ORIGINAL ARTICLE

Temporomandibular joint evaluation with magnetic resonance imaging in children with functional unilateral posterior crossbite, treated with rapid maxillary expansion

Marcia Masi,[a] Henrique M. Lederman,[b] Helio K. Yamashita,[c] and Luís Antônio de Arruda Aidar[d]
Santos and São Paulo, Brazil

Introduction: The purpose of this prospective study was to evaluate qualitatively articular disc position and configuration of the temporomandibular joint (TMJ) with magnetic resonance imaging (MRI) in children with functional unilateral posterior crossbite (FUPXB) treated with Haas-type orthopedic appliances. **Methods:** The sample included 30 Brazilian children (60 TMJs) of both sexes (8 boys, 22 girls), aged 6.8 to 14.2 years (mean, 10.5 years; SD, 2.1 years). The MRIs were acquired in closed-mouth (CM), maximum-intercuspal (MI), and open-mouth (OM) positions in 3 stages of treatment: initial (T1), at the beginning of treatment; intermediate (T2), immediately after the removal of the expander, and final (T3), 9 months later, at the end of the observation period. **Results:** No changes were found in articular disc positions of 96.6% of the TMJs in the CM and MI positions, and in 95% in the OM position at T1, T2, and T3. For the articular disc configuration, no changes were observed in 96.66% of the TMJs in the CM and MI positions, and in all TMJs in the OM position, at T1, T2, and T3. **Conclusions:** On average, this treatment method did not change articular disc positions and configurations. (Am J Orthod Dentofacial Orthop 2009;136:207-17)

Unilateral posterior crossbite is relatively common, already prevalent in the mixed or deciduous dentition, with an incidence of 7% to 23%.[1-6] The incidence of functional unilateral posterior crossbite (FUPXB) in all unilateral posterior crossbites is 67% to 79%.[1,2,5,7,8]

In most cases, it is characterized by a symmetric maxillary arch, and, when establishing the mandibular position in centric relation, a bilateral maxillary crossbite, in most cases prematurely, contacts the deciduous canine. This pattern has no occlusal stability; normally, the mandible deviates to the side of the crossbite to reach functional adjustment to the occlusal interferences.[2,8]

[a] Professor, Department of Orthodontics, Santa Cecília University, Santos, Brazil.
[b] Professor, Department of Imaging Diagnostic, Paulista School of Medicine, Federal, University of São Paulo, São Paulo, Brazil.
[c] Professor, Department of Imaging Diagnostic, Paulista School of Medicine, Federal University of São Paulo, São Paulo, Brazil.
[d] Professor, Department of Orthodontics, Santa Cecília University, Santos, Brazil.
The authors report no commercial, proprietary, or financial interest in the products or companies described in this article.
Reprint requests to: Marcia Masi, Avenue Ana Costa 416/72, Santos, São Paulo, Brazil, CEP: 11060-002; e-mail, mmasi@litoral.com.br.
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The etiology of crossbite is not yet completely known. Genetic factors, possibly associated with the epigenetics, are a probable hypothesis. Respiratory changes and bad oral habits can cause transversal changes in the maxilla, often associated with FUPXB.[2,9]

The changes in condyle position in the mandibular fossae in patients with FUPXB are troublesome because they can cause articular disc displacement and consequently change their morphology.[10] Despite the great adaptation capacity of children's temporomandibular joints (TMJs), early correction of a FUPXB is indicated with rapid maxillary expansion,[11-14] since it repositions the condyles in their respective mandibular fossae, thus lessening asymmetries of the facial skeleton.[6,8,15-17]

Of the new diagnostic methods, magnetic resonance imaging (MRI) is an excellent method to observe the soft tissues of TMJs, because it does not produce ion radiation; as of yet, no adverse effects are known.[18-26] On the other hand, comparative studies with MRI and cadavers have shown that this method is extremely effective in the detection of internal derangements in TMJs.[19,20,22,27]

Studies about temporomandibular disorders (TMD) in children are scarce, and it is tempting to extrapolate information from adult studies.[12] Although there are some similarities, the differences must be considered during treatment planning, especially because facial skull growth is still occurring in children. Children can also tolerate changes in masticatory structures.[12-14]

Some studies of the relationship between TMD and malocclusion show high prevalence of FUPXB in patients with internal derangements of the TMJs.[12,28,29] Nonetheless, Mohlin et al[30] found no associations and suggested that new longitudinal studies should be conducted.[9]

The literature is unanimous regarding early correction of FUPXB.[1,2,4,5,7,15,16,31,32] Spontaneous correction does not occur, and skeletal remodeling of the TMJ can symmetrically position the condyle in its fossa, improve facial asymmetry, and also leave the displacement of the medial line unaltered.[7]

Rapid maxillary expansion with a Haas-type appliance is an effective treatment choice.[33] Santos Pinto et al[16] affirmed that, after correction of the FUPXB, structural asymmetries in growing patients with this type of malocclusion will be corrected with facial growth. Thus, it is paramount to assess any changes in the TMJs after correction of the FUPXB with rapid maxillary expansion.

