

# Correlation of temporomandibular joint clinical signs with cone beam computed tomography radiologic features in juvenile idiopathic arthritis patients

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## SUMMARY

**Objective.** Patients with juvenile idiopathic arthritis (JIA) have a high risk of temporomandibular joint (TMJ) involvement. Early detection of osseous destruction of the TMJ that can be seen radiographically is vital to provide appropriate treatment before significant craniofacial deformities and problems with occlusion arise. The aim of study was to evaluate whether there is a correlation between the clinical signs and cone beam computed tomography (CBCT) radiologic features of TMJ in patients with JIA.

**Material and methods.** Study group consisted of 65 patients (46 females and 19 males) aged 10 to 17 years with a confirmed JIA diagnosis and mean disease duration 2 years 9 month, all patients underwent a clinical examination of the TMJ and masticatory muscles as well as a radiological assessment of the TMJ osseous structures by CBCT.

**Results.** Majority of the patients' study population experienced 2 or 3 clinical signs with mean number 2.1 (standard deviation (SD) =1.00) and 3-5 radiological features related to the TMJ destruction with mean number 4.9 (SD=1.96). Statistically significant weak correlation only between pain and condyle surface flattening (Spearman's Rho test ( $\rho$ ) =0.396; p value (p) =0.001) was found. No correlation between number of clinical signs and radiological features was found.

**Conclusions.** There was no conclusive evidence found regarding correlation between TMJ clinical signs and radiological features of osseous destruction in patients with JIA – only weak correlation between pain and condyle surface flattening was observed. The number of clinical TMJ signs does not correlate with number of radiological features. For the clinical decision both clinical examination and CBCT would be useful in the early detection of osseous destruction of the TMJ in JIA patients.

**Keywords:** Cone beam computed tomography, juvenile idiopathic arthritis, temporomandibular joint, clinical signs, radiologic features.

## INTRODUCTION

Juvenile idiopathic arthritis (JIA) is a common rheumatic disease amongst children. When JIA affects the temporomandibular joints (TMJ), it erodes the articular fibrocartilage and subsequently erodes bone, causing a condylar destruction (1). Mandibular development initiated by a layer of cells located into the growth cartilage which is located directly under the joint surface plays an important role by regulating the bone formation in intramembranous

and endochondral ossification of the mandible (2), it also leads to pathological changes in the TMJ, impacts craniofacial growth and length of the ramus and dento-alveolar abnormalities (3, 4).

Magnetic resonance imaging (MRI) is considered for diagnosing early involvement of the TMJ in patients with JIA (5) and diagnosing arthritic inflammatory signs in soft tissues before hard tissue damage has occurred (6).

A relatively new and promising radiologic examination method for the osseous structures of the TMJ in JIA patients is cone beam computed tomography (CBCT) (7), its imaging modality has been found to be superior than conventional radiographical examinations as well as MRI for assess-

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ment of the osseous destructive changes in TMJ (8).

Structural changes in the TMJ in children and adolescents with JIA encompass a collection of distinct clinical symptoms and signs. The clinical signs associated with inflammation of the TMJ include pain during function, crepitation, clicking and limited mouth opening. Early diagnosis of disease activity on the TMJ is more difficult than in other joints affected by JIA because the clinical symptoms can be very subtle (9). This highlights the insufficiency of relying solely on clinical symptoms and signs for determining the presence of osseous destruction in the TMJs of patients with JIA (10, 11). Nevertheless, clinical examination in JIA is recommended for monitoring patients in clinical practice and research (12).

The aim of this study is to evaluate whether there is a correlation between evaluated clinical signs and CBCT radiologic features of the osseous destructions of the TMJ in patients with JIA, thus encouraging the clinician to pay more attention to this joint during clinical and radiologic examinations. This will aid in early detection of the osseous destruction of the TMJ that is seen radiographically despite the subtlety of the clinical symptoms or absence of signs and complaints. Thus, appropriate treatment can be initiated before significant craniofacial deformities and problems of the occlusion arise.

