ORIGINAL ARTICLE

Herbst appliance therapy and temporomandibular joint disc position: A prospective longitudinal magnetic resonance imaging study

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Introduction: The objective of this prospective study was to verify changes in the position of the temporomandibular joint (TMJ) disc by means of magnetic resonance images (MRIs) in adolescent patients treated with the Herbst appliance. **Methods:** Twenty consecutive Class II Division 1 patients treated with Herbst appliances were selected for the study. MRIs were analyzed at 3 stages: immediately before Herbst treatment (T1), 8 to 10 weeks after appliance placement (T2), and at the end of the 12-month Herbst treatment, immediately after appliance removal (T3). **Results:** Class I or overcorrected Class I dental-arch relationships were observed after Herbst therapy. The qualitative evaluation showed that each patient had the disc within normal limits at T1. At T2, a slight tendency toward disc retrusion because of mandibular advancement was observed, but, at T3, the disc returned to normal, similar to T1 values. By using a quantitative evaluation, parasagittal MRIs (central, medial, and lateral slices) of the TMJs showed that there was no change of disc position from T1 to T3, except in the central slice, which had a retrusive position of the articular disc at T3. **Conclusions:** During the 12-month period of Herbst appliance treatment, mild changes in the position of the disc occurred in patients whose articular discs were within normal limits at T1. These changes were within normal physiological limits when evaluated in the short term. (Am J Orthod Dentofacial Orthop 2006;129:486-96)

The adaptation mechanism of the temporomandibular joint (TMJ) to mandibular advancement during correction of a Class II Division 1 malocclusion has been much debated.[1,2] Although some studies show that functional orthopedic treatment does not interfere with the integrity of the TMJ,[3-9] unexpected responses to this method of treatment can occur.[10,11]

The Herbst is a popular orthopedic appliance for correcting Class II malocclusion.[12] Because this appliance is fixed, the mandible is maintained in a continuous advanced position. This can result in a temporary capsular subclinical inflammation of the posterior ligament of the lower stratum caused by the permanent expansion that occurs with the jumping of the bite.[13] Consequently, the viscosity of the sinovial fluid can diminish, provoking alterations in the lubrication of the upper compartment of the joint.[14,15] This predisposes some people to temporomandibular disorders (TMD).[16]

Despite the high prevalence of disc displacement in asymptomatic patients,[17-22] there is a clear association between disc displacement and TMD.[19,21,23] For this reason, more studies are necessary that use appropriate diagnostic methods to evaluate TMD.

The literature shows that magnetic resonance imaging (MRI) is not invasive and does not require ionizing radiation to create an image that permits direct visualization of the disc.[23] Comparative MRI studies in corpses have shown that this method is extremely effective in detecting internal disarrangements of the TMJ.[24-26]

Treatment with functional appliances for a Class II Division 1 malocclusion, in which an increased overjet is normally present, can increase the risk of developing TMD.[27,28] However, MRI studies have shown no adverse effects in the TMJs of patients treated with the Herbst appliance.[8,9,13] On the other hand, Foucart et al[11] observed disc displacement in patients treated in the same way.

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Table I. Characteristics of patients at beginning of treatment

			Class II molar relationship			*Björk and Helm[29] stages*
Patient	*Sex*	*T1 (y/mo)*	*Right side*	*Left side*	*Overjet (mm)*	*Hand-wrist x-rays*
1	Female	11/11	¾	½	7	S
2	Female	12/11	¾	½	6	FM_3cap
3	Male	14/6	*	*	9	FM_3cap
4	Female	12/5	*	*	9.5	FM_3cap
5	Female	11/9	¾	*	10	S
6	Female	11/2	¾	*	11	S
7	Female	11	*	¾	13	S
8	Male	14/2	¾	½	6	FM_3cap
9	Female	11/9	¾	*	7	FM_3cap
10	Female	11/11	¾	¾	12	FM_3cap
11	Female	13/4	¾	¾	9	FM_3cap
12	Male	14/2	¾	*	10	S
13	Female	12/2	½	¾	9	FM_3cap
14	Male	13	¾	½	8	FM_3cap
15	Female	12/5	¾	*	8	FM_3cap
16	Female	11/6	½	½	6	FM_3cap
17	Male	13/2	½	¾	10	S
18	Male	13/10	½	½	5	FM_3cap
19	Male	13/9	*	¾	8	S
20	Female	12	*	¾	8	S

*Full Class II; *S,* Björk and Helm[29] third stage; *FM_3cap,* Björk and Helm[29] fourth stage.

