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Morphological Changes of Condyles and Helkimo Clinical Dysfunction Index in Patients Treated with Herbst - Orthodontic Appliance

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This study evaluated the morphological changes in the temporomandibular joint (TMJ) condyles and calculated the Helkimo clinical dysfunction index (CDI) in adolescents with Class II Division 1 malocclusion and mandibular retrognathism treated with the Herbst appliance (phase I) and fixed orthodontic appliances (phase II). Thirty-two consecutive adolescents underwent phase I, and 23 completed phase II. The TMJs were evaluated qualitatively using magnetic resonance imaging (MRI) at the beginning of treatment (T_1), during phase I (T_2), at the end of phase I (T_3) and at the end of phase II (T_4). The CDI was calculated at T_1, T_3 and T_4. From T_1 to T_3 ($p=0.326$), there were no changes in condyle morphology in 86.0% of the TMJs. From T_3 to T_4 ($p<0.05$) and T_1 to T_4 ($p<0.05$), changes occurred in 39.1% and 43.4% of the condyles. No significant changes in CDI occurred from T_1 to T_3, T_3 to T_4 and T_1 to T_4 ($p=1.000$; 86.6%, 76.2% and 76.2% concordance). After phase I, there were practically no changes in condyle morphology. At the end of phase II, a mild flattening was observed in some condyles. It may be concluded that no significant changes occurred in CDI after both treatment phases.

Key Words: magnetic resonance, Angle class II malocclusion, orthodontic appliance, temporomandibular joint disorders.

Introduction

Class II malocclusion associated with mandibular retrognathism may be treated using orthopedic functional appliances in the first phase of treatment to advance the mandible and to improve its anteroposterior adjustment during growth (1-9). In the second phase of treatment, fixed orthodontic appliances are used to refine occlusion (1,9). The responses of the temporomandibular joints (TMJs) treated using this method are controversial, which has led to the conduction of studies using the three-dimensional finite element method (10) as well as analyses in groups of experimental animals (11) or humans beings (1-9).

Functional analyses of the masticatory system (12,13) by means of clinical evaluations, combined with morphological changes in the TMJs diagnosed using imaging tests, have been included in some studies (1,6-9) to elucidate the effects of treatment using the Herbst appliance.

Studies using panoramic radiographs, computer tomography (CT) scanning and transpharyngeal exposure (6) aimed at evaluating TMJs after Herbst therapy. However, radiographs and CT scans are of limited value in imaging the condyle cartilage. On the other hand, magnetic resonance imaging (MRI) is noninvasive, does not require ionizing radiation for image acquisition and provides direct visualization of the disc and joint structures (14-19).

Investigations using MRI have identified the mechanisms of TMJ remodeling in patients treated with the Herbst appliance (7,8). However, in isolated cases, some authors have reported structural bone changes in different condyle morphologies after such treatments (20,21).

This prospective longitudinal study assessed possible changes in the condyle morphology of TMJs and calculated the Helkimo clinical dysfunction index (CDI) in adolescents with Class II, Division 1 mandibular retrognathism who were treated with the Herbst appliance followed by fixed orthodontic appliances.

Material and Methods

This study was approved by the Ethics Committee of the Federal University of São Paulo (Process #0428/09), and all patients or their guardians signed an informed consent form.

In this study, 32 consecutively white adolescents (16 male and 16 female) were treated using a Herbst appliance for 12 months (phase I). Mean pre-treatment age was 12.8 ± 1.2 years (range: 10.9 to 15.8 years). Immediately after completing phase I, 23 of the 32 adolescents (13 male and 10 female) continued treatment with a fixed orthodontic appliance (phase II) using pre-adjusted 0.022 x 0.028-inch brackets (mean phase II duration = 2.2 ± 0.9 years). Phases I and II were performed by the same orthodontist.

Patients with the following characteristics were enrolled in the study: clinical appearance of a retrognathic mandible with ANB angle greater than 4 degrees; Angle Class II, Division 1 malocclusion with permanent dentition; mean overjet of 8.6 ± 2.1 mm (range: 5 to 13 mm); maximum of skeletal pubertal growth peak evaluated by the hand and wrist X-rays (22).

The first phase consisted of treatment with a modified Herbst appliance (metal crowns, bands, upper Hyrax expander and lower lingual arch - Fig. 1). As transversal maxillary deficiency frequently occurs in Class II malocclusions (23), rapid maxillary expansion was performed during the first 2 weeks after placement of the Herbst appliance (one turn on the first day and half a turn on subsequent days until clinical correction was achieved (1)).

