EVALUATION OF RETRODISKAL TISSUE ASSOCIATED WITH ARTICULAR EMINENCE MORPHOLOGY, EFFUSION STATUS AND DISK DISPLACEMENT IN SYMPTOMATIC PATIENTS

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Abstract

The aim of this study was to evaluate the MRI signal intensity of retrodiskal tissue e and its relationship to articular eminence morphology, joint effusion status and disk displacement in symptomatic patients. Image archive from patients referred to MRI evaluation was assessed, totalizing 48 TMJ. The signal intensity of retrodiskal tissue was determined by using sagittal images and a ROI of 0.27 mm2 in the adjacent region of the posterior portion of the articular disk. Data about disk displacement, articular eminence morphology and presence of joint effusion were also recorded. Retrodiskal tissue signal intensity was statistically lower for the disk position in DDWR than in DDWoR ($p = 0.016$). There was a tendency for higher signal intensity in joints with effusion versus those without effusion ($p = 0.065$). No relationship between retrodiskal tissue signal intensity and shape of articular eminence was identified ($p = 0.159$). MRI is effective for assessing TMJ structures, including retrodiskal tissue portion. Changes in retrodiskal tissue signal intensity were associated only with joint effusion presence, confirming inflammation features. Further studies are indicated to elucidate retrodiskal tissue relationship with disk displacement.

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Introduction

Pain and internal derangement (ID) of the temporomandibular joint (TMJ) require studies of numerous factors related to the anatomy of the region, with particular focus on the bony structures, articular disk and surrounding tissues. The main cause of those symptoms is the abnormal relationship among articular disk, articular eminence and condyle, generally involving articular disk displacement with or without reduction (DDWR and DDWoR, respectively).[1] In addition, inflammatory changes as joint effusion can also be observed.[2]

Changes in retrodiskal tissue (RT) have also been associated to ID through MRI evaluation.[3,4]

The RT area consists mainly of reduced connective tissue, as well as elastin and collagen fibers, and incorporates a large venous plexus in its deepest layer.[5]

It has been attracting extensive interest from both clinicians and researchers because of its possible role as a cause of ID.[3]

Signal intensity alteration at RT in MRI exams has been associated to severe disk displacement and pain symptomatology.[3,4]

The aim of this study was to evaluate the MRI signal intensity of RT e and its relationship to joint effusion status, articular eminence morphology and disk displacement in symptomatic patients.

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Materials and Methods

An image archive from patients referred to MRI evaluation due to TMJ symptomatology was assessed. Images from 24 patients were selected, for a total of 48 TMJ. The images from patients submitted to surgical procedures or who presented inflammatory joint diseases, facial growth disturbances, facial bone trauma or fracture, as well as hypoplasia/hyperplasia/tumors in the condyle region were excluded from the study.

All MRI exams were performed at 1.5T Sigma MRI apparatus (G&E Medical Systems®, Madison, WI, USA) added by a 20 cm diameter dual surface coil (G&E Medical Systems®, Madison, WI, USA). T1, T2, and Proton Density weighted images were assessed in sagittal and coronal planes, including open-mouth and closed-mouth (maximal intercuspation) images. The images sequences were stored in DICOM format (*Digital Imaging and Communication in Medicine)* and assessed using a workstation running a high-resolution graphics program for digitization and manipulation (*Easy-Vision*® Phillips – AP8000). Two experts in Oral and Maxillofacial Radiology evaluated all images separately (E1 and E2), and one of the examiners did it twice due to statistical details (E1a, E1b). (Table 3)

	Evaluations	ICC*	Interval with 95% for ICC		p
Gray Matter	E1a and E1b	0,837	0,728	0,905	<0,001
	E1a and E2	0,850	0,748	0,913	<0,001
	E1b and E2	0,991	0,983	0,995	<0,001
	E1a + E1b and E2	0,892	0,834	0,934	<0,001
Retrodiskal Tissue	E1a and E1b	0,551	0,270	0,692	<0,001
	E1a and E2	0,664	0,472	0,796	<0,001
	E1b and E2	0,770	0,624	0,864	<0,001
	E1a + E1b and E2	0,650	0,507	0,770	<0,001