The objective of this study was to verify possible changes of the disc position in the TMJ in adolescents with retrognathic mandibles and treated with the Herbst appliance. Other parameters that could indicate TMD will be considered in future studies.

MATERIAL AND METHODS

Subjects

Twenty consecutively treated white Brazilian adolescents (7 boys, 13 girls) received Herbst therapy for 12 months to correct their malocclusions. Mean age at pretreatment was 12 years 8 months ± 1 year 1 month (range, 11 years-14 years 6 months).

Patients with the following characteristics were enrolled in the study (Table I): (1) clinical appearance of a retrognathic mandible, with ANB angle greater than 4°; (2) Angle Class II Division 1 malocclusion with permanent dentition; (3) treated during the maximum skeletal pubertal growth peak (evaluated by the hand-wrist radiograph, according to Björk and Helm[29]); (4) posterior band of disc between the 11 o'clock and 1 o'clock positions, which allowed a physiological variation[13] (MRIs visually evaluated by using the 12 o'clock criterion[30]). The Research Ethical Committee from the Federal University of São Paulo approved this project on June 12, 2002.

Each patient was treated with a modified Herbst appliance, with steel crowns on the maxillary first molars and mandibular first premolars, orthodontic bands on the maxillary first premolars and mandibular first molars, hyrax expanders adapted to the maxillary crowns and bands,[31] and Nance lingual arches adapted to the mandibular crowns and bands. Occlusal rests were used when maxillary or mandibular second molars were present. Rapid maxillary expansion was needed in all patients because transverse maxillary deficiency frequently occurs in Class II malocclusions.[32-37] Rapid maxillary expansion was performed during the first 2 weeks after placement of the Herbst appliance.

Up to 6-mm mandibular advancements were performed at the beginning of treatment. When necessary, complementary advances of 2 to 3 mm were done in the third month. Other mandibular advancements were performed as needed to correct the skeletal midline deviation[38-40] (Table II).

In all 20 subjects, Herbst appliance therapy resulted in Class I or overcorrected Class I dental-arch relationships.

Longitudinal evaluation with MRI

MRIs of both TMJs in closed-mouth (CM) and open-mouth (OM) positions were taken during 3 stages of treatment: immediately before Herbst treatment (T1), 8 to 10 weeks after appliance placement (T2), and at the end of the 12-month Herbst treatment, immediately after appliance removal (T3). A Gyroscan ACS-NT superconductor (Philips, Eindhoven, Netherlands), with

Table II. Measurement of mandibular advance

	T1 (mm)		After 3 months (mm)	
Patient	Right	Left	Right	Left
1	4	4	2	2
2	4	3	2	2
3	6	5	3	3
4	6	6	3	3
5	3	5	2	3
6	4	6	3	3
7	6	6	3	3
8	5	5		
9	5	5	2	2
10	6	6	2	2
11	6	6		
12	3	5	3	3
13	6	6		
14	6	3	2	3
15	3	5	3	3
16	5	5		
17	6	6		
18	5	5		
19	6	6	3	3
20	6	6	3	3

Table III. Measurements of buccal openings preestablished for MRIs in OM

Patient	Buccal opening (mm)
1	34
2	30
3	34
4	32
5	30
6	32
7	36
8	28
9	35
10	32
11	31
12	39
13	34
14	36
15	36
16	32
17	32
18	34
19	34
20	31

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 large number of recordings, the total examination time for each subject was approximately 45 minutes.

The MRIs were performed by using T1-weighted (T1-w) axial planning images; T1 TSE sagittal oblique images with closed and open mouth (TR/TE, 1300/70 ms; FOV, 16 cm; NSA, 4; matrix, 204 × 512); T2 TSE sagittal oblique images with closed and open mouth (TR/TE, 4300/120 ms; FOV, 16 cm; NSA, 4; matrix, 204 × 512); proton density FFE sagittal oblique (TR/TE, 60/14 ms; FOV, 16 cm; NSA, 4; matrix, 212 × 512), and T1 TSE coronal images (TR/TE, 580/15 ms; FOV, 16 cm; NSA, 4; matrix, 204 × 512). In all images, the thickness/increment was 1.5/0.1 mm except in the sagittal oblique sequence in the proton images in which the thickness/increment was 2.8/−1.3 mm.