Although epidemiologic studies suggest an association between FUPXB and TMD, few studies have evaluated the effects of rapid maxillary expansion on the components of TMJs.[2,3,28,34,35] The purpose of this study was to assess possible changes in the position and form of the articular discs of TMJs by using MRI in children and preadolescents treated with Haas-type orthopedic appliances.

Table I. Characteristics of patients at beginning of treatment (T1)

Patient	Sex	Age at T1 (y/mo)	Malocclusion: Right side	Malocclusion: Left side	Dentition	Crossbite side
1	Female	8/11	Class I	Class I	Mixed	Left
2	Female	10/1	Class III	Class III	Mixed	Right
3	Female	8/0	Class II	Class I	Mixed	Right
4	Female	14/2	Class I	Class I	Permanent	Right
5	Female	9/9	Class II	Class II	Mixed	Right
6	Male	8/0	Class I	Class I	Mixed	Right
7	Female	10/8	Class II	Class II	Mixed	Right
8	Female	14/0	Class I	Class I	Permanent	Right
9	Female	8/4	Class I	Class I	Mixed	Right
10	Female	10/6	Class II	Class II	Mixed	Right
11	Female	12/2	Class II	Class I	Mixed	Right
12	Male	8/11	Class I	Class I	Mixed	Right
13	Female	12/2	Class II	Class I	Permanent	Right
14	Male	11/10	Class II	Class II	Mixed	Right
15	Female	8/8	Class II	Class II	Mixed	Right
16	Female	7/5	Class II	Class I	Mixed	Right
17	Male	6/8	Class I	Class I	Mixed	Left
18	Female	7/5	Class I	Class II	Mixed	Left
19	Female	13/11	Class II	Class I	Permanent	Right
20	Male	8/5	Class I	Class II	Mixed	Left
21	Male	11/4	Class I	Class I	Mixed	Left
22	Female	12/9	Class I	Class II	Permanent	Left
23	Female	12/2	Class II	Class I	Permanent	Right
24	Female	11/6	Class I	Class I	Permanent	Left
25	Male	12/0	Class I	Class II	Mixed	Left
26	Female	11/3	Class III	Class III	Mixed	Left
27	Female	12/9	Class II	Class II	Permanent	Right
28	Female	11/3	Class I	Class I	Mixed	Right
29	Male	10/0	Class I	Class I	Mixed	Left
30	Female	9/5	Class II	Class I	Mixed	Right

MATERIAL AND METHODS

This prospective study was carried out with 30 Brazilian subjects (22 girls, 8 boys) aged 6.8 to 14.2 years (mean age, 10.5 years; SD, 2.1) and diagnosed with FUPXB. The treatment consisted of symmetrical maxillary arch expansion with the Haas-type appliance fabricated on each patient's diagnostic model. Success of treatment was defined as complete elimination of the FUPXB.

Patients with the following characteristics were enrolled in this study (Table I): FUPXB (minimum of 3 crossed teeth), and mixed dentition or the beginning of the permanent dentition. The Research Ethical Committee from the Federal University of São Paulo approved this project on May 9, 2003.

The appliance used was a modified Haas expander.[33] The midpalatal suture was opened to expand the transverse dimension. The activation protocol consisted of a full turn of the expander screw every day until good morphology of the maxilla was obtained, with some overcorrection.[33]

MRIs of both TMJs in closed-mouth (CM), maximum-intercuspal (MI), and open-mouth (OM) positions were taken during 3 stages of treatment: initial (T1), at the beginning of treatment; intermediate (T2), immediately after the removal of the expander (3 months after the end of the Haas appliance activation), and final (T3), 9 months later, at the end of the observation period (6 months after the end of the expansion). A Gyroscan Intera-NT15 superconductor (Philips, Eindhoven, Netherlands), with a magnetic field intensity of 1.5 T and bilateral TMJ surface coils, was used.

Sedation and contrast in the TMJs of these patients were not necessary. Because of the many recordings, the total examination time for each subject was approximately 30 minutes.