The mandible was advanced up to 6 mm at the beginning of the treatment. When necessary, supplementary advances of 2 to 3 mm were achieved in the third month. In all 32 adolescents, treatment with the Herbst appliance (1,7,8) resulted in Class I or overcorrected Class I dental arch relationships.

In phase II, an Interlandi headgear (IHG) was used during leveling to reduce possible loss of anchorage on maxillary molars, which had been moved distally during treatment with the Herbst appliance (3). At the end of phase II, all 23 patients showed good occlusal adjustment and functional occlusion.

MRI of the right (R) and left (L) TMJs with the mouth closed (MC) and mouth open (MO) were taken at four time points during treatment: immediately before the beginning of phase I (T_1), 8-10 weeks after Herbst appliance placement (T_2), at the end of phase I (T_3) and at the end of phase II (T_4).

A Philips Gyroscan ACS-NT superconductor (Philips, The Netherlands), with magnetic field intensity of 1.5 Tesla, and bilateral TMJ surface coils were used. MRI was performed using T1-weighted (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 x 512); T2 TSE sagittal oblique images with closed and open mouth (TR/TE: 4300/120 ms, FOV: 16 cm, NSA: 4, Matrix: 204 x 512); Proton density FFE sagittal oblique (TR/TE: 60/14 ms, FOV: 16 cm, NSA: 4, Matrix: 212 x 512) and T1 TSE coronal

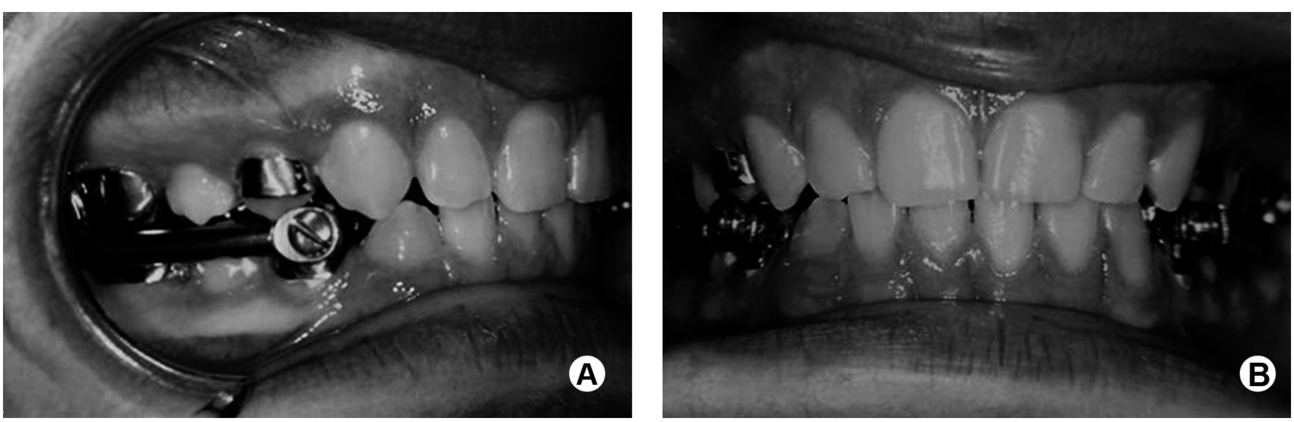

Figure 1. Right side view (A) and front view (B). Modified Herbst appliance (metal crowns, bands, upper Hyrax expander and lower lingual arc).

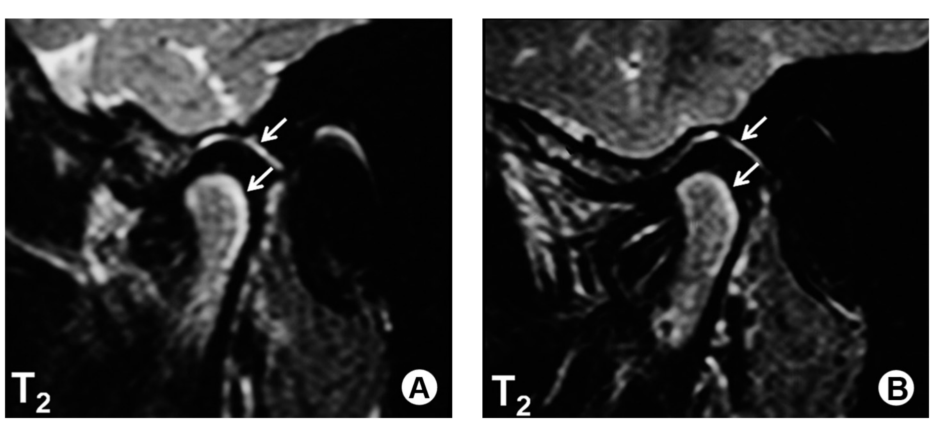

Figure 2. Patient 9 - MRIs of left (A) and right (B) TMJs at T_2 showed an area with hypersignal in posterior superior regions of condyles and supradiscal region, which confirmed the increase of bone remodeling in the region.