Parasagittal MRIs were taken perpendicular to the condyle long axis and the coronal MRIs parallel to the condyle long axis. In each sequence, 16 slices were acquired (8 for each TMJ). The MRIs were examined with 2× magnification.

The MRIs in the CM position at T1 and T3 were taken with the teeth in habitual occlusion and in the Herbst appliance position at T2. To obtain the MRIs at T1, T2, and T3 in the OM position, 2 mouth separators were used; they kept the mouth open in a maximum comfortable position, clinically preestablished for each patient (Table III).

The MRIs were, at first, visually assessed at T1, T2, and T3, and the anatomic position of the disc in CM was classified according to Ruf and Pancherz[13] (superior normal position: posterior band placed between 11 o'clock and 1 o'clock) and in OM according to Tasaki et al.[20] Disc function was considered normal in the CM when its position was within normal limits and in the OM when the disc was interposed between the mandibular condyle and the tuberculum articulare of the temporal bone.[20]

Coronal images were taken to avoid false-negative findings of sideways (lateral and medial) disc displacements. The position of the disc in the coronal plane was classified as medial or lateral based on its location either medial to a sagittal plane tangent to the medial pole of the condyle or lateral to a sagittal plane tangent to the lateral pole of the condyle, respectively.

All MRIs were analyzed by 2 observers (L.A.A.A. [observer A] and H.K.Y. [observer B]) with an MRI protocol to better define criteria for interpretation. Because the 2 observers had been trained differently, they were retrained for 4 months with images not included in this study, to achieve more standardized readings.[5] Images for this study were then interpreted 3 times by observer A and once by observer B (who also gave the final diagnosis). A double-blind procedure was used.[41] Observer A's interpretations, performed at regular 15-day intervals, were divided into preliminary and

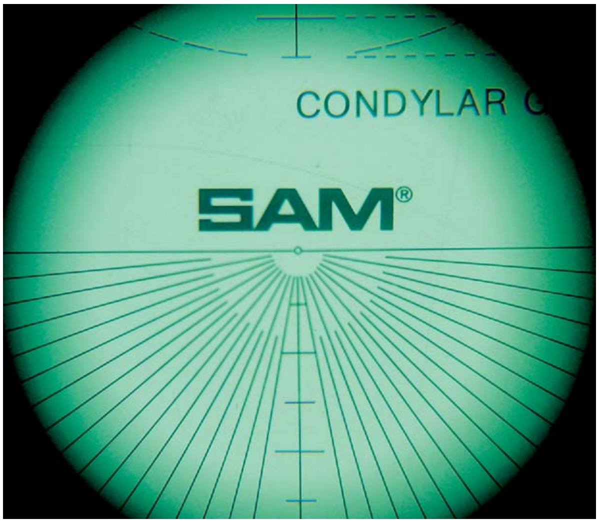

Fig 1. Semicircular protactor for use with lenses (SAM), which magnified tracings 7 times, used to measure articular disc position.

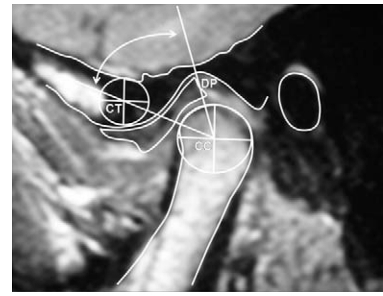

Fig 2. Anatomic drawing and tracing used to measure articular disc position in CM position.

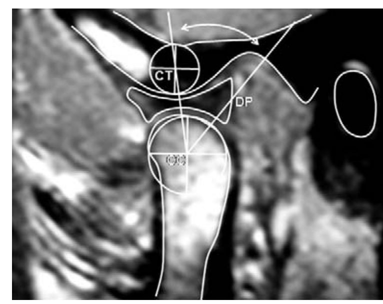

Fig 3. Anatomic drawing and tracing used to measure articular disc position in OM position.

final readings. The preliminary readings consisted of 1 interpretation before observer A received training (pretraining) and 1 after training (posttraining). Observer A's third reading was considered the final interpretation. Overall interobserver agreement was calculated as the proportion of the TMJs for which observer A's final interpretation and observer B's interpretation agreed.