The MRIs were performed by using T1-weighted axial plane images: T1 turbo spin echo sagittal oblique images with the mouth closed and open (repetition time/echo time, 450/15 ms; field of view, 15 cm; number of signs acquired, 4; matrix, 192 × 256); T2 turbo spin echo sagittal oblique images with the mouth close (repetition time/echo time, 2202/90 ms; field of view, 15 cm; number of signs acquired, 6; matrix, 192 × 256); and T3 turbo spin echo coronal images with the mouth closed (repetition time/echo time, 450/15 ms; field of view, 15 cm; number of signs acquired, 6; matrix, 192 × 256). In all images, the thickness/increment was 3.0/0.3 mm.

Parasagittal MRIs were taken perpendicular to the long axis of the condyle, and the coronal MRIs parallel to the long axis of the condyle. In each sequence, 12 slices were acquired (6 for each TMJ). The MRIs were examined with 2-times magnification.

The amount of mouth opening of each patient, to keep the same opening in every acquisition, was established in the T1 clinical evaluation.

The MRIs were interpreted visually at T1, T2, and T3 by 2 observers (observer A [M.M.] and observer B [H.K.Y.]). All MRIs were analyzed with the same protocol to better define the criteria for interpretation. Since the 2 observers had different academic backgrounds, they were trained for 4 months with images not included in this study.[36]

The images were then interpreted twice, after a double-blind procedure,[37] by observer A and once by observer B (who also gave the final diagnosis). Observer A's second reading was considered the final interpretation. Overall interobserver agreement was calculated as the proportion of the TMJs for which observers A's final interpretation and observer B's interpretation agreed.

The protocol included assessing the anatomic position and morphology of the articular disc in the CM, MI, and OM positions.

The anatomic disc positions with CM and MI were classified according to Tasaki et al[21] (adapted): (1) superior disc position (normal), the posterior band of the disc superior to the condyle in a relationship that varied from 11 o'clock to 1 o'clock; (2) anterior disc displacement, the disc displaced anterior to the 11 o'clock position on top of the condyle; (3) partial anterior disc displacement in the lateral third of the joint; (4) partial anterior disc displacement in the medial third of the joint; (5) anterolateral disc displacement; (6) anteromedial disc displacement; (7) lateral disc displacement, with the disc displaced laterally to the lateral pole of the condyle; (8) medial disc displacement, with the disc displaced medially to the medial pole of the condyle; (9) posterior disc displacement, with the disc displaced posteriorly to the 1 o'clock position on top of the condyle; and (10) indeterminate, with no clear image of the disc, preventing classification into any of the above categories.

Functional disc position with OM was classified according to Tasaki et al[21] (adapted): (1) interposed was noted when a disc in the OM position stayed interposed between the condyle and the articular eminence in all sections; (2) disc displacement with reduction was noted when a displaced disc in the CM position assumed a position interposed between the condyle and the articular eminence in the OM position; (3) disc displacement with no reduction was noted when a displaced disc in the CM position did not achieve a position between the condyle and the articular eminence in the OM position; (4) disc displacement with partial reduction was noted when a displaced disc in the CM position returned partially to its position between the condyle and the articular eminence in the OM position; (5) indeterminate was noted when the disc could not be identified.

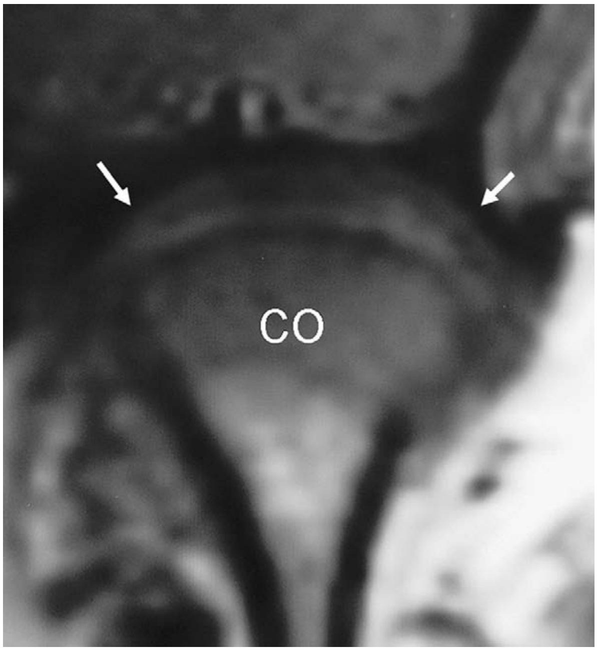

Fig 1. Patient 12: left TMJ in MRI at T3. The coronal plane was used to locate the articular disc position in the mediolateral direction (*arrows,* articular disc; *CO,* condyle).

