a reduction in symptoms in 100% of patients who received this treatment. Group II patients exhibited a class II deformity, with severe articular pain and disk displacement with reduction on both sides. This condition was corrected after surgery (see Figures 6A–6D).

This is the first study, to our knowledge, that used MRI scans in the preoperative and postoperative phases to evaluate spatial disk position after bimaxillary orthognathic surgery, with or without disk repositioning, performed in patients with the same morphologic facial pattern.

Evaluating the long-term stability of orthognathic surgery, Wolford et al.[10] and Gonçalves et al.[11] concluded that counterclockwise rotation of the maxillomandibular complex is a stable procedure when the TMJ is healthy or when repositioning the articular disk in cases of joint disorders diagnosed before orthognathic surgery. In a meta-analysis performed by Al-Moraissi and Wolford,[12] the authors evaluated the stability of counterclockwise rotation of the maxillomandibular complex in orthognathic surgery with or without concomitant TMJ surgical repair. As found in the studies by Wolford et al.[10] and Gonçalves et al.,[11] and in the present study, counterclockwise rotation of the maxillomandibular complex is a stable procedure when TMJ anchors are used. In the present study, both groups appeared to maintain a class I occlusal relationship, showing no difference in occlusal stability during the follow-up period, despite changes in articular disk position and evidence of condylar resorption in some patients who had orthognathic surgery only (group I). Condylar resorption observed at follow-up in group I had no changes in the final occlusion. This can be explained by the fact that the follow-up period was too short or that the resorption occurred slowly, allowing

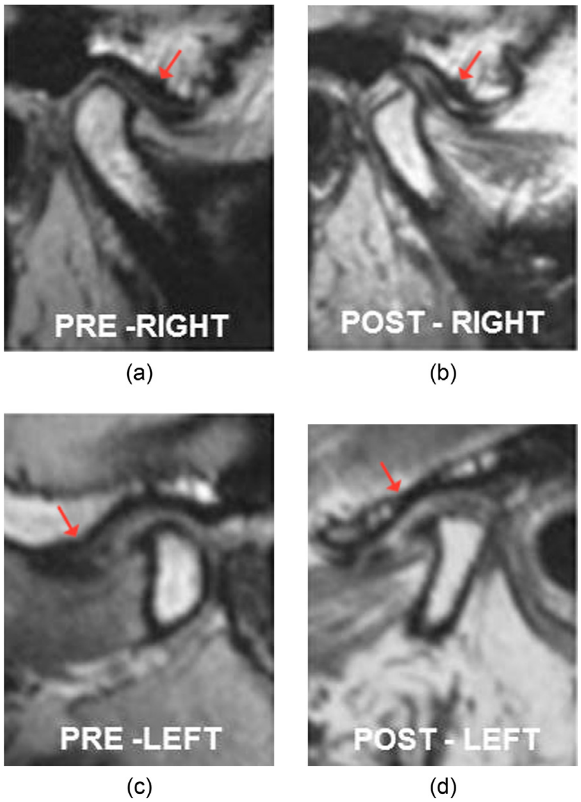


Fig. 5. Representative case of group I. Magnetic resonance imaging (MRI) scans. *Right side,* Before (A) and after (B) surgery. *Left side,* Before (C) and after (D) surgery. Arrow points to the position of the disks.

the dentition to adjust. However, the occlusal plane rotated in a clockwise direction, revealing relapse of the original counterclockwise rotation done (see Figures 5A−5D).

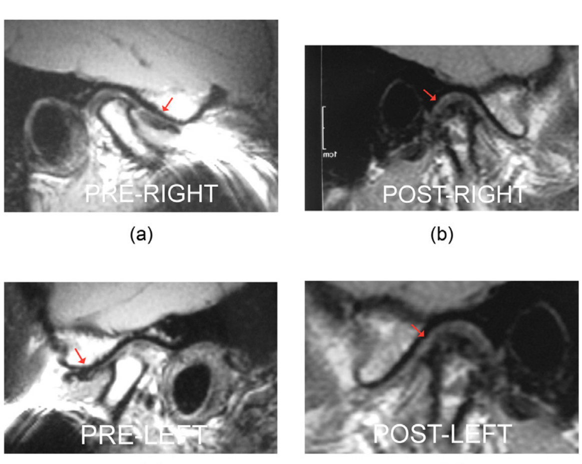


Fig. 6. Representative case of group II. Magnetic resonance imaging (MRI) scans. *Right side,* Before (A) and after (B) surgery. *Left side,* Before (C) and after (D) surgery. Arrow points to the position of the disks.