images (TR/TE: 580/15 ms, FOV: 16 cm, NSA: 4, Matrix: 204 x 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 perpendicularly to the condyle long axis and the coronal MRIs parallel to the condyle long axis. In each sequence, 16 slices were obtained (8 for each TMJ). The MRIs were examined under 2× magnification.

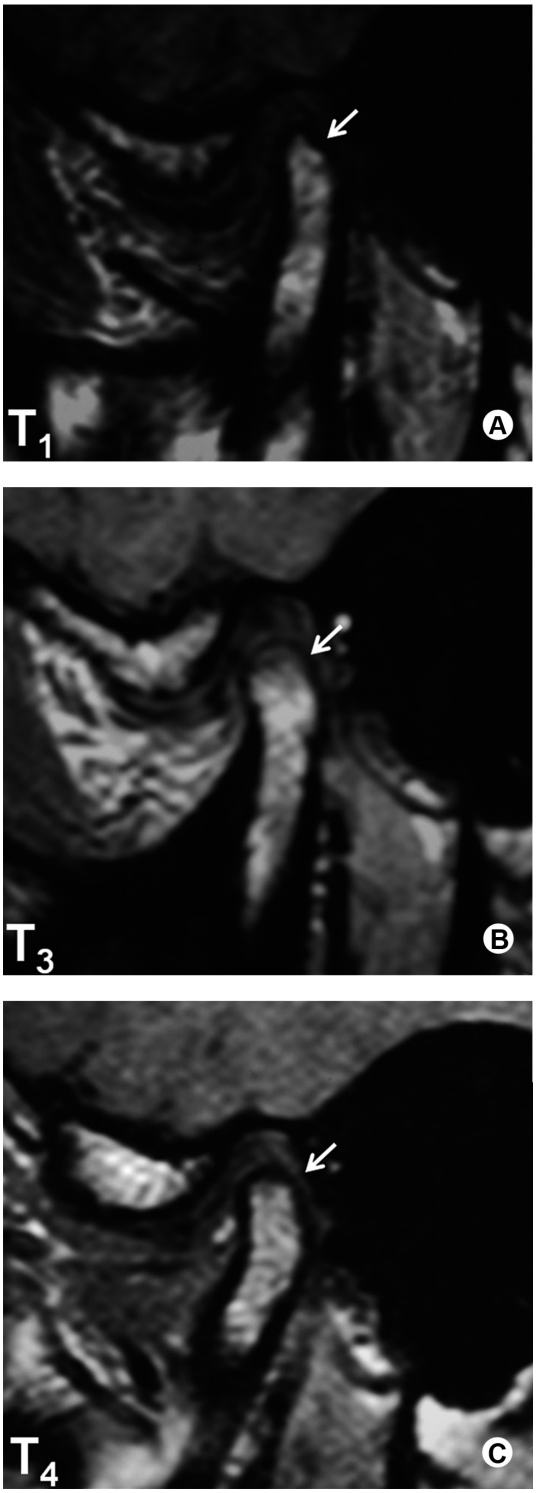

Figure 3. Patient 19 - MRIs of right TMJ. There was a significant change in condyle morphology (degenerative bone disease) at T_1 (A) and it improved with treatment at T_3 (B), remaining stable when evaluated at T_4 (C).

The MRIs were interpreted visually at the four time points (T_1, T_2, T_3 and T_4) by 2 observers ('A'and 'B') using an MRI protocol to better define criteria for interpretation. As the 2 observers had been trained differently because of their backgrounds, they were retrained for 4 months with images not included in this study, to achieve more standardized readings. 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 applied. Observer A's interpretations, performed at regular 15-day intervals, were divided into preliminary and final readings. The preliminary readings consisted of one interpretation before observer A received training (pre-training) and one after training (post-training). Observer A's third reading was considered the final interpretation. Overall interobserver agreement was calculated as the proportion of the joints for which observer A's final interpretation and observer B's interpretation agreed.