Images taken in the coronal plane were used to prevent false negative findings during displacement of the disc in a lateromedial direction (Fig 1). In these images, the position of the articular disc was classified as superior (normal) when it appeared to be located in the center of the mandibular condyle. A medial or lateral classification was determined when the disc was diagnosed in a medial or lateral pole of the condyle, as seen in a parasagittal plane tangent to the center of the condyle.[22,27,38]

The morphology of the articular disc was classified according to Ribeiro.[22] The morphology was analyzed and classified in the CM, MI, and OM positions in the

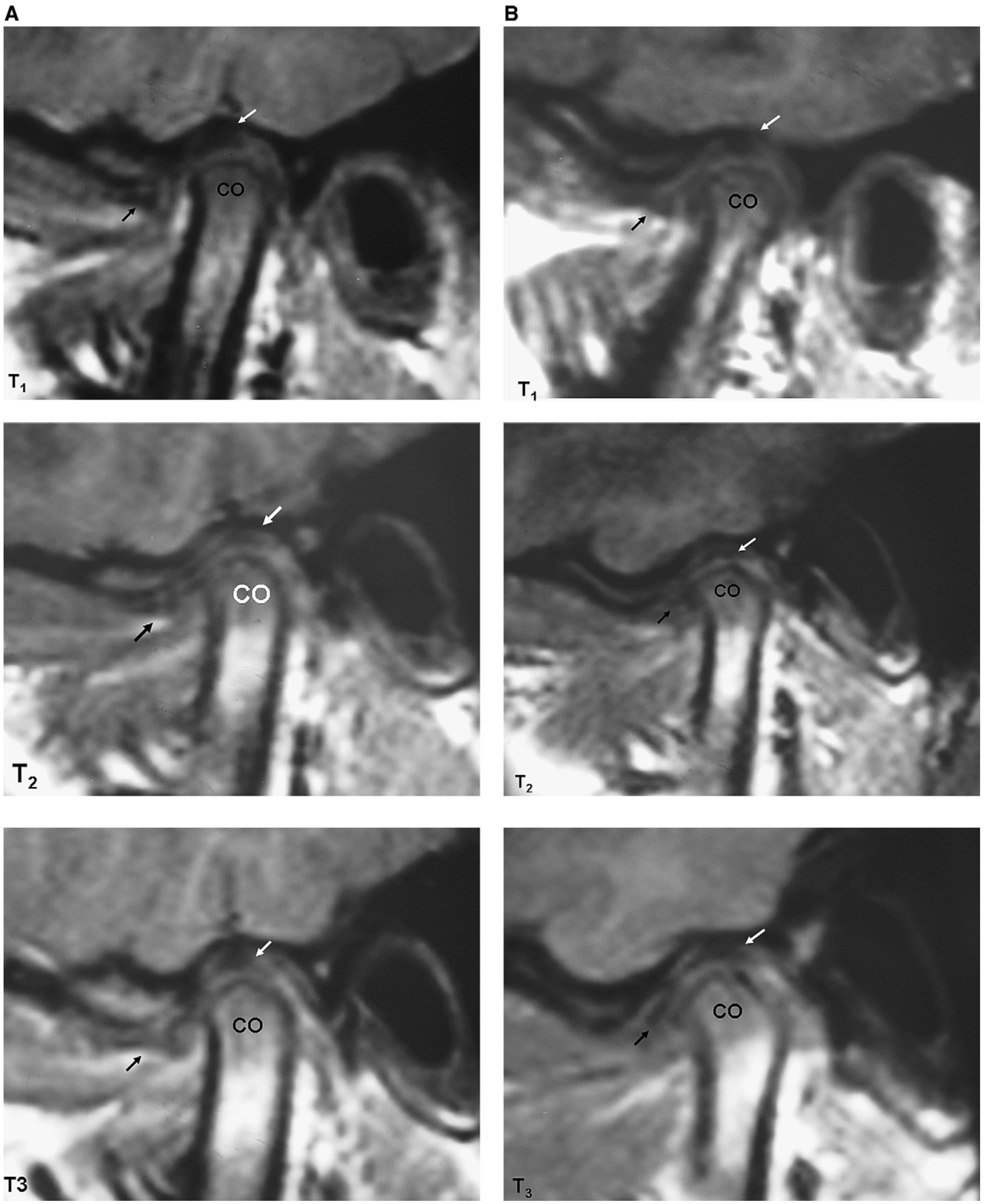

Fig 2. Patient 12: **A,** left and **B,** right TMJs in MRIs in the MC position. The articular disc is in its normal superior position at T1, T2, and T3 (*arrows,* articular disc; *CO,* condyle).

parasagittal images at T1, T2, and T3: (1) biconcave (normal morphology) with the disc resembling a bow tie, and the posterior band thicker (approximately 3 mm) than the anterior band (approximately 2 mm), and the intermediate zone is thin (approximately 1 mm); (2) not biconcave, with an increase or deformity of the bands of the disc; and (3) undetermined, when it was impossible to visualize the disc.

