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Does the use of panoramic radiography add information in the temporomandibular joint evaluation in Juvenile Idiopathic Arthritis patients? A case control study

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Abstract

Objective To determine the frequency of radiographic changes in the temporomandibular joint, in a representative population of patients with Juvenile Idiopathic Arthritis (JIA) and to compare with findings in healthy controls matched by sex and age.

Patients and Methods One hundred and thirty-seven panoramic radiographies (PR) from JIA patients of a pediatric rheumatology outpatient clinic were prospectively evaluated and compared to 137 PR from healthy individuals.

Results 102 (74.5%) JIA patients and 47 (34.3%) controls showed at least one radiological alteration ($p < 0.001$). The following radiographic alterations were more frequently observed in JIA patients than in controls: erosion ($p < 0.001$), altered condylar morphology ($p < 0.001$), disproportion between condylar process and the coronoid process ($p < 0.001$) and accentuated curve in the antegonial notch ($p = 0.002$). Twenty patients (14.6%) presented the four radiographic alterations simultaneously compared to only two controls (1.5%) ($p < 0.001$).

Conclusion Due to the difference in the frequency of findings in the PR of patients and controls, we concluded that PR has value as a screening tool. In the presence of major changes in the mandible head in the PR of patients with a confirmed diagnosis of JIA, MRI should be considered to detect an active inflammatory process in this joint.

Keywords Panoramic radiography, Juvenile idiopathic arthritis, Rheumatic diseases, Diagnostic imaging, Temporomandibular joint

Introduction

Juvenile Idiopathic Arthritis (JIA) is a chronic inflammatory disease that develops before age 16 and is characterized by persisting arthritis in at least one joint for at least six weeks. JIA is characterized by chronic synovitis and extra-articular manifestations and is diagnosed according to the criteria established by the International League of Associations for Rheumatology (ILAR) [1]. JIA prevalence in the city of Sao Paulo (Brazil) is 1.96 of 1000 schoolchildren from 1 to 16 years old [2].

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Temporomandibular joint (TMJ) involvement has been reported in 17–87% of all JIA patients [3]. Although TMJ arthritis can be asymptomatic, it can result in facial growth alterations [4].

Panoramic radiography (PR) of the mandible is a two-dimensional imaging method that uses a low dose of radiation and provides an overview of the teeth and bones of the lower third of the face, including the TMJ [5]. Unlike other imaging methods, it is inexpensive, with wide availability, and does not require sedation in young children [6].

Contrast-enhanced magnetic resonance imaging (MRI) is considered the reference standard for detecting early inflammatory changes and other soft tissue abnormalities in the TMJ, [7, 8] but PR can be used as an initial screening of TMJ involvement [9].

Several studies have found TMJ alterations in JIA patients using PR as an imaging method [10–15]. However, the radiographic evaluation of the presence of erosion and altered condylar morphology associated with disproportion between condylar process (COP) and the coronoid process (CRP) and accentuated curvature in the antegonial notch have not been addressed in the literature. Also, few studies have included a control group that helps in the assessment of pathological changes [16].

Because PR is routinely used during dental care in pediatrics, it would be important to determine the identifiable characteristics in this type of imaging that could indicate TMJ alterations resulting from an inflammatory process. Therefore, this study aimed to determine the frequency of radiographic changes in the TMJ in a representative population of subjects with JIA and to compare with findings in healthy controls matched by sex and age.

Patients and methods

This was an observational study that included JIA patients, according to the ILAR criteria [1], classified as polyarticular, oligoarticular, and systemic JIA subtypes regardless of treatment and disease activity status, who were followed between 2007 and 2017 and had a PR in their medical records. The control group was composed of healthy individuals that underwent a routine dental examination in a private clinic. Individuals in the control group were matched by age and sex. Participants with a previous history of orthodontic treatment or orthognathic surgery, facial trauma, were excluded, as well as those whose PR did not allow a complete view of both TMJ. The control group participants who presented any systemic disease or, facial trauma were also excluded. (Diagram 1). The Research Ethics Committee of our institution approved this study.

Methods

Demographic data

The following demographic data were obtained from the patient's records by a specialist in pediatric dentistry and temporomandibular disorders (TMD) and orofacial pain with experience in rheumatic disease (LMFZ) supervised by a pediatric rheumatologist (MTT): sex, current age at the time of the radiography, age at disease onset, JIA subtype classified as polyarticular, oligoarticular and systemic, disease duration and assessment of disease activity at the time of radiography. Disease activity status was evaluated as active and inactive, according to Wallace et al. [17]. Disease duration was defined as the time from the JIA diagnosis, made by a pediatric rheumatologist, to the date of radiography.