## MATERIALS AND METHODS

This is a cross-sectional observational study of pediatric patients with a confirmed JIA diagnosis according to the International League of Associations for Rheumatology (ILAR) (13) criteria. Patients with a clinical TMJ symptoms and positively confirmed by MRI findings were referred by the Paediatric Clinical University Hospital's Rheumatology Department to the Orthodontic Department of the University Institute. The referral was made to run examination of the TMJ, there were no specific criteria of the JIA. All children received specific JIA therapy. Out of 133 patients referred to the orthodontic clinic over specific time period 2009-2013 in the study group were included 65 patients – 46 females and 19 males with the inclusion as follows:

- ages between 10 and 17 years
- TMJ clinical signs
- parental consent to undergo a CBCT scan.
- acceptance of regular subsequent follow-up and orthopaedic or orthodontic treatment, if necessary.

Exclusion criteria were:

- incomplete/non-sufficient clinical and CBCT examination due to various reasons
- patients with previous orthopaedic or orthodontic treatment.

Two calibrated orthodontists for the TMJ examination in the Orthodontic Department subsequently examined these patients after their referral. The clinical examination was performed to determine pain in the masticatory muscles (*m. temporalis*, *m. masseter*, *m. pterygoideus lateralis* and *m. pterygoideus medialis*) by palpation and affirmation by the patient. Pain refers to patient-reported pain from palpation of masticatory muscles, pain in the TMJ region upon opening and closing of the mouth and general pain in the TMJ region. Clicking and crepitation during mouth opening and closing were noted, and the maximal mouth opening was measured to determine whether it was limited (<45 mm). All clinical signs, including pain, were documented as present/absent. After the clinical examination CBCT scans were taken to evaluate complex craniofacial patterns and determine any radiologic osseous destruction in the TMJ.

For the CBCT images, the data were processed and analysed with I-CAT Vision equipment (Imaging Sciences International, Inc. Hatfield, PA, USA). The equipment used a standardised protocol: voltage, 120 KV; current, 38 mA; field of view, 17 cm; resolution, 0.4 voxels; radiation dose, 36 µSv; and slice thickness, 0.4 mm, exposure time 4 seconds.

The radiologic features of the osseous structures of the condyle, fossa/eminence and position of condyle were assessed in the sagittal, coronal and axial planes in the CBCT image. The radiological examination was blinded to the clinical assessment of the patients. Criteria of the assessment of osseous destruction in the TMJ for image analysis were performed according to the Research Diagnostic Criteria for Temporomandibular Disorders. Disorder parameters described by Dworkin and Ahmad *et al.* (14, 15) for the inflammatory condition in the joint that results from a degenerative condition that generates abnormal joint form and structure. According to the aforementioned articles, articular surface flattening refers to the loss of the rounded contour of the surface of the condyle. Surface erosion indicates the loss of continuity of the articular cortex of the condyle, and osteophytes refer to the marginal hypertrophy with sclerotic borders and exophytic angular formation of osseous tissue rising from the surface of the condyle. Assessed radiological signs were coded for further analysis as present/absent.

The data were entered in Microsoft® Excel®

spread sheets and processed by Statistical Package for the Social Sciences software (SPSS) (version 17.0, SPSS Inc., Chicago, IL, USA).

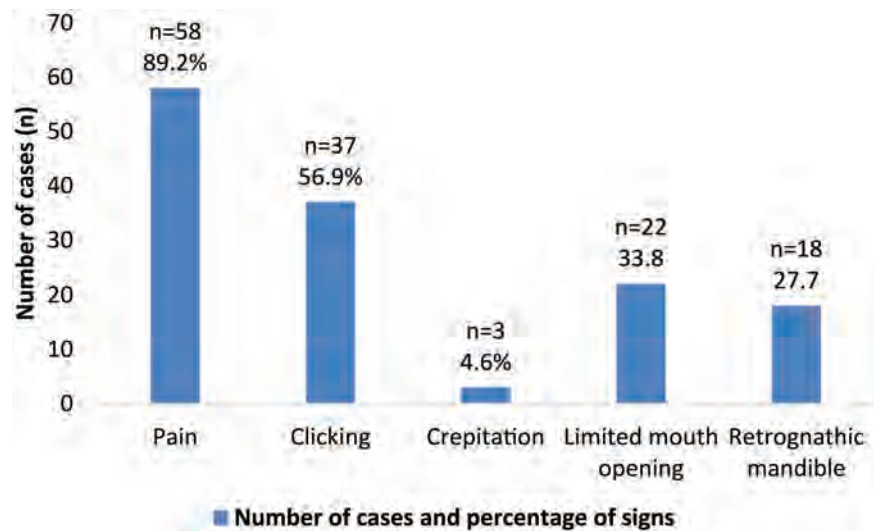
To determine the correlation between the radiologic features of the osseous structures of the TMJ and clinical signs and its statistical significance, the Spearman rank correlation coefficient with Bonferroni correction was calculated. P value less than 0.05 was chosen as a significance level. Intra-examiner agreement with a two-week interval between each evaluation of the CBCT scans was calculated by the Cohen's kappa coefficient.