Statistical analysis

To assess the concordances between the left and right TMJs, according to the previously defined positions (CM, MI, and OM) at T1, T2, and T3, the nonparametric kappa test was used when the crossings allowed the application of percentages or the assessment of the incidence when the test could not be used.

For the intraobserver and interobserver analyses, the kappa test was applied when the crossings allowed, or when the percentage assessment of the incidence was used if the test could not be applied.

The kappa test is a concordance test for 2 samples of qualitative nature (categorized); it was important to know the concordance or equivalence between the 2 classifications. The higher the value of kappa and the closer to 1, the better the concordance; 0 indicates that concordance was random.[39]

To evaluate the comparative findings of the T1, T2, and T3 assessments, the McNemar test was applied at 5% significance. This test is indicated to verify the difference in the classification distribution between 2 groups of the same classification with the measurement level categorized in matching samples.[40]

RESULTS

For the qualitative assessment of the position and morphology of the articular disc, the intraobserver assessment of variability showed that when readings 1 and 2 were correlated, the numbers for kappa were high for the morphology assessment of the articular disc (kappa = 0.9 in CM and MI, and 1.0 in OM). For the assessment of the articular disc position, the kappa could not be applied because of calculation restrictions. The results showed descriptive concordances of 97.3% (CM), 97.9% (MI), and 95.6% (OM). The interobserver assessment of disc morphology (kappa = 0.72 in CM and MI, and 98.3% in OM) and position of the disc (94.5% in CM, 95.1% in MI, and 95.0% in OM) showed good concordance.

For the qualitative analysis of TMJ disc position and morphology, the positions in CM and MI showed no differences; thus, they were discussed altogether. In a visual assessment of the MRIs, at T1 in the CM and MI

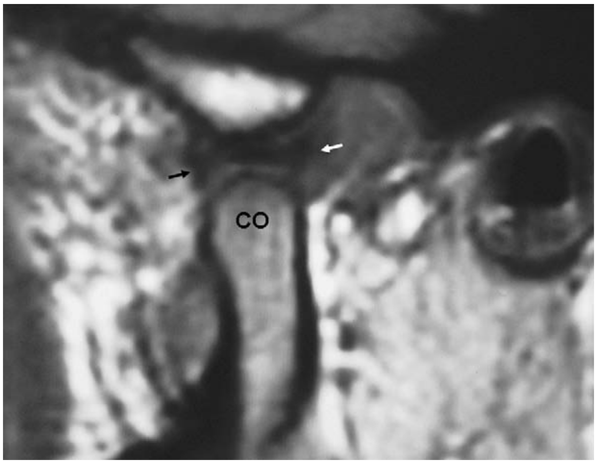

Fig 3. Patient 20: left TMJ in MRI in the MO position. The articular disc was interposed between the mandibular condyle (*CO*) and the articular eminence (*arrows,* articular disc).

positions, the disc was in a superior position (within normal limits) in 48 of 60 TMJs (patients 1 and 2, right TMJ; patient 4, left TMJ; patients 5, 6, 9-12, 14-25, and 27-30, both TMJs) and remained normal at T2 and T3 (Fig 2). In 4 TMJs (patient 4, right TMJ; patient 8, left TMJ; patient 26, both TMJs), the discs showed partial lateral displacement at T1, T2, and T3. In 3 TMJs (patient 2, left TMJ; patient 7, both TMJs), the discs showed anterolateral displacement at T1, T2, and T3. In 2 TMJs (patients 3 and 8, right TMJ), the discs showed partial medial displacement at T1, T2, and T3. In 1 TMJ (patient 3, left TMJ), the disc showed partial medial displacement at T1, normal at T2, and partial medial displacement at T3. In 1 TMJ (patient 13, left TMJ), the disc showed anteromedial displacement at T1, T2, and T3. In 1 TMJ (patient 13, right TMJ), the disc showed anteromedial displacement at T1 and was normal at T2 and T3.