Quantitative analysis

A luminator was used to manually trace the TMJ MRIs obtained in T1-w onto transparent acetate sheets with a 0.3-mm lead pencil. Anatomic details of the external auditory meatus, outline of the postglenoid spine, tuberculum articulare, glenoid fossa, mandibular condyles, articular disc, and floor of middle cranial fossa were copied.

The position of the articular disc was evaluated in CM parasagittal MRIs through the central, the proximal lateral, and the proximal medial slices from each TMJ, which were analyzed separately. In the OM parasagittal MRIs, the central slice from each TMJ was used. In both positions, T1 and T3 were considered.

Criteria to assess articular disc position

Articular disc position was assessed with a method modified from Orsini et al.[42] A reference line was traced from the center of the condyle to the center of the tuberculum articulare. Another line was traced from the center of the condyle to the DP point (defined below), located in the posterior band of the articular disc. The articular disc position was determined by the angular measurement that resulted from both lines in CM and OM positions. A semicircular protactor for use with lenses (SAM [München, Germany]), which magnified the tracings 7 times, was used (Fig 1). The following reference points, lines, and angle were used in CM (Fig 2) and OM (Fig 3) positions:

1. CC: midpoint found by the placement of the most fitted circle chosen from a circle template (Trident [São Paulo, Brazil]) to the condyle outline. The geometrical center of the condyle was found by the intersection of 2 lines traced in the farthest distance in both horizontal and vertical directions in the circle mentioned above (Figs 2 and 3).
2. CT: midpoint found by the placement of the most fitted circle chosen from a circle template (Trident) to the tuberculum articulare outline, the superior limit of which was the floor of middle cranial fossa. The geometrical center of the tuberculum articulare was found by the intersection of 2 lines traced in the farthest distance in both horizontal and vertical directions in the circle mentioned above (Figs 2 and 3).
3. DP: midpoint of the posterior band limit of the articular disc (assessed visually).
4. CC-CT line: line traced from the condyle geometric center (CC) to the tuberculum articulare geometric center (CT).

5. CC-DP line: line traced from the condyle geometric center (CC) to the DP point.
6. Angular measurement to assess the articular disc position: the angle formed by CC-CT and CC-DP lines.

Statistical methods

The intraobserver and interobserver variability in reporting MRIs of the TMJ was evaluated with kappa statistics and the 95% confidence interval as described by Fleiss.[43] A kappa of less than 0.4 was considered poor, and a kappa greater than 0.75 was considered excellent.

Tests for normal distribution showed an asymmetric distribution of values. Therefore, nonparametric tests were used for the statistical analysis. The means were calculated and are presented for information.

The nonparametric Wilcoxon signed rank test was used to evaluate differences between the left and right TMJs (at T1 and T3) and to compare T1 and T3 (pooled TMJs). The significance levels used were $P \leq .001$, $P \leq .01$, and $P \leq .05$.

MRIs of 20 TMJs of 10 randomly selected subjects were retraced and remeasured by the same examiner (L.A.A.A.) within a month. Systematic errors were estimated by the Wilcoxon signed rank test for paired data, and no significant differences were found.[44] Casual errors were calculated according Dahlberg's formula[45]: $S = \sqrt{\Sigma d^2 / 2n}$, where d is the difference between duplicate measurements and n is the number of double measurements. The results showed deviations between 1.0° and 1.5°.

RESULTS

The assessment of intraobserver variability showed that, when pretraining and posttraining readings (reading 1 vs reading 2) and posttraining and final readings (reading 2 vs reading 3) were correlated, the kappa test could not be used because of a calculus restriction. Descriptively, it was observed that 79.6% (reading 1 vs reading 2) and 95.4% (reading 2 vs reading 3) of the evaluations agreed. Interobserver performance (observer A's reading 3 vs observer B's reading) showed high levels of agreement (95% and 100%) with kappa values from 0.883 to 1.

In the visual inspection evaluation of the MRIs at T1, in the CM position, the disc showed a superior position (within normal limits) in all 40 TMJs. At T2, because of the mandibular advancement from the Herbst appliance, the discs had, on average, a tendency to a retrusive position in relation to the condyle. At T3, the disc returned to the superior position. In the OM position, the articular disc was interposed between the mandibular condyle and the tuberculum articulare in all 40 TMJs at T1, T2, and T3 (Table IV).