Radiographic images

One hundred and thirty-seven PR (274 TMJ) from JIA subjects of a pediatric rheumatology outpatient clinic (study group) were evaluated and compared to 137 PR (274 TMJ) from healthy individuals (control group). The exams in printed films were analyzed using a negatoscope by a radiologist (VLMR) specialized in TMD and orofacial pain, who was blind to which group the participants belonged. These aspects were observed in a dichotomous way: (1) the condylar morphology classified as altered or preserved [14], (2) the presence or absence of discontinuity in the condyle cortical classified as presence or absence of erosion [18], (3) the proportion between the height of the condylar process (COP) and the coronoid process (CRP) classified as preserved or altered [19], and (4) the curvature of the antegonial notch classified as accentuated or not according to the literature (Fig. 1) [20].

Statistical analysis

The frequency of radiographic changes was estimated from the rate of presence and absence of findings in both groups using the chi-square or Fisher test for categorical variables. Calculations of sensitivity, specificity, positive and negative predictive values were performed. Multiple logistic regression analysis was presented with the variables to verify statistical significance in the association test. The estimated risk measure was the odds ratio (OR) (SPSS Package, GLM, v22.0 for Windows; SPSS Inc., Chicago, IL). The level of statistical significance was $p \leq 0.05$.

Results

Table 1 shows the demographic and clinical data of patients and controls.

The following radiographic alterations were more frequently observed in JIA patients than in controls: erosion ($p < 0.001$), altered condylar morphology ($p < 0.001$),

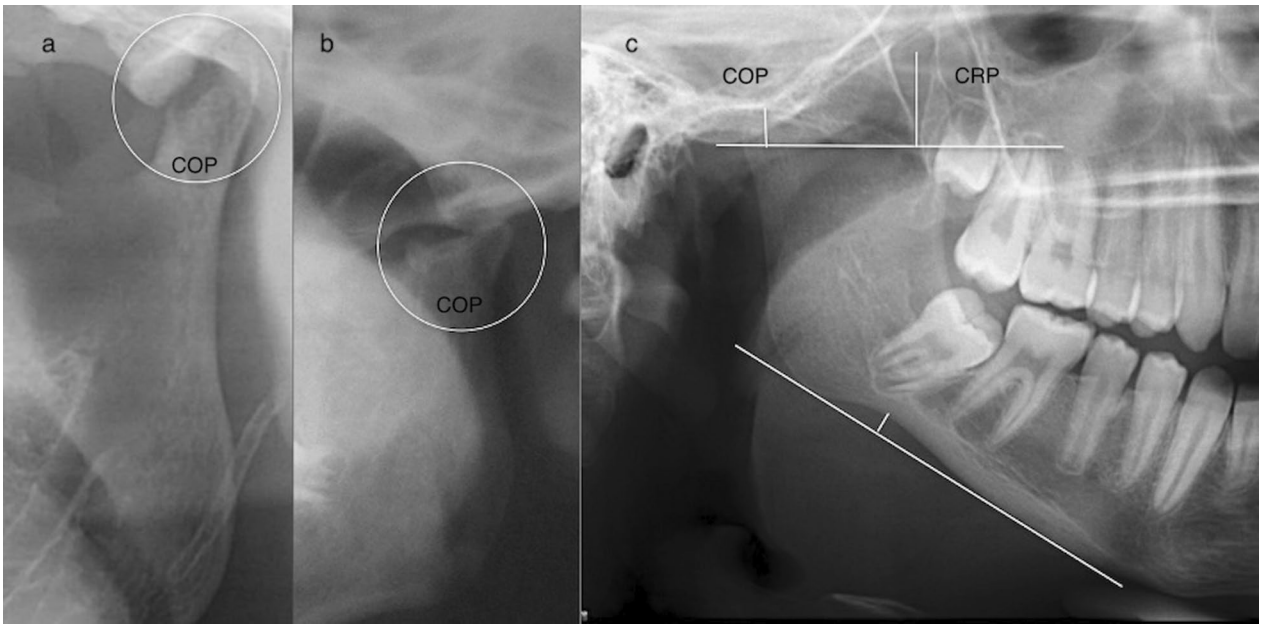

Fig. 1 **a** demonstrated the erosion in mandibular head; **b** totally disform mandibular head; and **c** the depth of the curvature of the antegonial notch and the disproportion between the height of the condylar process (COP) and the coronoid process (CRP)

