

# Magnetic resonance imaging changes in pediatric temporomandibular joint: literature review

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**ABSTRACT** | Magnetic resonance imaging is effective to diagnose some diseases that affect the temporomandibular joint (TMJ) of children. The images allow the detection of early stages of juvenile idiopathic arthritis, cases of joint ankylosis and is currently considered the most reliable exam for an objective and noninvasive assessment of intracapsular soft tissues. The objective of this literature review was to assess some of the temporomandibular joint changes in children using magnetic resonance imaging (MRI). The assessment of TMJs of children performed through MRI make the diagnosis more accurate and objective. Detecting alterations during the early stages of juvenile idiopathic arthritis using 3T MRI devices is possible utilizing contrast tools, which as a result, provides better prognosis and treatment.

**DESCRIPTORS** | Temporomandibular Joint; Child; Magnetic Resonance Imaging.

**RESUMO** | **Alterações na ressonância magnética em articulações temporomandibulares de crianças: revisão de literatura** • A ressonância magnética é eficaz para diagnosticar algumas doenças que afetam a articulação temporomandibular (ATM) de crianças. As imagens permitem a detecção dos estágios iniciais da artrite idiopática juvenil, casos de anquilose articular, sendo atualmente considerado o exame mais confiável para avaliação objetiva e não invasiva de tecidos moles intracapsulares. O objetivo desta revisão da literatura foi avaliar algumas das alterações da ATM em crianças por meio de imagens de ressonância magnética (IRM). A avaliação das ATM de crianças por meio de IRM torna o diagnóstico mais preciso e objetivo. A detecção de alterações durante os estágios iniciais da artrite idiopática juvenil usando aparelhos de RM de 3T (Tesla) é possível pela utilização de ferramentas de contraste, que, como resultado, proporcionam melhor prognóstico e tratamento.

**DESCRITORES** | Articulação Temporomandibular; Criança; Imagem por Ressonância Magnética.

**CORRESPONDING AUTHOR** | • **Juliane Piráquine Araujo** Department of Stomatology, School of Dentistry, University of São Paulo • **Avenida Professor Lineu Prestes, 2227, Butanta São Paulo, SP, Brazil** • **05508-000** E-mail: [jupiragine@usp.br](mailto:jupiragine@usp.br)

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## INTRODUCTION

The temporomandibular joint (TMJ) is a complex joint composed of a conjunction of soft and bony tissue structures. The squamous portion of the temporal bone (represented by the articular tubercle and the fossa of the mandible) and the condyle comprises the bony components. The soft tissues are represented by the articular disc, dense fibrous tissue, articular capsule, intrinsic and extrinsic ligaments, as well as articular cartilage.<sup>1</sup> Temporomandibular disorders (TMD) present a multifactorial etiology, which may include muscular disorders and disorders of the TMJ itself. Pain and clicking are the most common signs and symptoms reported by patients.<sup>2</sup>

Magnetic resonance imaging (MRI) is considered the golden standard for the diagnosis of changes in the structure of the TMJ,<sup>3,4</sup> due to the possibility of producing images in different planes, dynamic studies, and by not requiring ionizing radiation.<sup>5,6</sup> Currently, MRI is the most reliable examination for an objective and noninvasive assessment of the intracapsular soft tissue. Conventional radiographs and computed tomography present limitations for soft tissue evaluation, and arthroscopy is an invasive procedure.<sup>7</sup> Devices with a field energy of 1.5 Tesla (T) or 3T can be used, with the characteristics of each fiber determining the images generated. Signal-rich images appear clear (hypersignal) and a poor signal image appears dark (hyposignal).<sup>1</sup>

The objective of this study was to perform a literature review on the evaluation and diagnosis of the changes that can affect the TMJ of children through MRI images.