Table IV. Qualitative evaluation of articular disc position in CM and OM at T1, T2, and T3

	T1	*T2*	*T3*
CM	Sup	RPT	Sup
OM	I	I	I

Sup, Superior; *RPT,* retrusive position tendency; *I,* interposed.

When no statistically significant differences were observed in comparing the left and right TMJs (Table V), they were pooled.

In CM, the lateral and medial slices did not show statistically significant differences at T1 and T3 in contrast to the central slice, which showed a retrusive position of the articular disc at T3 (Table VI).

In OM, no statistically significant differences were observed at T1 and T3 (Table VII).

DISCUSSION

Among diagnostic methods, MRIs are preferred for evaluating adaptation responses of the TMJ when a patient is treated with functional orthopedic appliances.[5-9,11,13,46-49] This is because of the images' consistency and precision of the position and configuration of the disc.[30,50] In this study, the MRIs were obtained in the parasagittal and oblique coronal planes, which complement each other and follow the medial angulation of the condyles to better visualize the posterior band of the disc.[51] Using the oblique coronal plane helps avoid false negatives because of the multiplane capacity of the MRIs when the displacement of the disc rotation is evaluated.[52]

Studies in the literature demonstrate the use of MRIs to evaluate the position of the articular disc both qualitatively[20,24,53,54] and quantitatively.[55-58] The qualitative evaluations with MRIs are performed visually and are subjective. On the other hand, quantitative methods are more objective and permit the detection of small alterations in the position of the articular disc, although we still do not know the clinical importance of these variations.

Care is needed when making a quantitative evaluation because the method used must be standardized so that the comparisons of the MRIs at different stages are accurate. Although parasagittal MRIs are taken perpendicular to the long axis of the condyle, accuracy is not always possible because of minor

Table V. Quantitative evaluation of lateral, central, and medial slices of articular disc position between left and right TMJs in CM and OM at T1 and T3

			Left (°)	Right (°)		
Position	Stage	Slice	Mean	Mean	Wilcoxon Z	P
CM	T1	Lateral	53.95	55.13	−0.672	.501
CM	T3	Lateral	54.63	53.68	−0.224	.823
CM	T1	Central	53.40	53.38	−0.468	.640
CM	T3	Central	55.53	56.30	−0.523	.601
CM	T1	Medial	57.20	55.23	−1.176	.239
CM	T3	Medial	55.35	56.63	−0.342	.732
OM	T1	Central	53.90	54.60	−0.430	.667
OM	T3	Central	53.88	55.08	−1.009	.313

Table VI. Quantitative evaluation of lateral, central, and medial slices of articular disc position with pooled TMJs in CM, comparing T1 with T3

	T1 (°)	T3 (°)		
Slices	Mean	Mean	Wilcoxon Z	P
Lateral	54.54	54.15	−0.377	.706
Central	53.39	55.91	−2.618	.009*
Medial	56.21	55.99	−0.468	.640

*$P \leq .01$.

Table VII. Quantitative evaluation of central slice of articular disc position with pooled TMJs in OM, comparing T1 with T3

	T1 (°)	T3 (°)		
Slice	Mean	Mean	Wilcoxon Z	P
Central	54.25	54.48	−0.309	.757

variations of the angle of the parasagittal plane during the different stages of treatment.[59]

Despite the difficulties mentioned in standardizing MRIs when using a quantitative method, we consider its use relevant because it permits an objective evaluation even though there is variation in disc position in a healthy joint.[18,19,42,55,57] Another reason is to compare the different methodologies in the literature about Herbst appliance[8,11,13] to our own results.

To increase accuracy and minimize errors in the tracings of the MRIs at T1 and T3, relatively stable points were chosen. According to Ruf and Pancherz,[59,60] during treatment with the Herbst appliance, the condyles undergo remodeling. Therefore, a central point was used because presumably this is more stable.

The tuberculum articulare of the temporal bone reaches 90% of the adult angulation at premolar eruption.[61] Although bone age was a criterion for inclusion in this study, all patients had fully erupted maxillary and mandibular premolars.

Consequently, this region of the tuberculum articulare already had relative stability.[61] For this reason, the reference axis traced from the center of the condyle to the tuberculum articulare can be considered accurate.