This study was approved by the Ethics Committee of Riga Stradins University (decision accepted with the specifications in the Declaration of Helsinki).

## RESULTS

The characteristics of the study population are described in Table. The most prevalent diagnosis was seronegative polyarthritis. The mean disease duration was 2 years and 9 months. Of the 65 patients the most frequent sign, pain, was reported in 58 (89.2%) patients (Figure 1). Majority of the patients experienced 2 or 3 clinical signs (Figure 1). Mean number of clinical signs in study population was 2.1 (SD=1.00). All patients exhibited radiological features of osseous destruction related to the TMJ. In the majority of patients 3-5 radiological features were observed (Figure 2). Mean number of radiological features of osseous destruction related to the TMJ was 4.9 (SD=1.96). The most prevalent feature was condyle surface flattening in 62 (95.4%) of the patients, followed by condyle surface erosion in 48 (73.8%) patients, and osteophytes were found in 30 (46.2%) patients (Figures 3-5). Regarding the articular fossa, the most frequent radiological feature was fossa surface flattening, which was observed in 18 (27.7%) of the patients. The most prevalent condyle position was concentric with enough joint space, which was observed in 24 (36.9%) patients (Figure 2).

A statistically significant weak correlation only between pain and condyle surface flattening ( $\rho=0.396$ ;  $p=0.001$ ) was found. No correlation between number of clinical signs and radiologi-



**Fig. 1.** Distribution of the frequency of the clinical examination signs of TMJ in JIA patients. *Note:* One patient might have several clinical signs.

cal features was found. Patients with more clinical signs did not have more radiological features of TMJ destruction.

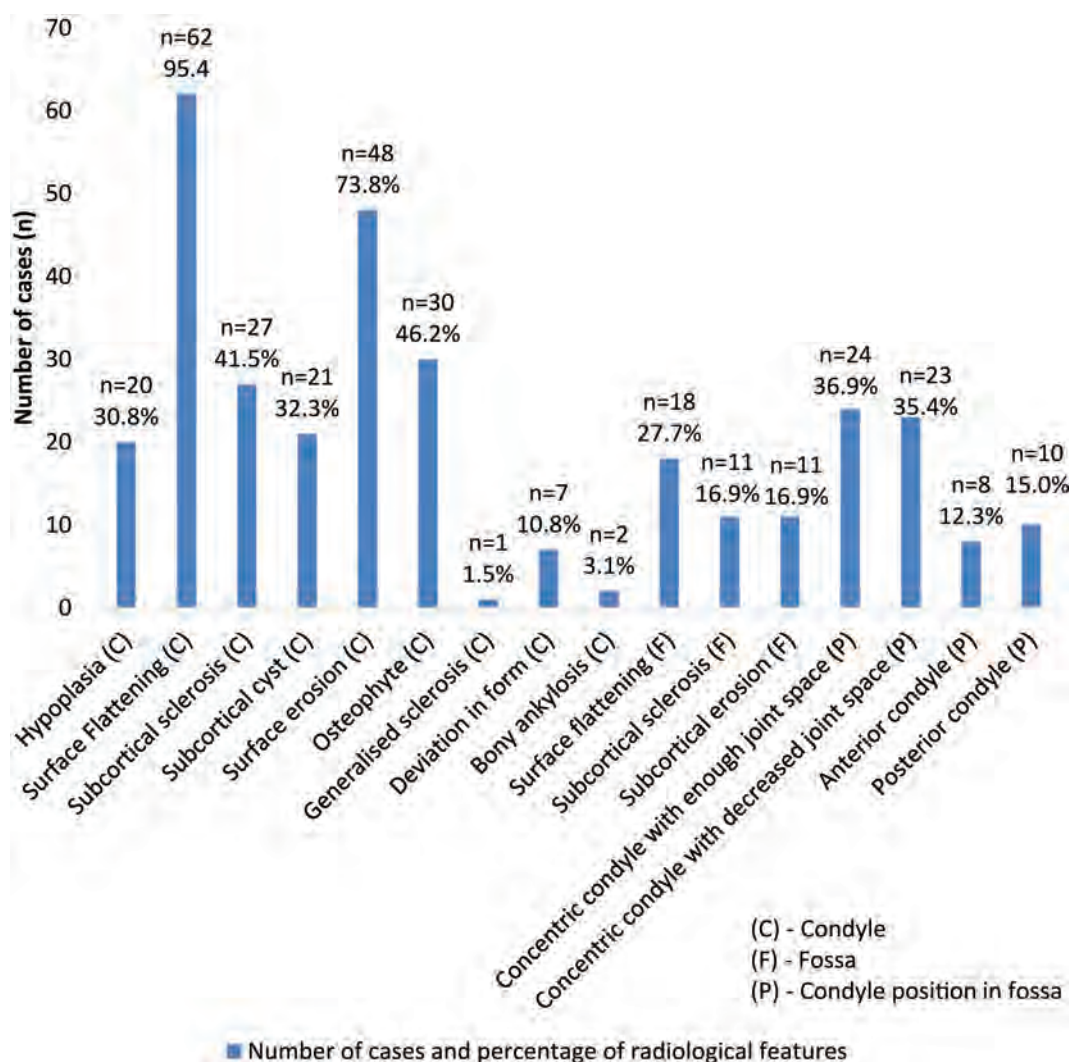
The kappa value was calculated at 0.834, which indicates an almost perfect agreement between the two evaluations.