The qualitative assessment of the articular disc position in OM showed that, in 55 of 60 TMJs (patients 1 and 2, right TMJ; patients 3-6, 8-12, and 14-30, both TMJs), the disc was interposed between the condyle and the articular tubercule at T1, T2, and T3 (Fig 3). In 2 TMJs (patient 7), the disc showed reduction at T1, T2, and T3. In 1 TMJ (patient 2, left TMJ), the disc showed partial reduction at T1, T2, and T3. In 1 TMJ (patient 13, left TMJ), the disc showed no reduction at T1 and T2 and partial reduction at T3. In 1 TMJ (patient 13, right TMJ), the disc showed partial reduction at T1 and interposed at T2 and T3 (Table II).

The qualitative assessment of the disc configuration in the CM and MI positions showed no differences; thus,

Table II. Qualitative assessment of articular disc position

	T1						*T2*						*T3*					
	TMJ L			*TMJ R*			*TMJ L*			*TMJ R*			*TMJ L*			*TMJ R*		
Patient	*CM*	*MI*	*OM*	*CM*	*MI*	*OM*	*CM*	*MI*	*OM*	*CM*	*MI*	*OM*	*CM*	*MI*	*OM*	*CM*	*MI*	*OM*
1	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
2	ALDD	ALDD	DDWPR	N	N	I	ALDD	ALDD	DDWPR	N	N	I	ALDD	ALDD	DDWPR	N	N	I
3	PMDD	PMDD	I	PMDD	PMDD	I	N	N	I	PMDD	PMDD	I	PMDD	PMDD	I	PMDD	PMDD	I
4	N	N	I	PLDD	PLDD	I	N	N	I	PLDD	PLDD	I	N	N	I	PLDD	PLDD	I
5	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
6	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
7	ALDD	ALDD	I	ALDD	ALDD	I	ALDD	ALDD	I	ALDD	ALDD	I	ALDD	ALDD	I	ALDD	ALDD	I
8	PLDD	PLDD	I	PMDD	PMDD	I	PLDD	PLDD	I	PMDD	PMDD	I	PLDD	PLDD	I	PMDD	PMDD	I
9	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
10	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
11	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
12	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
13	AMDD	AMDD	DDWNR	AMDD	AMDD	DDWPR	AMDD	AMDD	DDWNR	N	N	I	AMDD	AMDD	I	N	N	I
14	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
15	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
16	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
17	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
18	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
19	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
20	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
21	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
22	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
23	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
24	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
25	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
26	PLDD	PLDD	I	PLDD	PLDD	I	PLDD	PLDD	I	PLDD	PLDD	I	PLDD	PLDD	I	PLDD	PLDD	I
27	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
28	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
29	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I
30	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I	N	N	I

L, Left; *R,* right; *N,* normal; *ALDD,* anterolateral disc displacement; *PMDD,* posteromedial disc displacement; *PLDD,* posterolateral disc displacement; *AMDD,* anteromedial disc displacement; *I,* interposed; *DDWPR,* disc displacement with partial reduction; *DDWNR,* disc displacement with no reduction.

they were discussed altogether. In 56 of 60 TMJs (patients 1, 2, and 13, right TMJ; patients 3-6, 8-12, and 14-30, both TMJs), the discs were biconcave at T1, T2, and T3 (Fig 4). In 2 TMJs (patients 2 and 13, left TMJ), the discs were not biconcave at T1,T2, and T3 (Fig 5). In 2 TMJs (patient 7), the discs were not biconcave at T1, biconcave at T2, and not biconcave at T3.

In the OM assessment, in 59 of 60 TMJs (patients 1-12 and 14-30, both TMJs; patient 13, right TMJ), the discs were biconcave; 1 TMJ (patient 13, left TMJ) was not biconcave at T1, T2, and T3 (Table III).

DISCUSSION

Few studies have assessed the TMJs in patients with FUPXB by using MRI. This diagnostic method has shown high sensitivity, specificity, and accuracy to detect derangements in the position and form of the articular disc in the TMJs.[18-21,23-27] Despite the advantages of acquiring images without ion radiation, the cost of this examination is still high.

Studies suggest the use of MRI to assess qualitative[21,27] and quantitative[41-43] articular disc positions. The qualitative assessments are visual and therefore subjective.[44] On the other hand, quantitative methods are more objective and allow detection of small changes in articular disc position, although the clinical importance of these changes is unknown.[45]

In the quantitative assessment, it is paramount to establish a pattern for comparison methods between the MRIs at different stages. Although parasagittal MRIs are perpendicular to the condylar axis, it is not always possible to follow a pattern because of the small variations in the angle of the parasagittal plane at different stages of the treatment.[46]