The use of the posterior band of the disc was due to the ease with which it could be observed in the MRIs at T1-w. It was possible to identify the limit with the posterior ligament, perhaps because of more fat and water in the posterior ligament, as opposed to the darker disc tissue.[62]

The normal position of the posterior band of the disc is described as at 12 o'clock in relation to the condyle in CM position.[19-21,26,30] However, when asymptomatic volunteers were evaluated, studies suggest variations in the disc position in healthy joints.[20,21,42,56,58] In our study, the posterior band of the disc was classified as in a normal position when it was between 11 o'clock and 1 o'clock[13] as a physiological variation.

In the qualitative evaluation of the MRIs at T1, the position of the posterior band of the articular disc was within normal limits in all TMJs. At T2, a tendency toward a physiological retrusion of the disc in relation to the condyle was observed; this agrees with other studies.[8,13] This happens probably because the condyles are partially out of the glenoid fossa. This occurs because of the therapeutic position, determined by the Herbst appliance, which in this case consisted of mandibular advancement of a maximum of 6 mm at the beginning of treatment. Other studies suggest that mandibles should be advanced to an edge-to-edge relationship without considering the initial overjet.[8,13,59,60] It is possible to speculate that the greater mandibular advancement at the beginning of treatment could have more effect on the degree of retrusion of the articular disc at T2 and even at T3. Bearing this in mind, for our subjects who required

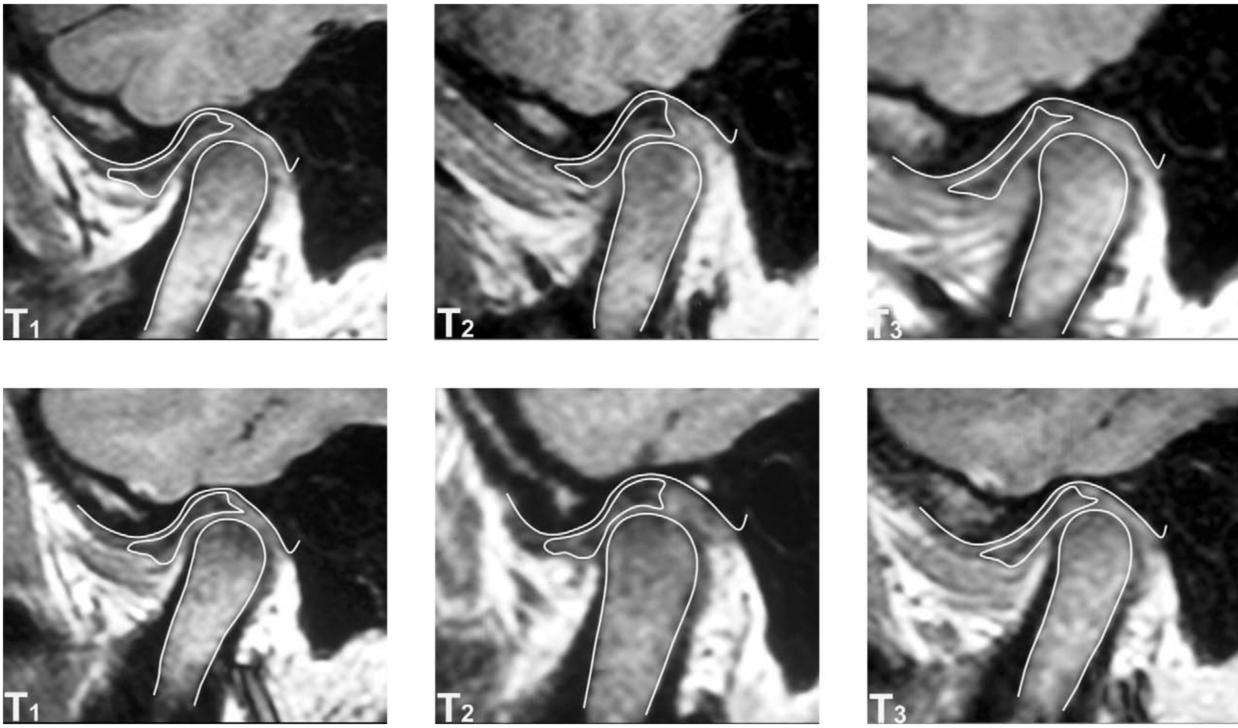

Fig 4. MRIs of treated TMJs in CM position. **Top row,** right; **Bottom row,** left. Articular disc is in superior normal position at T1 and T3, with retrusive tendency at T2.

mandibular advancement of more than 6 mm to obtain Class I relationships, these advances were performed in degrees between T2 and T3. An evaluation at T3 showed that on average the condyles had returned to their original positions in the glenoid fossa, and the position of the articular disc remained within normal limits (Fig 4).