## DISCUSSION

There are several limitations of the present study that may influence interpretation of the results. Since the referral of all pediatric JIA patients from Pediatric Clinical University Hospital's Rheumatol-

**Table.** Main characteristics of the study population

Variable	N=65
Gender (%)	
• Females	46 (70.77%)
• Males	19 (29.23%)
Mean age, years (SD)	14.2 years-old (SD 1.89)
JIA diagnosis (%)	
• Enthesitis-related subtype	10 (15.38%)
• Oligoarthritis extended subtype	3 (4.62%)
• Polyarthritis seronegative subtype	50 (76.92%)
• Polyarthritis seropositive subtype	1 (1.54%)
• Systemic subtype	1 (1.54%)
Mean time elapse between diagnosis and iCAT, months (SD)	17.4 months (SD 26.42)
Duration of disease, years (SD)	SD 2.9
Number of clinical symptoms of TMJ and masticatory muscles combined in patients (%)	
• None	4 (6.15%)
• One symptom	12 (18.46%)
• Combination of two clinical symptoms	27 (41.54%)
• Combination of three clinical symptoms	17 (26.15%)
• Combination of four clinical symptoms	5 (7.69%)



**Fig. 2.** Distribution of the frequency of the clinical examination signs of TMJ in JIA patients. *Note:* One patient might have several clinical signs.

ogy Department to the Orthodontic Department of the University Clinic was voluntary, substantial part of asymptomatic patients did not attend Orthodontic clinic. Therefore, this study population tends to reflect the status of patients with different level of complaints regarding TMJ.

It is also known, that the extent of TMJ destruction depends greatly on the duration of the disease (16). In our study time between confirmation of JIA diagnosis and the CBCT for each patient varied, which could have affected the extent of the clinical symptoms as well as the degree of severity of the radiologic characteristics that were observed.

Polyarticular and early-onset arthritis carry a high risk of TMJ involvement, and severe condylar bone loss can be expected (16). This was found among our sample to an extent, because the majority of the patients had a polyarticular subtype of JIA.

MRI is regarded as the gold standard for the early diagnosis of TMJ involvement in the JIA because of its ability to detect soft-tissue alterations

during the early stages of the disease (17) therefore the investigation was performed in all patients included in the presented study.