*Interclass Correlation Coefficient; E1a: first evaluation examiner 1; E1b: second evaluation examiner 1; E2: examiner 2

Table 3. Interclass Correlation Coefficient between the two examiners for both ROI: gray matter and RT

The signal intensity of RT was determined by OziriX™ Dicom Viewer image processing software (Apple Inc, version 3.9.4, 32 Bits - Pixmeo, Geneva, Switzerland). Signal data was processed in accordance with the following protocol: by using in sagittal images, a ROI (region of interest) of 0.27 mm^2 was selected in the adjacent region of the posterior portion of the articular disk. Another ROI of the same size was elected in the region of the cerebral gray matter, oriented in the upward 12 o'clock position relative to the center of the condyle so the signal intensity could be compared (Figures 1 and 2).[6] The mean values, standard deviation and total values provided by the software were recorded.

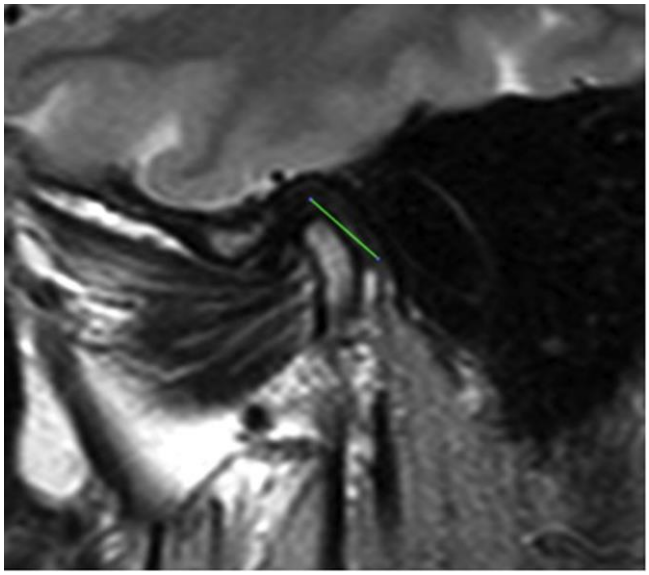

Figure 1. MRI: sagittal plane, T2-weighted image. Retrodiskal Zone.

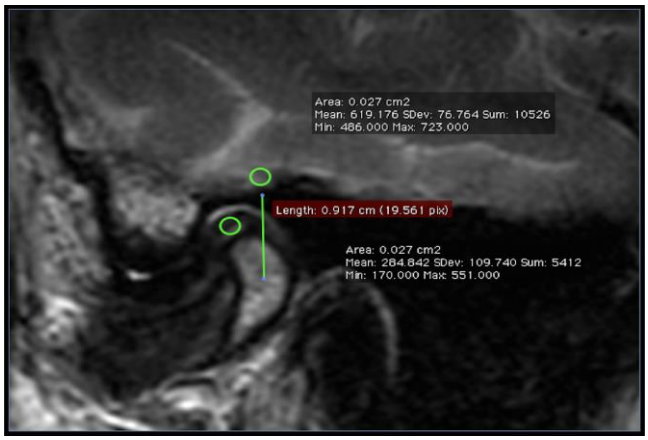

Figure 2. MRI: sagittal plane, T2-weighted image. The ROI selection at retrodiskal tissue and gray matter.

The disk position was classified into (a) normal (N), in closed-mouth position, the posterior band of the disk is centered in relation to the condyle and to the roof of the mandibular

fossa, while in open mouth position the disk is interposed between the bony structures (condyle and articular eminence of the temporal bone); (b) DDWR, in closed-mouth position the disk is located anteriorly to the anterior articular slope of the condyle, returning to its normal topography between the bony structures in intermediate positions or maximum mouth opening (figure 3); and (c) DDWoR, in the closed-mouth and open-mouth positions the disk is located anteriorly to the anterior articular slope of the condyle (figure 3).