At T_1, T_3 and T_4, condyle morphology was evaluated using the MRIs acquired at T1 (weighted parasagittal and coronal scans) in the MC position (14), and classified as normal (NL), when the articular component was rounded with a soft and intact cortex, or remodeled (R), when there was a flattening (anterior and/or superior slope, posterior - parasagittal images; contour of the cortical bone of the articular surface from lateral to medial area of the condyle - coronal images), or variation of the morphology but an intact cortex. Degenerative bone disease (DBD) was diagnosed when cavities, erosion, osteophytes or resorption were seen in the mandibular condyles (Table 1).

This study also describes findings reported in a previous publication (1) (position and shape of the joint disc at T_1, T_3 and T_4 - Table 1) for the same patients enrolled here. The purpose is to make it easier for readers to understand the possible changes in condyle morphology and Helkimo CDI (13).

Clinical exams were carried out to determine the Helkimo CDI at T_1, T_3 and T_4. Clinical functional analysis was performed and the muscles of the stomatognathic system were palpated (24). The analysis of mandibular movements was carried out using a ruler to measure the length of the widest opening and its quality, the extension of border protrusion movements, and left and right laterotrusion. The left and right TMJs were palpated laterally and posteriorly, at rest and during movements. The presence of joint noises or crackling was also checked. The clinical findings were analyzed and scored according to the criteria (13) shown in Table 2. Next, the added score allowed classification into one of the four levels of dysfunction: 0 points, CDI-0 (Asymptomatic); 1-4 points, CDI-I (Mild); 5-9 points, CDI-II (Moderate); and 10-25 points, CDI-III (Severe). The clinical exams were performed by two examiners experienced in the use of the method ('A' and 'B'), both following the same protocol. The clinical evaluations in this study were performed twice by examiner "A" (10-day interval) and once by examiner "B" (who also gave the final diagnosis). The second evaluation by examiner "A" was considered final and was compared with the evaluation by examiner