CBCT is important for early detection and a more accurate diagnosis of the osseous changes in the TMJ without obstruction from overlapping anatomic structures, which is why this method was used when carrying out the radiologic examination of osseous alterations of the TMJ in our patient group. Another advantage of the CBCT is the low radiation dose, which is up to 98% lower than conventional computed tomography

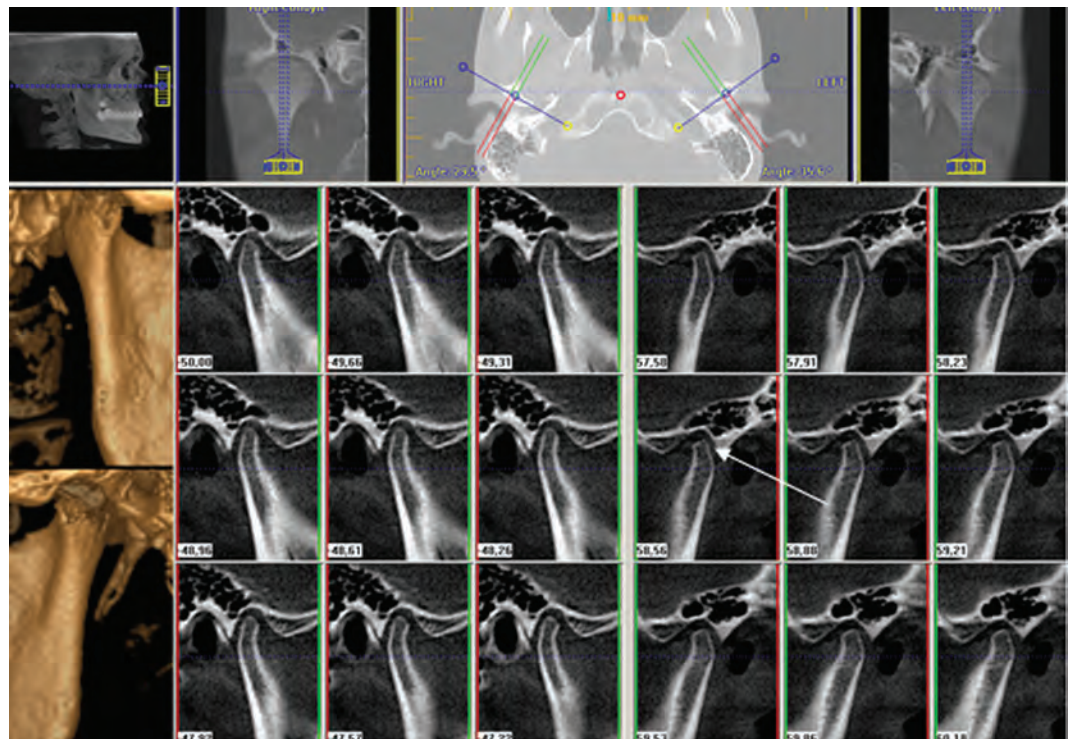
and equals 3 to 7 times the dose of an OPG (18). According to the literature, the effective radiation doses of CBCT fall into a considerably wide range, from 19 microsieverts ( $\mu$ Sv) to 1073  $\mu$ Sv. The patient radiation dose is closely related to the field of vision (FOV) and exposure parameters used for a CBCT examination. Without alteration of any other exposure parameters, the larger the FOV used for scanning, the higher the radiation dose (19). This dose range depends on the device. The lower end of the range can be achieved by taking a 13 cm CBCT that would only show the condyle head and ramus, thus excluding the rest of the mandible, and this not depict mandibular asymmetry accurately. However, a CBCT image of 17 cm is useful for both cephalometric data and OPG view and TMJ reconstruction.

The literature data reveal that the condyle head is more often affected, followed by the articular fossa in JIA patients (20, 21). The most common radiographic features of TMJ osseous destruction