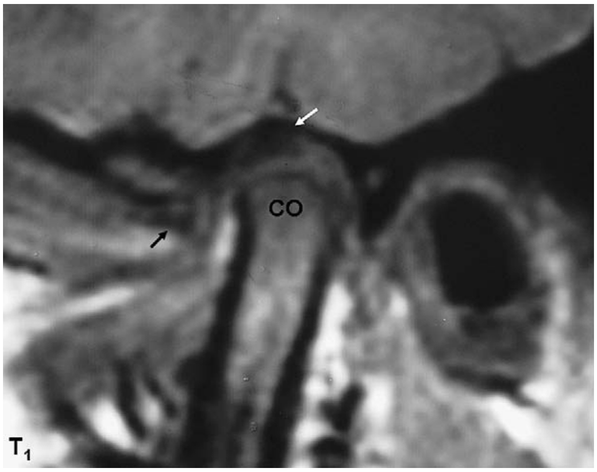

Fig 4. Patient 12: disc morphology is biconcave at T1 (*arrows,* articular disc; *CO,* condyle).

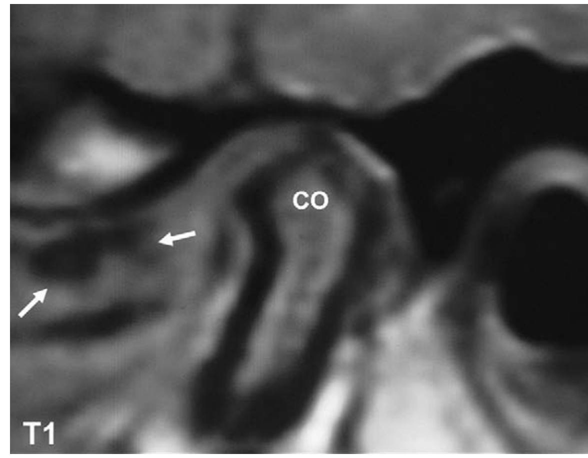

Fig 5. Patient 7: disc morphology is not biconcave at T1 (*arrows,* articular disc; *CO,* condyle).

We are confident of our results because the assessments were taken qualitatively by 2 calibrated observers. High percentages were obtained in the intraobserver and interobserver assessments.

Epidemiologic studies show that subjective symptoms and clinical signs of TMD are commonly found in children and adults,[12,47] increasing in both prevalence and severity from childhood to adulthood,[47,48] especially in girls.[13,38,49]

In our study at T1, in the CM and MI positions, in 12 of 60 TMJs (20%), the articular disc was displaced. Pellizoni et al[14] found, in 2 of 30 TMJs (6.7%) in the CM position, that the articular disc was displaced; this does not agree with our results.

We can speculate that the differences in the prevalence of disc displacement in our study and that of Pellizoni et al[14] is that our patients had twice as many TMJs assessed, and our group was somewhat older. Pellizoni et al[14] found the same prevalence of disc displacement in the crossbite and the control groups, suggesting that disc displacement also involves other factors, because the control group included subjects without malocclusion. On the other hand, Kecik et al[50] found disc displacement in 14 of 70 TMJs (20%) in a FUPXB group with a mean age of 10.6 years; this agrees with our study. Those authors found a higher prevalence of disc displacement in the control group (normal occlusion) than in the FUPXB group.

As for articular disc morphology, we found at T1 that 56 of 60 TMJs (93.3%) in the CM and MI positions and 59 of 60 TMJs (98.33%) in the OM position had biconcave discs. Although in this assessment 20% of the TMJs had disc displacement (12 TMJs), disc displacement is commonly associated with changes in their morphology. In 7 of these TMJs, the discs were displaced in the lateral or medial direction, without the anterior component. In all these articulations, the disc was biconcave in the CM, MI, and OM positions in the parasagittal slices. In 5 TMJs, with disc displacement associated with the anterior component, they had not-biconcave form in the CM and MI positions. Pellizoni et al[14] found, in 24 of 30 TMJs (80%), biconcave configuration of the disc, although 2 of 30 TMJs had disc displacement.

Many studies in the literature assessed the effects in TMJs with MRI in functional orthopedic appliance treatments.[44,51-53] On the other hand, we found only 1 study that used a quad-helix to expand the maxilla, and it recorded the status of TMJs with MRI only at the start of the treatment.[50] That study assessed treatment effects only with transcranial TMJ and submentovertex radiographs, thus making it difficult to compare those results with ours, since different methodologies were used.