Table 1. Condyle morphology, joint disc position and shape at T_1, T_3 and T_4

Patient	Condyle morphology						Joint disc position											
	Left TMJ			Right TMJ			Left TMJ						Right TMJ					
	T_1	T_3	T_4	T_1	T_3	T_4	T_1		T_3		T_4		T_1		T_3		T_4	
	MC	MC	MC	MC	MC	MC	MC	MO	MC	MO	MC	MO	MC	MO	MC	MO	MC	MO
1	NL	NL	RPCS	NL	NL	RCS	NL	I	NL	I	ADD	DDWR	NL	I	NL	I	AMDD	DDWR
2	NL	NL	NL	NL	NL	NL	NL	I	NL	I	NL	I	NL	I	NL	I	NL	I
3	NL	NL	RPS	NL	NL	RPS	NL	I	NL	I	NL	I	NL	I	NL	I	NL	I
4	NL	NL	RCS	NL	NL	RCS	LDD	I	LDD	I	LDD	I	NL	I	NL	I	NL	I
5	NL	NL	NL	NL	NL	NL	MDD	I	MDD	I	MDD	I	MDD	I	MDD	I	MDD	I
6	NL	NL	NL	NL	NL	NL	NL	I	NL	I	NL	I	NL	I	NL	I	NL	I
7	NL	NL	NL	NL	NL	NL	NL	I	NL	I	NL	I	NL	I	NL	I	NL	I
8	RPS	NL	RPCS	RPS	NL	RPCS	MDD	I	MDD	I	MDD	I	NL	I	NL	I	NL	I
9	NL	NL	RCS	NL	NL	RPCS	NL	I	NL	I	NL	I	NL	I	NL	I	NL	I
10	NL	NL		RPS	RPS		AMDD	DDWR	AMDD	DDWR			AMDD	DDWR	AMDD	DDWR		
11	NL	NL	NL	NL	NL	NL	NL	I	NL	I	ADD	DDWR	ALDD	DDWR	LDD	I	ALDD	DDWR
12	NL	NL		NL	NL		NL	I	NL	I			NL	I	NL	I		
13	RPCS	RPCS		RPS	RCS		ALDD	DDWR	ALDD	DDWR			ADD	DDWR	ADD	DDWR		
14	RPS	RPS	NL	RPS	NL	RPCS	NL	I	NL	I	NL	I	NL	I	NL	I	NL	I
15	RCS	RCS		RPCS	RCS		NL	I	NL	I			NL	I	NL	I		
16	RPS	NL		NL	NL		NL	I	NL	I			NL	I	NL	I		
17	NL	NL		NL	NL		NL	I	NL	I			NL	I	NL	I		
18	NL	RCS	RCS	NL	NL	NL	NL	I	NL	I	NL	I	NL	I	NL	I	NL	I
19	RPCS	RPCS	RPCS	DBD	RPCS	RPCS	ALDD	DDWPR	ALDD	DDWR	ALDD	DDWR	ALDD	DDWPR	ALDD	DDWR	ALDD	DDWR
20	NL	NL	NL	NL	NL	NL	NL	I	NL	I	NL	I	NL	I	NL	I	NL	I
21	NL	NL	RPCS	RCS	RCS	RCS	ALDD	DDWR	ALDD	DDWR	ALDD	DDWR	NL	I	NL	I	NL	I
22	NL	NL		NL	NL		NL	I	NL	I			NL	I	NL	I		
23	NL	NL	NL	NL	NL	NL	NL	I	NL	I	NL	I	NL	I	NL	I	LDD	I
24	NL	NL		NL	NL		NL	I	NL	I			NL	I	NL	I		
25	NL	NL	NL	NL	NL	NL	MDD	I	MDD	I	MDD	I	MDD	I	MDD	I	MDD	I
26	DBD	DBD	DBD	RCS	RCS	RPCS	ALDD	DDWR	ALDD	DDWR	ALDD	DDWR	AMDD	DDWPR	AMDD	DDWPR	AMDD	DDWPR
27	NL	NL	RCS	NL	NL	NL	AMDD	DDWR	AMDD	DDWR	AMDD	DDWR	AMDD	DDWR	AMDD	DDWR	AMDD	DDWR
28	NL	NL	NL	NL	NL	NL	ADD	DDWR	ADD	DDWR	ADD	DDWR	AMDD	DDWR	AMDD	DDWR	AMDD	DDWR
29	NL	NL	NL	NL	NL	NL	ADD	DDWR	ADD	DDWR	ADD	DDWR	AMDD	DDWR	AMDD	DDWR	AMDD	DDWR
30	NL	NL		NL	NL		NL	I	NL	I			NL	I	NL	I		
31	NL	RPS	RPCS	RPCS	RPCS	RPCS	NL	I	NL	I	NL	I	NL	I	NL	I	NL	I
32	NL	NL	RPS	NL	NL	RPS	NL	I	NL	I	NL	I	NL	I	NL	I	NL	I

MC, Mouth closed; MO, Mouth open; NL, Normal; RPS, Remodeled parasagittal slice; RCS, Remodeled coronal slice; RPCS, Remodeled parasagittal and coronal slice; DBD, Degenerative bone disease; ADD, Anterior disc displacement ; AMDD, Anteromedial disc displacement ; ALDD, Anterolateral disc displacement; MDD, Medial disc displacement; LDD, Lateral disc displacement; I, Interposed; DDWR, disc displacement with reduction ; DDWPR , disc displacement with partial reduction; RP, Retrusive position; Recap, Recaptured; P Recap, Partially recaptured; B, Biconcave; NB, Non-biconcave. Joint disc position and shape. Source: Aidar et al., 2010 (1).

"B" to assess interexaminer concordance.

Intraobserver and interobserver variability was evaluated. Agreement was poor when kappa was below 0.4, and excellent when greater than 0.75. The nonparametric K and the McNemar tests were used to evaluate concordance between left and right TMJs (condyle morphology) and changes due to treatment (condyle morphology and Helkimo CDI). The level of significance was set at 5%. To evaluate independent data at the same observation time (2 x 2 tables: condyle morphology x disc position and condyle morphology x disc shape), a chi-square test was used with Yates's correction for continuity. If the lowest expected frequency was below 5, the Fishers's Exact test was used (2 x 2 tables: CDI categories x diagnosis using MRI of joint disc position) at a 5% level of significance.