## DISCUSSION

The main imaging examinations used to evaluate the TMJ are panoramic radiography, ultrasonography, computed tomography (CT), cone beam computed tomography, and MRI. Each method has advantages and limitations, thus, the

radiologist must know their correct indications. Panoramic radiographs should not be used to assess the condyle and joint fossa due to the overlapping of structures.<sup>6</sup> Ultrasonography represents a convenient and noninvasive modality without exposure to ionizing radiation. The limitation of this examination is the lack of view of osseous and dense soft tissue structures, resulting in the visualization of the superficial (lateral) region of the TMJ. Ultrasound-guided procedures are excellent to guide the intra-articular injection of anti-inflammatory drugs.<sup>8</sup> The articular disc cannot be observed through conventional radiographs or CT, which provide information about traumas, infections and congenital anomalies of the TMJ.<sup>9</sup> CT allows the detection of fractures, small erosions and morphological alterations of the bone tissue. Soft tissue structures, including the articular disc, can be observed but are difficult to identify in the presence of joint effusion or synovial thickening.<sup>8</sup> Based on its high sensitivity and specificity, MRI became the modality of choice for the early diagnosis of TMJ damage. MRI is the only technique that allows the detection of bone marrow edema<sup>6</sup> and also an excellent evaluation of the articular disc and its supporting structures, joint fluid, synovial thickening, and bone changes (edema, erosion and morphology).<sup>8</sup> MRI effectively assists in various TMJ treatments and is important in monitoring structural changes that may occur in the TMJ, thus, allowing for adjustments in the clinical therapy.<sup>10</sup> The disadvantages of MRI include long periods of patient scanning, device noise, and discomfort due to need of maintaining the mouth open for the sequences to acquire the images.<sup>8</sup>

The most common observed image findings in the MRI of children are synovitis and effusion. If there is evolution in the condition, subchondral cysts, erosions, a decrease in the volume condyle process and anomalies on the morphology of the articular disc may be observed.<sup>4,6,11</sup> Moe et al., performed

a study with imaging findings of the TMJ of 87 healthy children. The tests were performed using 1.5 and 3T devices, standardized protocols, with or without contrast (Table 1). The following structures were observed with hypersignal: medullary bone of

the mandibular condyle in 70% of the cases (Fig. 1), articular fossa cortex in 64%, and condyle cortex in 56% (Fig. 2). The authors claim that the image findings of healthy children should present clinical correlation for correct diagnosis.<sup>4</sup>