In our study, the MRIs were obtained in the parasagittal oblique and coronal planes, which are complementary and follow the medial angulation of the condyle, for better visualization of the posterior band of the articular disc.[54] It helped to use the coronal plane to assess the rotational displacement of the disc and to prevent false negatives because of the multiplane capacity of MRI.[55-57]

In the qualitative assessment of articular disc position, the CM and MI positions showed no differences, so they were discussed altogether. In 48 of 60 TMJs (80%), the articular discs were well positioned at T1 and remained in the normal range at T2 and T3. In 10 TMJs (16.66%), the discs had displacement at T1 and

Table III. Qualitative assessment of the disc configuration

	T1						*T2*						*T3*					
	TMJ L			*TMJ R*			*TMJ L*			*TMJ R*			*TMJ L*			*TMJ R*		
Patient	*CM*	*MI*	*OM*	*CM*	*MI*	*OM*	*CM*	*MI*	*OM*	*CM*	*MI*	*OM*	*CM*	*MI*	*OM*	*CM*	*MI*	OM
1	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
2	NB	NB	B	B	B	B	NB	NB	B	B	B	B	NB	NB	B	B	B	B
3	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
4	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
5	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
6	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
7	NB	NB	B	NB	NB	B	B	B	B	B	B	B	NB	NB	B	NB	NB	B
8	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
9	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
10	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
11	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
12	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
13	NB	NB	NB	B	B	B	NB	NB	NB	B	B	B	NB	NB	NB	B	B	B
14	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
15	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
16	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
17	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
18	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
19	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
20	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
21	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
22	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
23	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
24	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
25	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
26	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
27	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
28	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
29	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
30	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B

L, Left; *R,* right; *B,* biconcave; *NB,* not biconcave.

kept the same form at T2 and T3. Thus, no changes were found in the articular disc position in CM and MI in 58 of 60 TMJs (96.66%) at T1, T2, and T3. In 1 TMJ (1.66%), the disc had partial medial displacement at T1, was normal at T2, and had partial medial displacement at T3. On the other hand, in 1 TMJ (1.66%), the disc had anteromedial displacement at T1 and was normal at T2 and T3.

A study with Herbst appliances showed the possibility of repositioning the articular disc with this method of treatment.[52] This occurs mainly because of changes in condylar position in the sagittal orientation with functional orthopedic appliances. We think that, with rapid maxillary expansion, the changes in condylar position could have contributed to the articular disc reposition.

Articular disc displacement is relatively common in asymptomatic children.[22,38,45,49,50,58] Kircos et al[59] stated that anterior displacement of the articular disc does not indicate TMD, although Ribeiro et al[58] suggest a strong association. The patients of our study had no signs or symptoms of TMJ dysfunction during any of the 3 stages of the treatment.

No change occurred in articular disc position in OM in 58 of 60 TMJs (96.66%) in the 3 stages of the treatment. In 1 TMJ (1.66%), the disc showed no reduction at T1 and T2 and was partially reduced at T3. In 1 TMJ (1.66%), the disc was partially reduced at T1 and interposed at T2 and T3. Thus, this method of treatment brings better results in TMJs.

In the OM position, there was a high efficacy percentage for disc localization, and the degree of disc displacement can diminish when compared with the CM images.[41] Helms and Kaplan[60] affirmed that the acquisition of MRIs of the TMJs with the patient in the CM position is good to assess disc position, whereas in OM position it is easier to identify the size and form of the articular disc.

The qualitative assessment of the disc form in the CM and MI positions showed no differences, so they were discussed altogether. No changes were found in the articular disc form in the CM and MI positions in 58 of 60 TMJs (96.66%) at T1, T2, and T3. The only change was in patient 7, whose articular discs of both TMJs were not biconcave at T1, biconcave at T2, and back to not biconcave at T3.

Solberg et al[61] suggested that the form of displaced discs varies from biconcave to various degrees of folding and deformation. As the disc degenerates, it also loses its normal morphology and eventually becomes deformed.[55,62] The changes in disc morphology can be interpreted as factors that increase the risks and signs of TMD symptoms.[63] Additionally, morphologic changes were found in asymptomatic volunteers.[22]

In the OM assessment, in 59 of 60 TMJs (98.33%), the discs became biconcave and, in 1 TMJ (1.66%), not biconcave at T1, T2, and T3. No changes occurred in the articular disc form in the OM position in all TMJs in the 3 stages of the treatment.

Despite the high adaptative capacity of TMJs in children, there is still the controversial role of FUPXB as an etiologic factor in the development of TMD. It would be interesting in future studies to compare these findings with a control group with the same malocclusion and the same chronologic age to better understand the effects of treatment with rapid maxillary expansion in TMJs.

CONCLUSIONS

Based on the results of articular disc position and configuration in the CM, MI, and OM positions in the 3 stages of treatment, we concluded the following.

1. Most children have their discs in place, and expansion of their dental arches did not impact them negatively.
2. In the few patients without the disc in the proper place, treatment did not seem to change anything.
3. There were no adverse changes in articular disc morphology.

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