Joint disc shape											
Left TMJ						Right TMJ					
T_1		T_3		T_4		T_1		T_3		T_4	
MC	MO	MC	MO	MC	MO	MC	MO	MC	MO	MC	MO
NB	B	NB	B	NB	B	NB	B	NB	B	NB	B
B	B	B	B	B	B	B	B	B	B	B	B
B	B	B	B	B	B	B	B	B	B	B	B
B	B	B	B	B	B	B	B	B	B	B	B
B	B	B	B	NB	B	B	B	B	B	NB	B
B	B	B	B	B	B	B	B	B	B	B	B
B	B	B	B	B	B	B	B	B	B	B	B
B	B	B	B	B	B	B	B	B	B	B	B
B	B	B	B	B	B	B	B	B	B	B	B
NB	B	NB	N			NB	N	NB	B		
B	B	NB	B	NB	B	NB	B	NB	B	NB	B
B	B	B	B			B	B	B	B		
NB	B	NB	NB			NB	B	NB	B		
B	B	B	B	B	B	B	B	B	B	B	B
B	B	B	B			B	B	B	B		
B	B	B	B			B	B	B	B		
B	B	B	B			B	B	B	B		
B	B	B	B	B	B	B	B	B	B	B	B
NB	NB	NB	B	NB	B	NB	NB	NB	B	NB	B
B	B	B	B	B	B	B	B	B	B	B	B
NB	B	NB	B	NB	B	B	B	B	B	B	B
B	B	B	B			B	B	B	B		
B	B	B	B	B	B	B	B	B	B	B	B
B	B	B	B			B	B	B	B		
B	B	B	B	B	B	B	B	B	B	B	B
NB	B	NB	B	NB	B	NB	NB	NB	B	NB	B
NB	B	NB	B	NB	B	NB	B	NB	B	NB	B
NB	B	NB	B	NB	B	NB	B	NB	B	NB	B
NB	B	NB	B	NB	NB	NB	B	NB	B	NB	NB
B	B	B	B			B	B	B	B		
B	B	B	B	B	B	B	B	B	B	B	B
NB	B	NB	B	NB	B	NB	B	NB	B	NB	B

Results

Intraobserver variability in the analysis of condyle morphology was K=0.52 for reading 1 *vs.* 2 and K=0.67 for reading 2 *vs.* 3. Interobserver kappa (observer A's reading 3 *vs.* observer B's reading) for condyle morphology (k=0.87) indicated excellent agreement. Intraobserver and interobserver concordance for CDI was also excellent (k=0.94 and k=0.84).

The classifications of condyle morphology with MC and position and shape of the joint disc with MC and MO at T_1, T_3 and T_4 are shown in Table 1.

Comparing left and right TMJ condyle morphology at T_1, a K value of 0.405 ($p<0.001$) was found, with a 75.1% concordance. It was not possible to calculate Kappa for T_3 and T_4 (concordance of 78.1% and 69.5%). Once substantial agreement was observed, they were pooled.

There was no association between condyle morphology (remodeled and normal) and joint disc position at T_1 ($p=0.523$), T_3 ($p=0.665$), T_4 ($p=0.526$) and shape at T_1 ($p=0.771$), T_3 ($p=0.566$), T_4 ($p=1.000$) or between CDI categories (0 and I) and the MRI diagnosis of joint disc position at T_1 ($p=0.057$), T_3 ($p=0.358$) and T_4 ($p=1.000$).

Condyle Morphology

There were no changes in 55 (86.0%), 28 (60.8%) and 26 (56.5%) TMJs at T_1-T_3 ($p=0.326$), T_3-T_4 ($p<0.05$) and T_1-T_4 ($p<0.05$), respectively. Changes were found in 9 (14.0%), 18 (39.1%) and 20 (43.4%) TMJs at T_1-T_3, T_3-T_4 and T_1-T_4, respectively.

CDI

There were no changes in 26 (86.6%), 16 (76.2%) and 16 (76.2%) patients at T_1-T_3 ($p=1.000$), T_3-T_4 ($p=1.000$) and T_1-T_4 ($p=1.000$), respectively. There were changes in 4 (13.3%), 5 (23.8%) and 5 (23.8%) patients at T_1-T_3, T_3-T_4 and T_1-T_4, respectively.

Discussion

MRI has been shown to be efficient in detecting joint disc disorders and changes in the shape of the fossa, eminence and mandibular condyle (14,15). In this study,