**Table 1** | Imaging protocol used in some studies.

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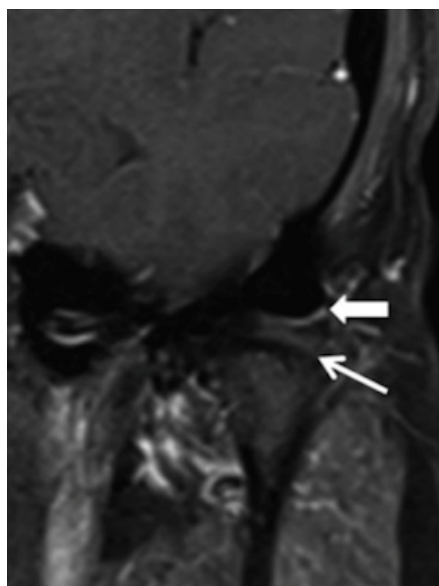
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			Navallas et al./2017	MR Imaging of the Temporomandibular Joint in Juvenile Idiopathic Arthritis: Technique and Findings	To provide a comprehensive review and update of the most relevant aspects of assessment for JIA, with emphasis on the MR imaging findings.	<table border="1"> <thead> <tr> <th colspan="11">MR Imaging protocol</th> </tr> <tr> <th>Sequence</th> <th>Contrast Material</th> <th>FOV (cm)</th> <th>Section Thickness (mm)</th> <th>Intersection Gap</th> <th>TR (msec)</th> <th>TE (msec)</th> <th>Frequency</th> <th>Phase</th> <th>NSA</th> <th>Time (min:sec)</th> </tr> </thead> <tbody> <tr> <td>Proton-density-weighted sagittal</td> <td>Precontrast</td> <td>12</td> <td>2</td> <td>0</td> <td>1500</td> <td>24</td> <td>256</td> <td>224</td> <td>3</td> <td>2:09</td> </tr> <tr> <td>Fat-suppressed T2-weighted sagittal</td> <td>Precontrast</td> <td>12</td> <td>2</td> <td>0</td> <td>3000</td> <td>85</td> <td>256</td> <td>224</td> <td>3</td> <td>2:12</td> </tr> <tr> <td>T1-weighted coronal</td> <td>Precontrast</td> <td>15</td> <td>2</td> <td>0</td> <td>400</td> <td>MinFull</td> <td>256</td> <td>224</td> <td>1.5</td> <td>4:03</td> </tr> <tr> <td>Fat-suppressed T1-weighted axial</td> <td>Postcontrast</td> <td>14</td> <td>2</td> <td>0</td> <td>375</td> <td>MinFull</td> <td>256</td> <td>224</td> <td>1.5</td> <td>4:15</td> </tr> <tr> <td>Fat-suppressed T1-weighted coronal</td> <td>Postcontrast</td> <td>12</td> <td>2</td> <td>0</td> <td>500</td> <td>MinFull</td> <td>256</td> <td>224</td> <td>3</td> <td>3:49</td> </tr> </tbody> </table> <p>Note - FOV = field of view, NSA = number of signals acquired, TE = echo time, TR = repetition time.</p>	MR Imaging protocol											Sequence	Contrast Material	FOV (cm)	Section Thickness (mm)	Intersection Gap	TR (msec)	TE (msec)	Frequency	Phase	NSA	Time (min:sec)	Proton-density-weighted sagittal	Precontrast	12	2	0	1500	24	256	224	3	2:09	Fat-suppressed T2-weighted sagittal	Precontrast	12	2	0	3000	85	256	224	3	2:12	T1-weighted coronal	Precontrast	15	2	0	400	MinFull	256	224	1.5	4:03	Fat-suppressed T1-weighted axial	Postcontrast	14	2	0	375	MinFull	256	224	1.5	4:15	Fat-suppressed T1-weighted coronal	Postcontrast	12	2	0	500	MinFull	256	224	3	3:49	
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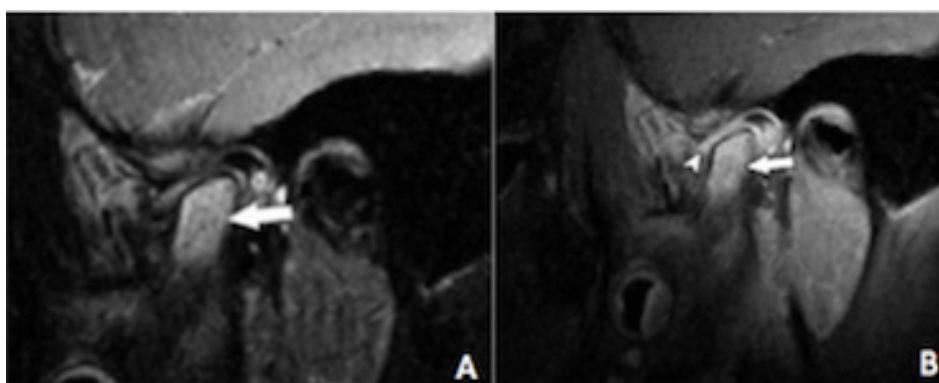
**Figure 1** | Coronal T1 fat-saturated post-contrast image shows condylar enhancement (arrow).<sup>3</sup>



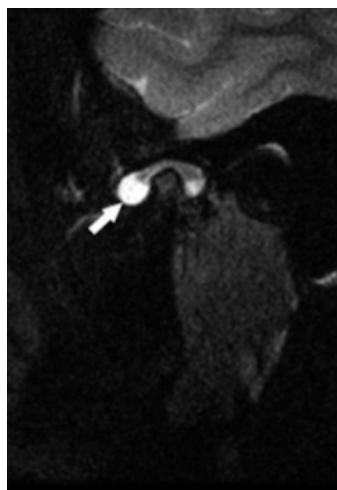
**Figure 2** | Coronal T1 fat-saturated post-contrast (right) images of the left temporomandibular joint show glenoid synovial enhancement (thick arrow) and condylar margin synovial enhancement (thin arrow).<sup>3</sup>