Table 1 Demographic data of patients with juvenile idiopathic arthritis and control group and clinical data of patients

Female N (%)	**Patients (137)**		**Controls (137)**		**p value**
	106	**(77.4)**	**106**	**(77.4)**	**1.000**
Age at evaluation mean (± SD)	12.07	(± 4.4)	12	(± 4.3)	0.97
Age at diagnosis mean (± SD)	4	(± 3.6)			
Disease duration mean (± SD)**	7	(± 4.3*)			
JIA[a] subtype Polyarticular N (%)	88	(64.2)			
JIA[a] subtype Oligoarticular N (%)	37	(27.0)			
JIA[a] subtype Systemic N (%)	12	(8.8)			
Disease Activity N (%)	75	(54.7)			

*in one patient the data was unknown

JIA[a]—Juvenile Idiopathic Arthritis

**in years

Table 2 Radiographic changes in panoramic radiographs of patients with juvenile idiopathic arthritis and control group

	Patients (137)		**Controls (137)**		**p Value**
	N	**%**	**N**	**%**	
Erosion	46	33.6	12	8.8	< 0.001
Altered condylar morphology	72	52.6	10	7.3	< 0.001
Disproportion between COP[a] and CRP[b]	75	54.7	25	18.2	< 0.001
Accentuated antegonial notch	47	34.3	24	17.5	0.002
Presence of any alteration	102	74.5	47	34.3	< 0.001
Presence of all alterations	20	14.6	2	1.5	< 0.001
No alterations	35	25.5	90	65.7	< 0.001

[a] condylar process (COP) and the [b]coronoid process (CRP)

disproportion between COP and CRP ($p < 0.001$) and accentuated curve in the antegonial notch ($p = 0.002$). The patients showed a higher frequency of presence of any radiographic alteration (74.5% vs. 34.3%, $p < 0.001$). Twenty patients (14.6%) presented the four radiographic alterations simultaneously compared to only two controls (1.5%) ($p < 0.001$). (Table 2).

Table 3 shows the different sensitivities and specificities, as well as the positive and negative predictive values (PV) of the presence of radiographic changes, either alone or in association. The radiographic finding with the highest sensitivity was the disproportion between the COP and CRP (53% and positive PV 74%). The most specific result was the altered condylar morphology (92% and negative PV 66%). However, the presence of the four changes showed a 98% specificity and a sensitivity of 14%.

Table 4 shows the logistic regression of the variables assessed on the PR. We observed that the presence of erosion, altered condylar morphology, disproportion between COP and CRP, and accentuated curve in the

Table 3 Sensitivity, specificity, positive predictive value and negative predictive value of radiographic changes in patients with juvenile idiopathic arthritis and control group

	Sensitivity	CI 95%	Specificity	[c]CI 95%	+[d]PV	[c]CI 95%	-[d]PV	CI 95%
Erosion	0.34	(0.25–0.42)	0.91	(0.85–0.95)	0.79	(0.66–0.88)	0.58	(0.50–0.64)
Altered condylar morphology	0.52	(0.43–0.61)	0.92	(0.86–0.96)	0.87	(0.78–0.93)	0.66	(0.58–0.72)
Disproportion between COP[a] and CRP[b]	0.53	(0.46–0.63)	0.81	(0.74–0.87)	0.74	(0.65–0.83)	0.64	(0.56–0.71)
Accentuated antegonial notch	0.34	(0.26–0.42)	0.82	(0.75–0.88)	0.66	(0.53–0.77)	0.55	(0.48–0.62)
Presence of all alterations	0.14	(0.09–0.21)	0.98	(0.94–0.99)	0.90	(0.70–0.98)	0.53	(0.47–0.59)
No alterations	0.25	(0.18–0.33)	0.34	(0.26–0.35)	0.28	(0.20–0.35)	0.31	(0.24–0.39)

[a] condylar process (COP) and the [b]coronoid process (CRP) [c]CI—confidence interval; + [d]PV—positive predictive value and -[d]PV—negative predictive value

Table 4 Logistic regression of the variables assessed on the panoramic radiograph of patients with juvenile idiopathic arthritis and control group

Variable	OR	IC95%	p
Erosion	5.26	(2.64–10.50)	< 0.001
Altered condylar morphology	14.07	(6.80–29.07)	< 0.001
Disproportion between COP[a] and CRP[b]	5.42	(3.13–9.38)	< 0.001
Accentuated antegonial notch	2.46	(1.39–4.32)	0.002

[a] condylar process (COP) and the

[b] coronoid process (CRP)

antegonial notch, increases from 2.4 to 14 times the likelihood of these findings being related to JIA.