Table 2. Composition of clinical dysfunction index (CDI) at T_1,T_3 and T_4

Patient	Mandibular mobility index (A)			Altered TMJ function (B)			Muscle pain (C)			Joint pain at rest (D)			Joint pain with movement (E)			Sum			CDI		
	T_1	T_3	T_4	T_1	T_3	T_4	T_1	T_3	T_4	T_1	T_3	T_4	T_1	T_3	T_4	T_1	T_3	T_4	T_1	T_3	T_4
1		1		1	1	1	1		1				1			3	2	2	1	1	1
2													1	1		1	1	0	1	1	0
3				1		1										1	0	1	1	0	1
4		1		1	1	1							1	1		2	3	1	1	1	1
5				1	1								1			2	1	0	1	1	0
6		1	1	1	1	1										1	2	2	1	1	1
7				1	1	1	5	5					1	1		7	7	1	11	11	1
8		1		1	1								1			2	2	0	1	1	0
9				1	1	1										1	1	1	1	1	1
10				1	1											1	1		1	1	
11				1		1							1		1	2	0	2	1	0	1
12																0	0		0	0	
13	1	1		1	1									1		2	3		1	1	
14					1	1										0	1	1	0	1	1
15																0	0		0	0	
16					1								1			1	1		1	1	
17				1	1											1	1		1	1	
18				1	1	1							1			2	1	1	1	1	1
19		1		1	1								1	1	1	2	3	1	1	1	1
20																0	0	0	0	0	0
21			1	1	1	1		1					1	1	1	2	3	3	1	1	1
22																0	0		0	0	

23					1	1								0	1	1	0	I	I
24				1	1						1			2	1		I	I	
25				1	1	1								1	1	1	I	I	I
26				1	1	1				5	1	1	1	7	2	2	II	I	I
27				1	1	1								1	1	1	I	I	I
28				1	1	1					1			2	1	1	I	I	I
29				1	1				1	1	1	1		3	2	1	I	I	I
30				1	1						1			2	1		I	I	
31				1	1				1		1	1	1	2	2	2	I	I	I
32				1				1	1		1			2	1	1	I	I	I
Total	1	6 *5	2	24 *19	24 *18	15	6 *6	7 *7	4	6 *6	18 *14	9 *8	5	55 *46	46 *38	26			

CDI 0: asymptomatic; I: mild dysfunction; II: moderate dysfunction. *: 23 patients who completed the second phase of treatment.

coronal images prevented false negative diagnoses when interpreting condyle morphology in 16 TMJs (9.19%) and reinforced the diagnosis of condylar remodeling already made using the parasagittal slices in 19 TMJs (10.91%). MRIs at T_2 showed an area with increased signal intensity (bright area) in the posterior superior region of the condyles in virtually all joints under study (Fig. 2), which confirmed the increase of bone remodeling in the region (11). Another study (5) found similar evidence in patients treated with an activator appliance. This phenomenon was not seen when a twin-block appliance was used (4), probably because the MRI sequences were different.

Our results showed that between T_1 and T_3 (p=0.326) there were no significant changes in condyle morphology in most TMJs (86.0%). In six TMJs, condyle morphology improved at T_3, regardless of position and shape of the joint disc. In case 19 (right TMJ), there was a significant change in condyle morphology (DBD) associated with anterolateral disc displacement (ALDD) and non-biconcave disc shape at T_1. Considerable improvement was observed in condyle morphology at T_3, which remained stable when evaluated at T_4 (Fig. 3).

Our results are in agreement with a study that found a decreased prevalence of structural bone changes during treatment with the Herbst appliance (9), probably due to remodeling (6-9). In contrast, the left condyle in case 26 had osteophytes (DBD) associated with ALDD and a non-biconcave shape of the disc at T_1. No improvement was seen in condyle morphology at T_3 or T_4. In both TMJs, disc displacement was reduced, and the time of disc derangement and the degree of tissue changes in the joint components was not known.

Significant changes were found when T3 and T4 were compared ($p<0.05$). Condyle morphology became flatter at T4 in 17 TMJs (36.9%). In fact, mild flattening took place in joints with normal disc position and shape and in joints that already had a displaced disc at T1 and T3 or began to show disc displacement at T4. Three TMJs that had condyle morphology improvements at T3 exhibited recurrences at T4. Our results differ from those reported in a study that found a reduction in the prevalence of bone structural changes in the condyle one year after treatment with the Herbst appliance (9). In our study, patients were assessed at a mean 2.2 ± 0.9 years after the end of the Herbst phase, which complicates the comparison of results because of method differences. The evaluations at T1 and T4 revealed significant changes ($p<0.05$). Condyle morphology became flatter in 18 TMJs (39.1%). Another study (25) found that mild condyle flattening, when associated with asymptomatic patients without internal derangement, probably has no clinical significance. That study (25) was cross-sectional and the individuals were not undergoing treatment, and it was not known how long those bone changes had been in place. In contrast, the participants in this study experienced condylar flattening over the course of treatment, with nearly all of the changes occurring during phase II. Changes observed could be associated with possible future problems.