Juvenile idiopathic arthritis (JIA) is an autoimmune disease that affects the joints, especially the TMJ of children, which may cause chronic synovial inflammation with a high risk of progressive joint destruction, leading to important functional alterations. JIA starts before the age of 16, with a minimum duration of six weeks. MRI can detect the presence of osseous edema (Fig. 3), joint effusion (Fig. 4), bone erosion (Fig. 5), joint damage, and changes in the articular disc, which may correspond to the initial stage of the disease.<sup>6</sup> Therefore, the use of T1-weighted images after administration of the contrast material gadolinium, is mandatory for the correct diagnosis.<sup>6</sup> A T2-weighted sequence with fat saturation provides the

optimal assessment for joint fluid and edema within tissues.<sup>8</sup> One study showed that when 3T MRI devices were used with contrast, 87% of the children presented changes on the TMJ due to a disease, such as condylar erosion. This high percentage corresponds to the best condition of observing the articular disc and synovial changes.<sup>10</sup> In another study, 11 patients (12 TMJs) were evaluated following the protocols with and without contrast in an 1.5T device. The results showed that 71% of patients presented JIA and active synovitis (Fig. 6) in TMJs that were asymptomatic. Furthermore, 63% presented normal results in the physical examinations<sup>6</sup>, highlighting the importance of the early detection of these alterations, which will influence the treatment of these patients.<sup>12,13</sup>



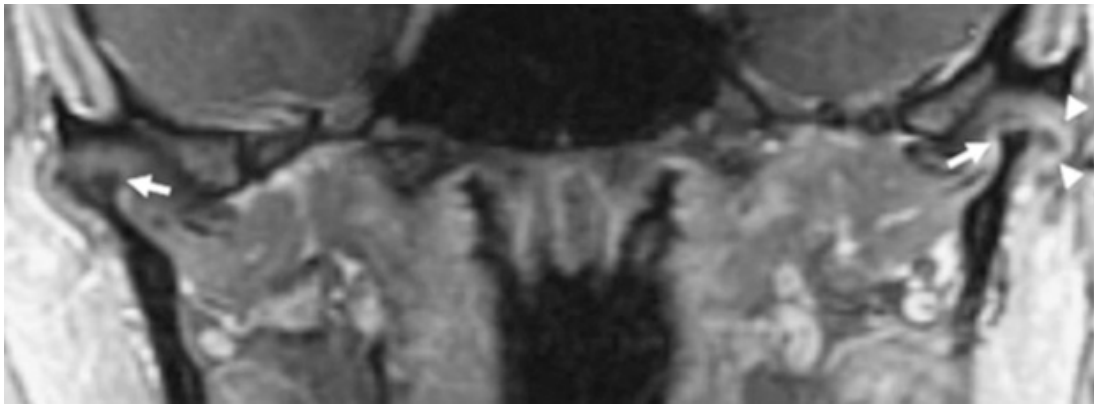
**Figure 3** | A: Sagittal oblique T2-weighted fat-suppressed image shows an edema-like signal intensity within the mandibular condyle (arrow). B: Sagittal oblique T1-weighted contrast-enhanced fat-suppressed image shows diffuse enhancement of the mandibular condyle (arrow) associated with active synovitis (arrowhead).<sup>5</sup>