In the quantitative evaluation, when T1 and T3 were compared, our results did not show changes in the position of the disc in relation to the lateral and medial slices when the mouth was closed. However, in the central slice, the disc appeared in a retrusive position at T3. Pancherz et al[8] evaluated the effects on the position of the articular disc of the TMJs of 15 patients treated with the Herbst appliance. They observed that, on average at the end of treatment, the disc had returned to its original pretreatment position with the exception of a slight retrusive tendency that was significant in the lateral slices of the left joint. This result was not the reason for the change in the position of the condyle. On the other hand, Ruf and Pancherz[13] affirmed that the more retrusive position of the disc immediately after treatment seemed to be due to the anterior position of the condyle. However, in an evaluation of treated subjects, a year after appliance removal, they observed that the average retrusion of the disc remained, despite the unchanged condyle position in relation to the pretreatment values. They commented that the reason for this retrusion was unknown. It could be, however, that this retrusion of the disc resulted from remodeling of the condyle and the glenoid fossa. In addition to remodeling the disc,[63] the Herbst appliance might have induced and thus contributed to the retrusion of the disc.

The treatment time of the patients in this study was 12 months rather than an average of 7 months in the other studies.[8,13,59,60] The longer treatment time might have allowed more sagittal condyle growth,[59,64,65] and more remodeling of the condyle[59,60] and the glenoid fossa,[59,64,66] and made possible the return of the condyle to the glenoid fossa. In this study, to not interrupt the 12-month treatment period, breakage problems of the Herbst appliance (3 patients) were solved within 24 hours.

The frequent occurrence of disc retrusion during Herbst appliance treatment can perhaps be used as a therapeutic measure in cases of anterior disc displacement. Ruf and Pancherz[13] found stable repositioning of the disc in patients who had partial disc displacement before treatment. In patients with total disc displacement, with or without reduction, the