In group I, 14 patients (78%) had stable occlusion (class I); 3 patients (16%) showed a 1- to 2-mm relapse; and 1 patient (5.5%) had a relapse bigger than 3 mm. These results are similar to those reported by Wolford et al. and demonstrates that in large occlusal plane rotations and mandibular advances, condylar accommodation leads to occlusal changes in 21% of cases. It is possible that with longer follow-up, the relapse rate in group 1 would have been higher. Patients in this group also reported pain in the first years after surgery (26%), with resolution and no complaints after healing even if the disks were out of place. The mean follow-up period for our study was 16.2 months; however, not all radiographs were available at that time point. In group II, all the patients maintained a class I occlusion (100%) at longest follow-up; 70% had no complaints of pain despite having slight lateral excursive movement restrictions.

The stability of mandibular advancement surgery is less predictable for patients with long face patterns (facial morphology with a high occlusal plane).[13,14] Changes in condylar position and TMJ loading during surgical MMA have been associated with postoperative condylar remodeling, resorption, and instability of the surgical correction.[15] It is possible that a healthier TMJ with an adequate TMJ disk position can withstand the movement better over time.

There is controversy regarding the appropriate treatment for patients with pre-existing TMDP requiring orthognathic surgery. Some advocate that orthognathic surgery alone helps reduce symptoms and alleviate TMDP, whereas some others have shown that orthognathic surgery causes deleterious effects by worsening the symptoms in the postoperative period. Others propose surgical treatment of TMDP as an initial procedure, separately or in conjunction with orthognathic surgery.[16]

The benefits of simultaneous TMJ and orthognathic surgeries include the need for only 1 surgery and general anesthesia and decreased overall treatment time. These procedures provide high-quality results with regard to function, aesthetics, patients satisfaction, and the elimination or even significant reduction in pain.[17] All of the patients in this study ho had simultaneous TMJ and orthognathic surgery obtained the aforementioned benefits, including reduction in the severity of TMJ pain, headaches, and muscle pain.

In group II, 97.3% of TMJs showed improved disk position. In the TMJs with disk displacement with reduction, 88.2% exhibited normal position, and no cases deteriorated over time. Among patients with disk displacement without reduction, the condition improved in 94.5%. This demonstrates efficiency in the application of the proper technique and excellent results for the study group. In addition, both groups had aesthetic improvement.

Table III. Clinical evaluation results for group I – MMA and group II – MMA-ADR, in the pre- and postoperative stages

Group I – MMA		*Facial pain/headaches**	*TMJ pain**	*Myalgia**	*Jaw function**	*MIO*†	*Lateral excursions – R*†	*Lateral excursions – L*†
Preoperative	Mean ± SD	2.94 ± 3.22	2.28 ± 1.96	3.33 ± 3.15	1.22 ± 2.10	44.42 ± 5.29	8.86 ± 1.93	9.02 ± 2.06
	Median	2.50	2.50	3.25	0.00	44.00	9.00	9.00
Postoperative	Mean ± SD	0.67 ± 2.05	1.11 ± 2.90	1.67 ± 3.46	0.22 ± 0.64	43.11 ± 7.21	6.29 ± 1.64	7.36 ± 1.85
	Median	0.00	0.00	0.00	0.00	43.50	6.50	7.50
P value		.066	.160	.140	.078	.424	.001	< .001
Group II – MMA-ADR		*Facial pain / headaches**	*TMJ pain**	*Myalgia**	*Jaw function**	*MIO*†	*Lateral excursions – R*†	*Lateral excursions – L*†
Preoperative	Mean ± SD	5.47 ± 3.48	4.89 ± 3.28	3.74 ± 3.46	4.42 ± 2.83	45.03 ± 6.59	8.54 ± 2.99	8.35 ± 2.81
	Median	5.00	5.00	3.00	5.00	45.00	10.00	8.00
Postoperative	Mean ± SD	0.63 ± 1.30	1.16 ± 1.60	0.89 ± 1.69	0.79 ± 1.81	38.13 ± 7.47	4.47 ± 1.76	5.18 ± 2.06
	Median	0.00	0.00	0.00	0.00	40.00	4.00	4.20
P value		< .001	.001	.001	.003	.005	< .001	.004