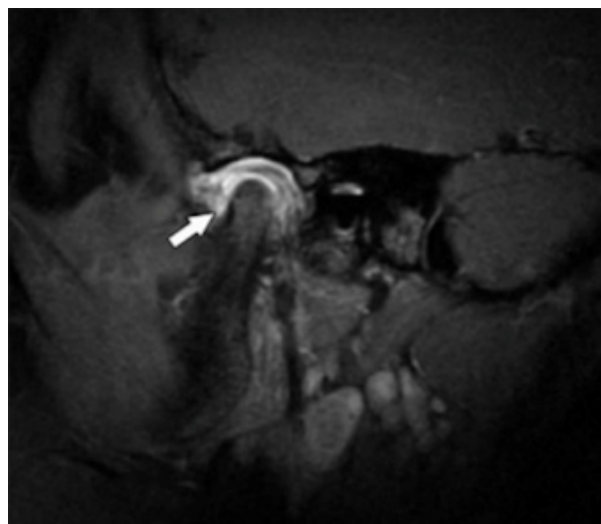
**Figure 4** | Sagittal oblique T2-weighted fat-suppressed image shows joint fluid (arrow) that clearly delineates the shape of the disk between the upper and lower joint spaces.<sup>5</sup>

The articular disc is composed of a fibrocartilaginous tissue with a biconcave shape, it is divided into an anterior band, a posterior band and the intermediate zone which is located between the articular eminence and the condyle. The disc is seen as a hyposignal in T1-, T2- and T2\*-weighted images.<sup>9</sup> Studies with asymptomatic children and adolescents present a prevalence of cases of joint disc displacement, which were verified using MRI produced by 1.5T devices. For T1, the images were observed in the sagittal and coronal sections of the condyles. The prevalence was of 6% in children with

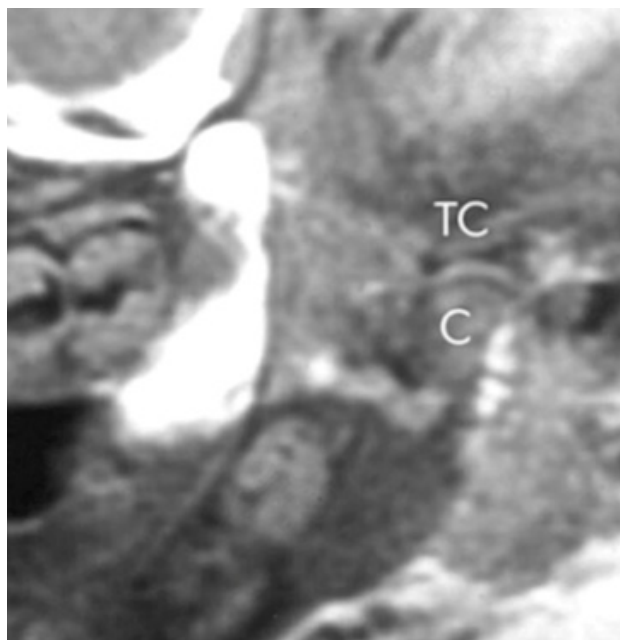
a mean age of 11 years and of 34% in adolescents with a mean age of 17 years.<sup>14,15</sup> Another study using T2 sagittal sectioned images obtained from an 1.5T device, showed that there is a minimum probability of joint disc displacement occurring in children younger than 5 years, due to the relatively flat morphology of the mandibular fossa and the small projection of the articular eminence (Fig. 7). Therefore, the authors believe that joint disc displacement may be an acquired anatomical condition, since the prevalence of this condition in adolescents is very similar to that of adults.<sup>16</sup>



**Figure 5** | Erosive deformity in the temporomandibular joint of a 16-year-old girl with JIA. Coronal T1-weighted contrast-enhanced MR image shows extensive bilateral erosive changes of both mandibular condyles (arrows). Both discs are severely attenuated. There is left temporomandibular joint synovial thickening and enhancement (arrowheads).<sup>7</sup>