In our study, patients with and without changes on MRIs are distributed similarly within the different CDI categories at all time points. This leads to the conclusion that clinical symptoms might be present even when there are no MRI findings. Disc displacement is relatively common in asymptomatic individuals (14), and the clinical diagnosis of no TMD is linked to the high rates of internal derangement detection using MRI (16). In agreement with our findings, a previous study (17) demonstrated that joint noises are not sufficient evidence of dysfunction when there are no other corroborating symptoms, although they may be found in patients with TMJ disc displacement detected using MRI. Joint pain with movement was observed in 18 of 32 patients at T_1 (9 of the 18 patients had disc displacement). There is a low correlation between MRI disc displacement detections and the extent of TMJ pain and dysfunction (18). At T_3, pain disappeared in 10 patients, persisted in 8 and started in 1. At T_4, that number fell to 5 out of 23 patients who already felt pain at T_1 and T_3, with the exception of patient 11, who felt pain at T_1, which disappeared at T_3 and resumed at T_4. Patients 26 and 29 (disc displacement in both joints) were the only ones with joint pain at palpation at rest at T_1, but pain disappeared at T_3 and T_4. Patient 26 had DBD (left condyle), and painful joints are known to be more frequent in the presence of this type of change (15).

The analysis of muscle pain revealed that only patients 1 and 7 had scores 1 and 5 at T_1, with CDI-I and II. For patient 1, muscle pain vanished at T_3, but dysfunction remained at CDI-I. At T_4, although no change occurred in CDI-I, muscle pain resumed in association with disc displacement (left and right TMJs). No changes occurred in patient 7 at T_3; however, at T_4 muscle pain disappeared, and the dysfunction index changed to CDI-I. At T_4, patients 29, 31 and 32 began complaining of muscle pain. Range of movement is the most evident expression of joint function (24), and its limitation may be caused by disc displacement (14). In our study, 13 patients already had disc displacement at T_1, and only patient 13 had limited movements (lower than 7 mm). Patient 1, who had a well-positioned joint disc at T_1, T_3 and T_4 had disc displacement according to both MRIs, a likely sign of dysfunction. Patient 6, the only one not to have a displaced disc at any time during treatment, had limited movements at T_3 and T_4. Our results demonstrated that limited range of movement did not characterize disc displacement in all cases. Limited lateral mandibular movements may be assigned to restricted movements caused by use of the Herbst appliance (12) and are transient. In our study, at T_3, 6 patients had limited lateral movements and only patient 6 maintained limited movements at T_4; patient 21 started to have this problem at T_4.

Finally, a follow-up evaluation of these patients will be important to elucidate the long-term effects of treatment with Herbst and fixed appliances on the form and function of the TMJ. In conclusion, after phase I, the condyle morphology did not change significantly. At the end of phase II, a mild flattening was seen in some condyles when patients underwent short-term evaluation. In general, no changes occurred in the clinical dysfunction index after the two phases.

Resumo

Este estudo avaliou as mudanças morfológicas nas cabeças da mandíbula das articulações temporo mandibulares (ATMs) e calculou o índex de disfunção clínico de Helkimo (IDC) em adolescentes com má oclusão de Classe II Divisão1 e retrognatismo mandibular, tratados com aparelho de Herbst (fase I) e aparelho ortodôntico fixo (fase II). Trinta e dois adolescentes consecutivos passaram pela fase I e 23 completaram a fase II. As ATMs foram avaliadas qualitativamente por meio de imagem da resonância magnética (IRM) ao início do tratamento (T_1), durante a fase I (T_2), no final da fase I (T_3) e no final da fase II (T_4). O IDC foi calculado em T_1, T_3 e T_4. De T_1 a T_3 (p=0,326) não ocorreram mudanças na morfologia da cabeça da mandíbula em 86,0% das ATMs. De T_3 a T_4 (p<0,05) e T_1 a T_4 (p<0,05) ocorreram mudanças em 39,1% e 43,4% das cabeças das mandíbulas. Não ocorreram mudanças significantes no IDC de T_1 a T_3, T_3 a T_4 e T_1 a T_4 (p=1,000; 86,6%, 76,2% e 76,2% concordância). Após a fase I, não houve praticamente mudanças na morfologia da cabeça da mandíbula. Ao final da fase II, um leve aplainamento foi observado em algumas cabeças das mandíbulas. Pode ser concluído que não ocorreram mudanças significantes no IDC após ambas as fases de tratamento.

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