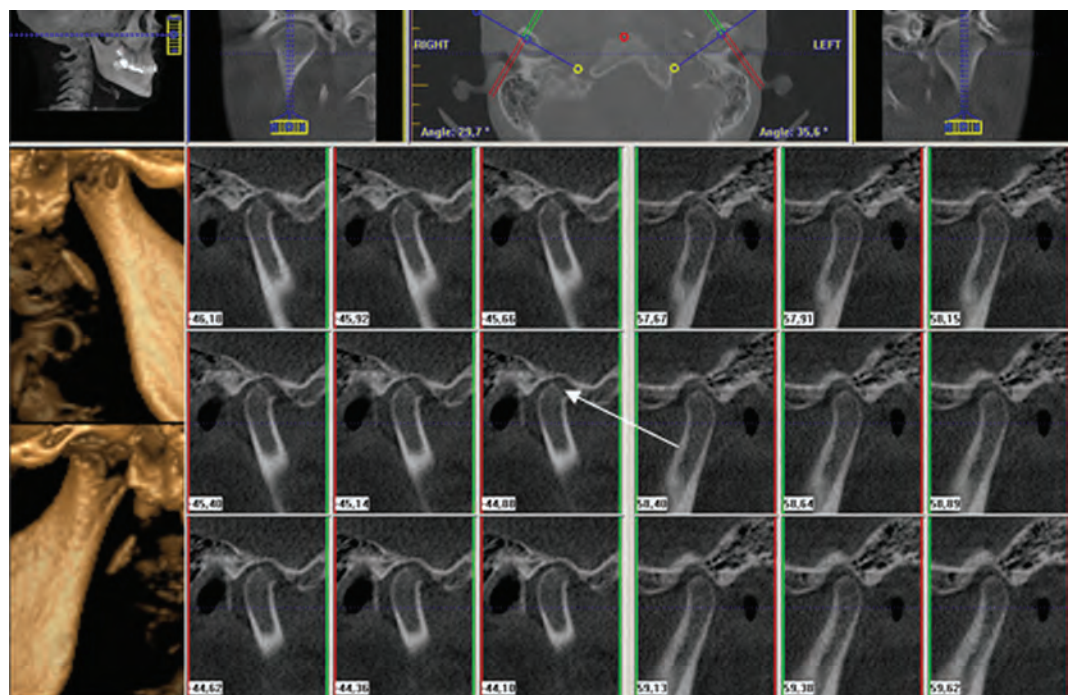
as degenerative disease caused by inflammation in JIA patients in our study were condyle surface flattening, erosion and osteophytes. In the literature data as destruction, erosion and resorption are frequently found expressions of the bone damage; often these result in a remodelling of the condyle with both bone-destructive and bone-productive changes, and the abnormal bone shape could be considered a form of growth disturbance within the TMJ as a response to the inflammatory activity (10). Radiographically visible condylar lesions seem to be the major factor that influences mandibular growth. The condyle head is more often affected, followed by the articular fossa (1, 20, 21). These features were also demonstrated in our study.

If to compare our results with a study conducted by Ferraz *et al.*

(20) where 15 JIA patients were included at the age range from 6 to 28 years with mean disease duration of 13 years and 7 months, there was detected that the frequency of bone alterations in CBCT scan slices of 1 mm thick was 66.6% of TMJs presented with condyle flattening. Our sample showed 95.4% out of 65 patients at the age from 10 to 17 years

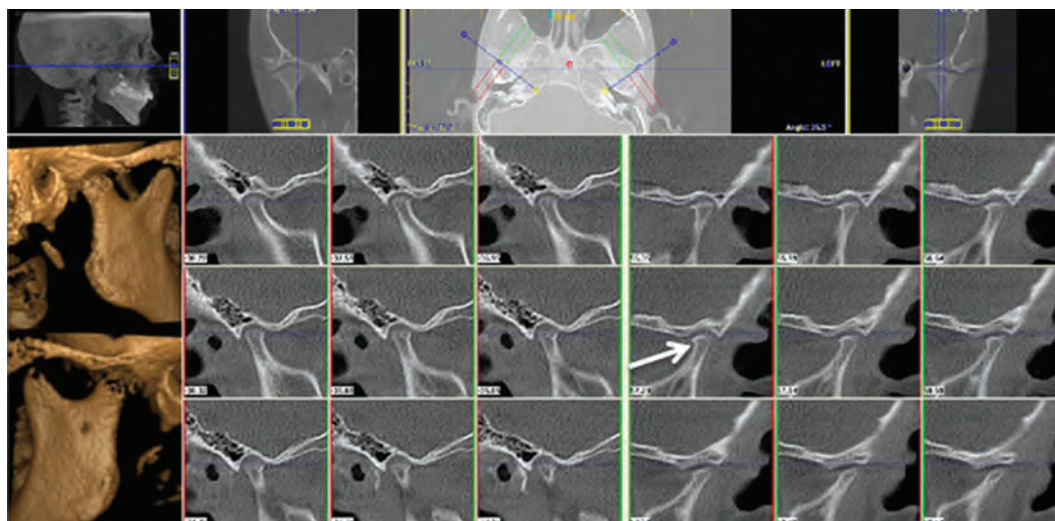


**Fig. 3.** CBCT reconstructed image in sagittal projection with axial correction – surface flattening of the condyle



**Fig. 4.** CBCT reconstructed image in sagittal projection with axial correction – articular surface erosion of the condyle