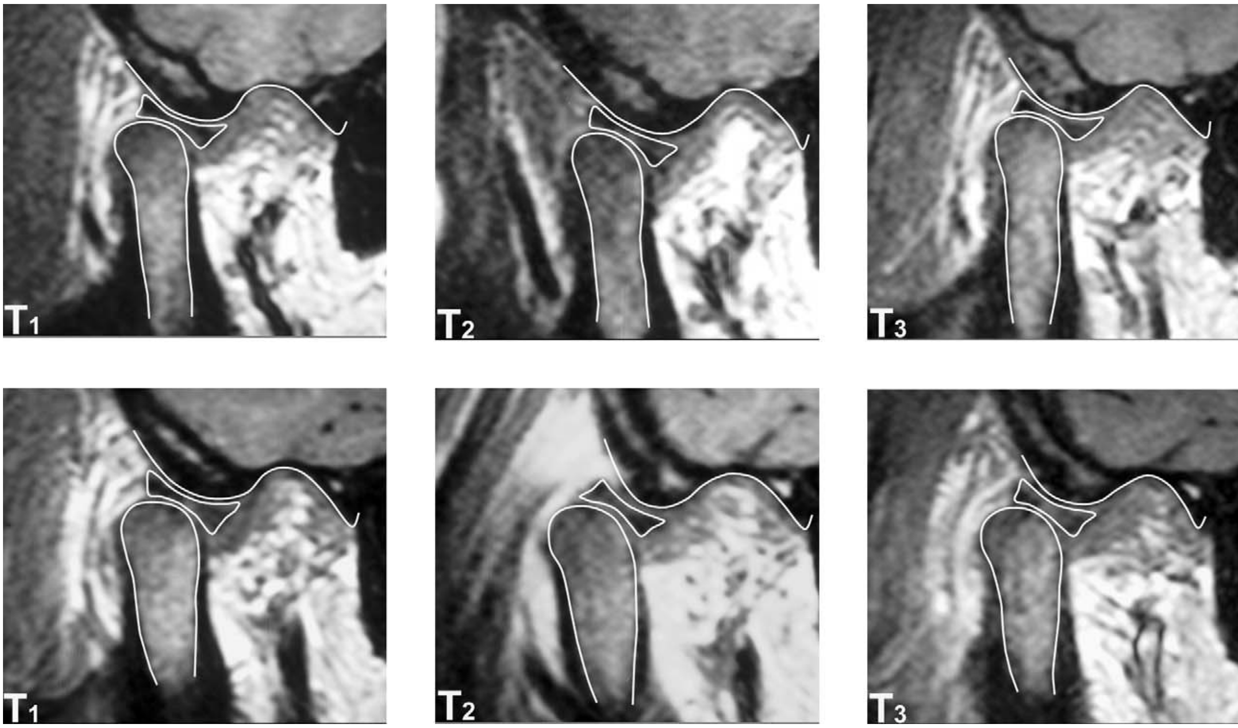

Fig 5. MRIs of treated TMJs in OM position. **Top row,** right; **Bottom row,** left. Articular disc is interposed between tuberculum articulare and condyle at T1, T2, and T3.

disc cannot be reseated as a result of Herbst appliance treatment. Other studies with orthopedic functional appliances (activator and Twin-block) produced no convincing evidence that the disc was reseated as a result of these methods of treatment.[7,47] In our study, it was not possible to evaluate this because patients with disc displacement were not included.

In contrast to our results, Foucart et al,[11] in 3 patients in a sample of 10 who underwent Herbst appliance treatment, found varying degrees of disc displacement in at least 1 TMJ. According to Ruf and Pancherz,[13] these findings can be the result of using removable appliances rather than fixed Herbst appliance and sagittal MRIs instead of parasagittal. This hypothesis gains force from the fact that 2 patients in the sample of Foucart et al[11] had no clinical symptoms of disc displacement, although the literature shows that this can occur in asymptomatic patients.[17-22]

In a long-term study on the effects on the TMJ in patients treated with the Herbst appliance, evaluated with clinical investigation and MRIs, Ruf and Pancherz[46] observed that 25% of the subjects showed signs of moderate to severe TMD, varying from partial to total disc displacement, associated with deviations in condyle shape. Another 15% of the subjects had mild symptoms of TMD with either small condyle displacement or subclinical lesions of the soft tissues. However, because nothing was known about the condition of the TMJs at the pretreatment phase, some pathological changes might have existed before treatment and so should not be attributed to the Herbst appliance treatment. The data in that study were evaluated 4 years after Herbst appliance treatment, and thus it is difficult to make comparisons with our results obtained immediately after treatment.

Our results agree with other studies in which other types of orthopedic functional appliances (Twin-block, Andresen activator, and bionator associated with headgear anchorage and vertical elastics plus activator) were used.[47-49] They found no adverse effects in the position of the articular disc when evaluated with MRIs, even though the results were analyzed by different quantitative methods.

In the qualitative evaluation of the MRIs in OM position, the articular disc was positioned between the condyle and the tuberculum articulare at T1, T2, and T3 (Fig 5). These findings result from the physiological changes between the condyle and the disc during mouth opening and agree with other studies.[5,8] In the quantitative evaluation with the mouth open, no significant differences were found in the position of the articular disc when comparing T1 with T3.

Finally, despite the adaptation response of the TMJ because of the action of orthopedic functional appliances, a detailed clinical examination of the TMJ should be performed before beginning orthopedic or orthodontic treatment.[4-9,47-49,59,60] In this way, subclinical signs and symptoms can be investigated, and, when necessary, MRIs can be indicated.[52,67]

Although in this study there was no displacement of the articular disc in the treated patients, the future consequences of the changes in position of the articular disc during treatment are unknown. In future studies, it would be interesting to compare these findings with asymptomatic subjects of similar age or skeletal maturity. All patients in this study are now undergoing the second phase of treatment with fixed appliance. At the end of treatment, further MRI examinations will be performed to better understand the cause-and-effect relationship between orthopedic-orthodontic treatment and TMD.

CONCLUSIONS

Based on the results, we conclude that, during a 12-month treatment period with the Herbst appliance in patients with normal positions of the articular disc at pretreatment, mild changes in the position of the disc occurred. These changes were within normal physiological limits when evaluated in the short term.

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