Discussion

This study shows that several changes in the PR of JIA subjects (erosion, altered condylar morphology, the disproportion between COP and CRP, and accentuated curve of antegonial notch) were statistically more frequent in patients than in control subjects. We observed different sensitivities and specificities depending on the radiographic alteration; however, the disproportion and the altered condylar morphology were the most sensitive findings, and the presence of altered condylar morphology and erosion the most specific. The presence of several alterations in the PR increased the likelihood of these findings being related to JIA, to varying degrees.

These TMJ changes are often asymptomatic, which means that they could not be considered as involved in the JIA patient's clinical evaluations. This can lead us to classify the patient as having oligoarticular JIA when, in reality, he would present polyarticular subtype if we consider this involvement or to classify the patient as inactive when he presents TMJ active involvement. However, it is worth noting that even if alterations are present on the patient's PR, this should not be considered sufficient to change their status from "inactive disease" to "active disease". The changes found on the PR may reflect disease activity, or alternatively, represent sequelae of previous inflammatory status. This study tried to answer questions that are still poorly defined: How often these frequent alterations in PR of JIA subjects are present in healthy children? Which changes or combinations among them are specifically associated with TMJ involvement in JIA? Once these alterations or combinations are present, in which cases is there a justification for a referral to a pediatric rheumatologist?

We observed that alterations in the PR of subjects with JIA are persistent findings. When comparing to the control group, we found a difference in all the evaluated findings, which shows that these changes are rarely present in images of healthy individuals. This observation agrees with other studies that found PR alterations in only 6 to 20% of the control participants [11, 16].

We found low sensitivity and high specificity of the presence of these radiographic alterations. This trend is accentuated when we associated two, three, and even four findings in the same participant. It means that many patients with JIA will not have identifiable alterations in their PR, but when these findings are present there is a higher likelihood of being related to JIA. Our findings are in agreement with those of Im et al. [21]. They demonstrated in adult individuals that PR had limited diagnostic accuracy and acceptable reliability in the TMJ's detection of bone lesions [21].

In the logistic regression, it is evident that alterations in PR are factors to be considered since individuals with the presence of erosion, altered condylar morphology, disproportion between CRP and COP and accentuated curve of antegonial notch are more likely to be patients than controls. We propose that PR should be used as a diagnostic tool for assessing TMJ, always considering its limitations, but using it as an important tool that indicates a higher likelihood of being a patient than a variation in normality.

The rationale of this study was based on the advantages of PR (low cost, low dose of radiation exposure, and ease of access), turning this imaging into an important screening tool. However, it has limitations related

to early structural changes, as it can only detect them at a later stage.

In a survey of 87 centers on how pediatric rheumatologists diagnosed TMJ involvement in JIA subjects, 33 centers answered that they still used PR, although the low sensitivity of this imaging modality to identify early changes in TMJ arthritis is well known [22]. This study showed that for 24.6% of the professionals, PR was the first imaging option.

Although MRI is considered the gold standard in the diagnosis of early TMJ involvement in JIA patients [7, 8], the study of Abramowicz et al. [23] shows that the presence of alterations in the condylar morphology in PR is highly sensitive and specific and could reflect the occurrence of synovitis in MRI. These authors compared PR findings with TMJ contrast-enhanced MRI findings. The combination of altered condylar morphology and accentuated curve of antegonial notch in the PR was correlated with the presence of synovitis in the MRI. It confirms the importance of using this imaging modality [23]. The use of MRI in detecting active inflammatory process in this joint is essential, in the presence of significant changes in the mandible head, on the PR of subjects with a confirmed diagnosis of JIA.

We have as strengths of this study the sample size, its prospective nature, and the presence of a control group.

Conclusions

We conclude that PR has value as a screening tool for JIA subjects due to the difference in the frequency of findings in the PR of patients and controls. Although this type of image cannot demonstrate any active inflammatory process [10], it can be useful in patients with JIA because it allows an assessment of the morphology of the TMJ's mineralized structures. In the presence of significant changes in the mandible head in the PR of subjects with a confirmed diagnosis of JIA, MRI should be considered to detect an active inflammatory process in this joint.

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Author contributions
All authors have contributed to the development of this study and this manuscript and have read and approved the final manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical approval and consent to participate
The Research Ethics Committee of our institution approved this study (Ethics Committee Number: 1.658.738).

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests related to the content of this manuscript.

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