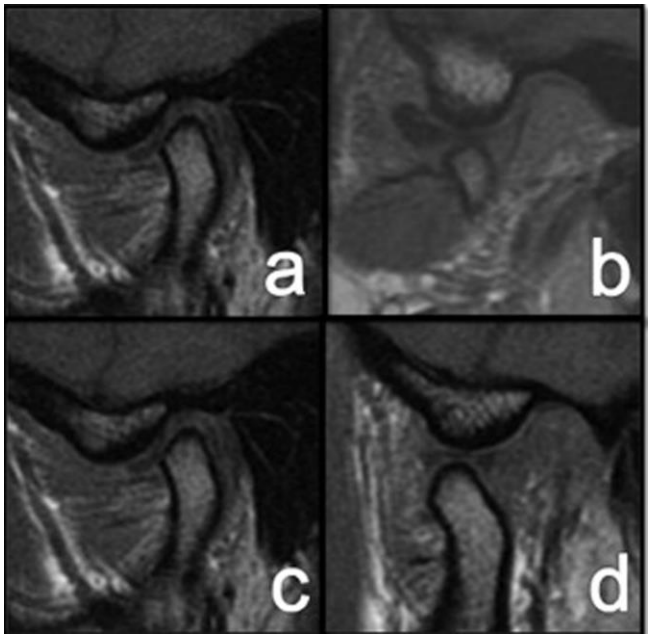

Figure 3. MRI: Sagittal plane, PD-weighted image. (A) and (C) TMJ at closed mouth position; (B) and (D), TMJ at opened mouth position. Observe in (A) and (C) disk displacement. (B) disk displacement without reduction (DDWoR). (D) disk displacement with reduction (DDWR).

Articular eminence morphology was assessed using templates based on the following classification: box, sigmoid, flattened and deformed (Figure 4) .[1]

The presence or absences of joint effusion were evaluated by just observing high signal intensity in articular spaces on T2 weighted images (Figure 5).

All data was submitted to statistical analysis by using Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) 19.0 software: the t-Student test was applied to evaluate the possible relationship between RT signal intensity and joint effusion presence (Table 2); the ANOVA with single fixed factor test was performed to evaluate the possible relationship between RT signal intensity, articular disk position and articular eminence morphology (Table 2); and the Interclass Correlation Coefficient was used to evaluate examiners concordance (Table 3). For all tests, the significance level was fixed into 95%.

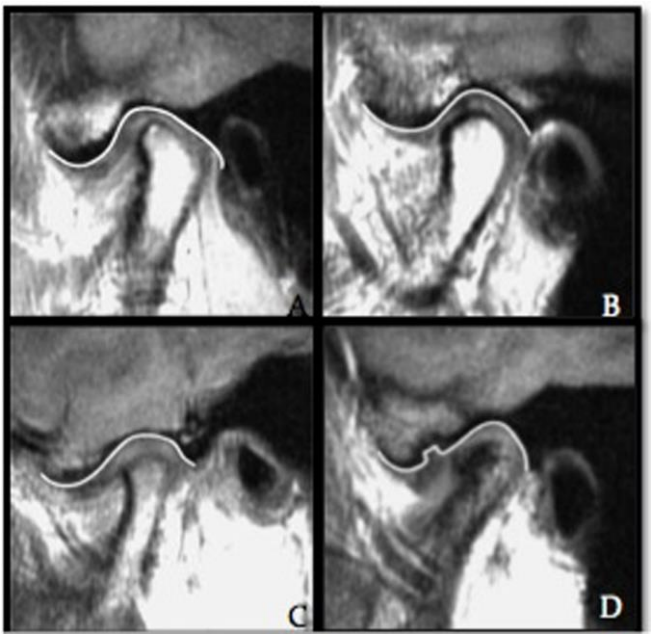

Figure 4. Articular eminence morphology - (A) box; (B) Sigmoid; (C) Flattened; (D) Deformed.