MIO, maximal incisal opening; *MMA*, maxillomandibular advancement with orthognathic surgery only; *MMA-ADR*, maxillomandibular advancement with articular disk repositioning surgery; *TMJ*, temporomandibular joint; *SD*, standard deviation.
*Visual analog scale (VAS), where 0 = no pain and best function; and 10 = worst pain and no function.
†Millimeters (mm)

Gonçalves et al.,[18] in a recent study, found that the anterior surface resorption of the condyle was more frequent in the group with MMA only, whereas posterior surface resorption occurred mainly in the group with MMA-ADR, particularly adjacent to the area of bone anchor placement. Bone apposition was observed only after TMJ articular disk repositioning (MMA-ADR group), which seemed to facilitate condylar bone repair. New bone formation and repair were markedly variable 1 year after surgery and were observed in all condylar surfaces, except the lateral pole. Patients with a vertical facial pattern treated with surgical MMA showed marked condylar displacement and bone remodeling adaptive changes 1 year after surgery. One year after surgery, mild condylar resorptive changes were observed in both groups, although articular disk repositioning facilitated bone apposition in localized condylar regions. The present study demonstrated, with the use of MRI scans, normal position of the articular disks in 78.9% of patients after TMJ surgery. According to Gonçalves et al.,[18] this may be a favorable and determining factor for this bone apposition.

In our study, there was a worsening trend in articular disk positions in the group with orthognathic surgery only, creating the risk of TMDP in the future for these patients. Studies have shown that clinical assessment of TMJ status is unreliable[19]; thus, diagnostic imaging is imperative. The MRI analysis result was a decisive factor in this study, validating our findings—that is, changes in disk position occur after orthognathic surgery because the load in the TMJs is altered after the surgery. It is important to point out that the condition of patients in group II did not spontaneously improve without TMJ surgery. There is a trend toward worsening of disk position if disk dislocation is performed without surgical disk repositioning. Therefore, clinical symptoms, such as pain and hypomobility, are important indications for disk repositioning surgery.[20]

Changes in mandibular movement were significant in group II, which showed a decrease in MIO and lateral excursions. This is expected after TMJ surgery and usually resolves with time; however, MIO was within normal limits, and the restrictions were not relevant.

The incidence of clicking was reduced after surgery in both groups. Although not submitted to TMJ surgery, all patients in group I with joint sounds in the preoperative phase (11 patients) did not show this postoperative sign. This may be explained by the fact that some of the joints where the disk was displaced with reduction became nonreducing, giving the false impression of clinical improvement. Despite changes in disk position, this study agrees with the literature in that one-third of patients may show disk displacement without clinical symptoms, suggesting that the condition might represent a common congenital anatomic variant.[21-24] However, it is worth noting that patients in group I showed no improvement in disk position, and 2 patients had severe pain after MMA (5.4%), requiring further TMJ treatment. This did not occur in group II, where 100% of the patients showed clinical improvement in all of the symptoms evaluated, suggesting greater predictability.

It is important to note that the patients in group II had worse symptoms than those in group I, and therefore, changes in their condition were statistically significant; they were also more likely to benefit from open joint surgery. Besides that, those patients who did not undergo open joint surgery had worsening disk position postoperatively, although there was no statistical significance with regard to changes in pain, MIO, function, and so on. Thus, we understand that the 2 groups were not "equal" preoperatively with regard to their complaints, but they all had the same facial and malocclusion patterns, in addition to the fact that all of them, regardless of the group, underwent MMA with counterclockwise rotation of the occlusal plane. However, it is really difficult to control in a retrospective study, but something to look at if a future prospective study is being considered.

This study had some limitations. (1) On the basis of pre- and postoperative MRI scans, only the disk position was evaluated, but not its morphology; (2) changes in condyle morphology or position within the fossa were not assessed; (3) follow-up periods may have been short, particularly in reference to MRI assessments because the minimum postoperative time was 6 months.

CONCLUSIONS

TMJ disk repositioning surgery has benefits only when it is clearly indicated and for patients who have pain symptoms that do not respond to conventional treatments and to disk displacement with reduction because 97.3% of patients showed improved the disk position after surgery. There was no statistical difference in disk position in the non-operated group; however, many of the displaced disks worsen when only orthognathic surgery is performed. There was clinical significance in the improvement of symptoms in all% of the patients in group II and no significant clinical modifications in group I. Therefore, it is suggested that joint surgery, preferably dislocation with reduction, be performed only in patients with disks with good morphology because they have the best results, as demonstrated by MRI. Additional studies are necessary to verify the data presented in this report.

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