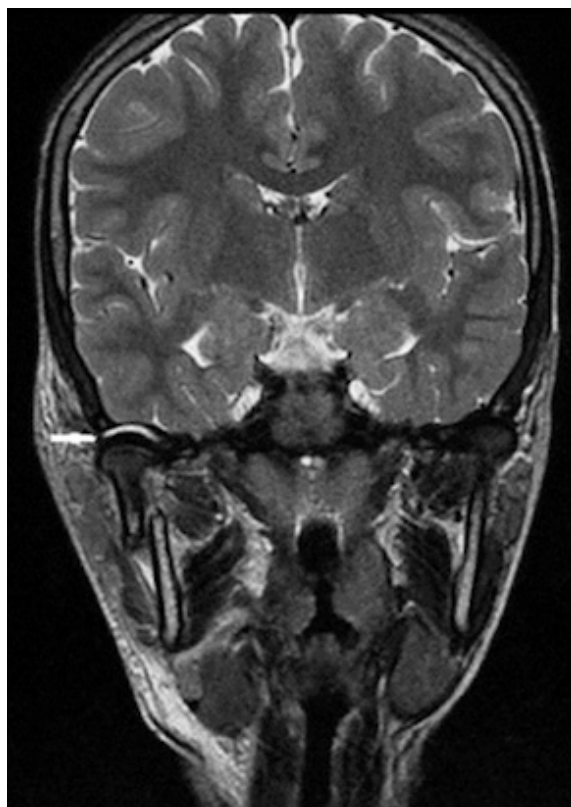


**Figure 6** | Sagittal oblique T1-weighted contrast-enhanced fat-suppressed image shows active synovitis.<sup>5</sup>

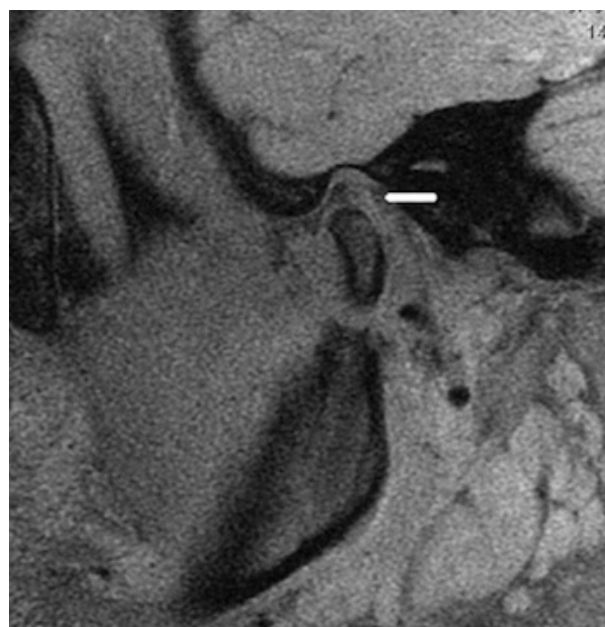


**Figure 7** | 2-month-old baby with normal TMJ disk position above the condyle (C). Temporal joint component (TC) is flat, with little articular eminence.<sup>13</sup>

TMJ ankylosis is a condition that may be associated with trauma (Fig. 8 and 9), local or systemic infections, untreated condyle fractures, congenital disorders or in some cases, it can be idiopathic. The clinical manifestation is a limitation of mouth opening, which can lead to the deformation of the mandible associated with facial asymmetry and occlusion problems.<sup>17,18</sup> This change can be complete, in which the condyle of the residual mandible and the joint fossa are completely fused, or partial, in which it is possible to distinguish the condyle from the rest of the joint. For the correct diagnosis and elaboration of an adequate treatment plan, it is necessary to evaluate the condition of the articular disc (shape, dimension and position). MRI associated with CT images, which are used to study the anatomical structures of the TMJ and its respective bone alterations, is the best image exam that provides this data.<sup>19,9</sup>



**Figure 8** | Coronal magnetic resonance image of a 13-year-old child showing a right subcondylar fracture and a tear of the joint capsule (arrow).<sup>6</sup>



**Figure 9** | MRI of a 12-year-old child with a condyle fracture showing an anteriorly displaced disc (arrow).<sup>6</sup>

## CONCLUSION

Assessments using MRI images of the TMJs of children cause the diagnosis to be more accurate and objective. Therefore, it allows the alterations to be detected in the early stages of juvenile idiopathic arthritis. Using 3T MRI devices with contrast implies a better prognosis and treatment. In cases of condyle and ankylosis fractures, MRI seems to be satisfactory, however, the association with CT images is essential for the conclusion of the diagnosis.

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