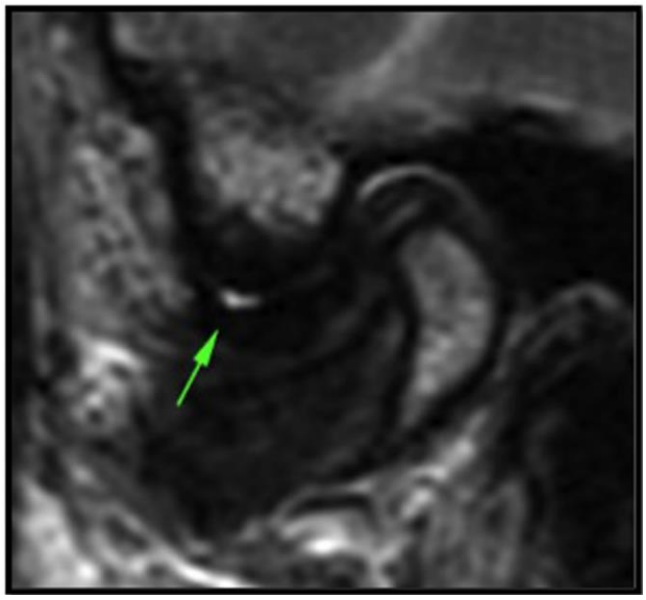

Figure 5. MRI: Sagittal plane, T2-weighted image. TMJ presenting joint effusion (arrow).

	Signal intensity of RT						
	N	Mean	Median	Minimum	Maximum	Standard Deviation	p
Disk position							0.021[b]
DDWR	23	0.26	0.24	0.11	0.48	0.10	
DDWoR	20	0.39	0.35	0.15	0.79	0.20	
Normal	5	0,27	0,27	0,14	0,43	0,12	
Total	48	0,32	0,27	0,11	0,79	0,16	
Articular Eminence morphology							0.159[b]
Box	15	0.36	0.33	0.13	0.79	0.18	
Sigmoid	12	0.26	0.23	0.14	0.49	0.11	
Flattened	10	0.26	0.22	0.11	0.70	0.17	
Deformed	11	0.38	0.40	0.15	0.61	0.15	
Total	48	0.32	0.27	0.11	0.79	0.16	
Joint Effusion							0.065[a]
Yes	32	0.35	0.31	0.11	0.79	0.16	
No	16	0.26	0.23	0.13	0.70	0.14	
Total	48	0.32	0.27	0.11	0.79	0.16	

[a]Student's *t*-test for independent samples, [b]ANOVA with single Fixed Factor

Table 2. Summarized measurements of RT signal intensity, according to articular eminence shape, disk position and effusion status

This study was approved by the institutional ethical committee of School of Dentistry, University of São Paulo, São Paulo, Brazil (108.473).

Results

The study comprised 24 patients (19 women and 5 men). The mean age of the women group was 37.6 years, ranging from 22 to 53 years, with a standard deviation of 9.2 years. The mean age of the men group was 33.0 years, ranging from 24 to 52 years, with a standard deviation of 11.5 years.

Table 1 shows the distribution of articular eminence morphology, articular disk position and joint effusion status. For articular disk position, 5 (10.4%) joints were normal, 23 (47.9%) showed DDWR and 20 (41.7%) DDWoR. Regarding articular eminence morphology, 15 (31.3%) joints were classified as box-shaped, 12 (25.0%) as sigmoid, 10 (20.8%) flattened and 11 (22.9%) deformed. The majority of TMJs (32 joints or 66.7%) showed effusion.

Table 2 shows summarized measurements of RT signal intensity according to AE shape, sagittal position of disk and JE status. RT signal intensity was statistically lower for the disk position in DDWR than in DDWoR ($p = 0.016$).

There was a tendency for higher signal intensity in joints with effusion versus those without effusion ($p = 0.065$). No relationship between RT signal intensity and shape of articular eminence was identified ($p = 0.159$).

		Frequency	Percentage
Disk Position	Normal	5	10.4%
	DDWR	23	47.9%
	DDWoR	20	41.7%
	Total	48	100.0%
Articular Eminence morphology	Box	15	31.3%
	Sigmoid	12	25.0%
	Flattened	10	20.8%
	Deformed	11	22.9%
	Total	48	100.0%
Joint Effusion	No	16	33.3%
	Yes	32	66.7%
	Total	48	100.0%

Table 1. Distribution of articular eminence morphology, disk position and effusion status of TMJ assessed

Table 3 shows the agreement between examiners. A significant statistical agreement between the two examiners was verified, confirming previous calibration.

Discussion

The MRI advantages regarding TMJ evaluation are well established: it is a radiation-free technique which can effectively document TMJ changes by clearly depicting the bony and soft tissue structures.[3,7-10,12,16] Studies are unanimous on the utility of MRI for analysis of changes in articular disk and articular eminence and joint effusion observation.[1,2,4,6,8-15]It has also proved effectiveness for RT assessment.[3,6,9,12,16-18] findings of the present study corroborate with literature data, confirming the efficacy of MRI for assessing articular disk, articular eminence, joint effusion and RT.

The TMJ derangement is related to any disturbance that affects joints function, and is frequently associated to articular disk, bony structures and joint effusion presence.[10,11] Anterior disk displacement is a well-known anatomic disorder that may produce functional disturbance, and numerous studies have demonstrated a high prevalence of disk displacement in TMJ pain and dysfunction.[1,10,11,19-21] From 48 TMJ evaluated in this study, 20 (41,7%) presented DDWoR, 23 (47,9%) presented DDWR, and 5 (10,4%) showed articular disk normal position. (Table1) The bone remodeling at articular eminence was considered by Atkinson and Bates[22] to play an important role into articular disk displacement, but studies only associated the increasing flattening with TMJ derangement severity. [1,10,15,19] Considering all TMJ in this study, the articular eminence morphology was identified as following: 15 (31,3%) box, 12 (25,0%) sigmoid, 10 (20,8%) flattened and 11 (22,9%) deformed. (Table 1) The joint effusion, characterized by high signal intensity observed in articular spaces at T2-weighted images, is a pathologic collection of fluid in the articular space and its presence has been associated to articular disk displacement.[3,9,10,12-14,23,24] The presence of joint effusion was observed in the majority of the TMJ. (Table 1) All these aspects mentioned above confirm that all patients from this study were symptomatic and presented TMJ derangement in several degrees.

Symptomatology at TMJ has been associated to impingement on the RT, inflammatory changes in the joint with joint effusion, and inflammatory reaction in the joint capsule.[25] The RT involves the bilaminar zone with its elastin-rich upper bundle and collagen-rich lower bundle, along with vascular nervous structures. It extends from the posterior band of the articular disk, and its upper bundle attaches to the posterior of the mandibular fossa, and its lower bundle attaches to the posterior portion of the condyle.[25]

Studies demonstrated that, histologically, the number of blood vessels in the RT is increased in patients with TMJ derangement. The RT of symptomatic patients was found to be hyperemic with perivascular inflammation, and showed increased signal intensity on MRI. [2,4,18,25,26] The RT signal abnormality has been associated to joint effusion presence[4,17], and this relationship was focus on this study: the results indicate a tendency of higher RT signal intensity in TMJ with joint effusion ($p = 0.065$), as shown in Table 2. The association between RT signal change and articular disk displacement was also investigated: the results showed a statistically lower RT signal intensity in TMJ with DDwR compared to DDwoR ($p = 0.016$). (Table 2) However, studies confirm significant increase in RT signal intensity in patients with DDwR compared to those with DDwoR. This result is plausible considering the histological changes in RT during at later stages of disk displacement.[4,6,18,25] Our study, just like Sano and Westesson[4] study, failed to find an association between RT signal intensity and disk displacement.

The relationship between RT signal intensity and articular eminence morphology was also investigated, as an effort to indicate any association of articular eminence and meniscus changes. The results did not show any possible association between the parts ($p = 0.159$). (Table 2) This result may indicate that the articular eminence and its morphology do not influence meniscus displacement, and consequently, its histological changes.

Conclusion

The MRI is effective for assessing TMJ structures, including retrodiskal tissue portion. Changes in retrodiskal tissue signal intensity were associated only with joint effusion presence, confirming inflammation features. Further studies are indicated to elucidate retrodiskal tissue relationship with disk displacement.

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