with mean disease duration of 2 years and 9 months, thickness of slices was 0.3 mm. Osteophytes were exhibited in 46.6% of condyles, which is similar to our results – 46.2%; condylar sclerosis was detected in 16.6% of condyles, whereas in our study this feature was found in 41.5%. Condyle erosions were observed in 13.3% of condyles; however, in



**Fig. 5.** CBCT reconstructed image in sagittal projection with axial correction – articular surface exophytic formation of the condyle

our sample such erosions were presented in 73.8% of patients. Various occurrence of these features within two studies would be explained as a result of small sample size including 15 patients in the aforementioned study, as well as CBCT reconstructions of the coronal and sagittal cuts were 1 mm thick, and duration of disease and patients age were different.

According to several authors a prevalent clinical sign among JIA patients was pain; however, this sign is unreliable because it is observed in only 14% to 20% of patients with apparent radiologic signs of TMJ arthritis as observed by MRI (14, 22). It has been suggested that despite the severity of condyle destruction, it does not inevitably lead to pain (23). Thus, symptoms patients describe cannot always confirm the presence of TMJ destruction that is observed radiographically. However, in a present study majority of patients regardless of the presence or absence of radiological features reported pain. It has also been reported that the destruction of the condyle occurred in 30% of patients in a study conducted in by Pedersen *et al.*, which is lower than in other studies (16, 24). It was explained that a reason could be the inclusion criterion of disease duration of less than 3 years, because it has been proven that condylar erosion increases with early onset (16). In fact, our results showed that clinically assessed pain was quite frequent within our sample, with an incidence of 89.2%, and was coincident with condyle destruction features observed in the CBCT. It is possible that patients with pain of our sample were motivated more to visit specialist.

Hatcher (2013) describes degenerative joint diseases of the TMJ in no JIA patients and severity of the changes of the condyle in the CBCT images and

its relation to clinical symptoms. The authors observed that in early stages, it is possible to identify minor changes in osseous shape (flattening) and cortical thickening (sclerosis) primarily in the areas of joint loading. The next stage is a non-reducing disc displacement, which is a risk factor for the onset of hard tissues char-

acterised by erosive lesions in functional areas of the condyle and an increase in the clinical signs and symptoms (pain, limited open and cessation of a clicking). Late changes include the formation of osteophytes and subchondral bone cysts, and despite the progression of the degenerative joint disease, the process becomes stable and the signs and symptoms reduce (25). That could refer to absence of correlation between changes of condylar destruction and other clinical signs in our data.

Other clinical signs occur limited mouth opening <40 mm in almost one third of patients (26), malocclusion (19), and clicking or crepitation during TMJ movement (14, 22). Sensitivity on palpation of the masticatory muscles is another observed symptom that occurred with less frequency than the aforementioned clinical signs. It should be stressed that not all patients present with clinical signs; thus, radiologic diagnostic methods are important in the examination of the TMJ destruction in patients with JIA (20). There are assumptions that the early detection of TMJ arthritis and treatment by medication and splinting eventually can maintain the function of the TMJ, allow regeneration of the affected condyle and prevent further destruction (27, 28).

In one study, limited mouth opening was the most prevalent symptom, found in almost one-third of patients. This limited movement is a result of condylar resorption and subsequent remodelling, and it can disturb mandibular growth because the stimulation of bone growth by muscle traction is hindered or even absent as a result of jaw inactivity (26). It has been reported that this symptom was more frequent in JIA patients with an increased duration of the disease as well as for patients with active or severe forms of the disease. Similarly, in

our sample, limited mouth opening occurred with a frequency of 33.8%. Another finding observed by Billiau *et al.* was that a poor correlation exists between the clinical symptoms and the presence of radiologic damage that is visible on OPG and lateral cephalograms (26).

In many children with JIA, TMJ arthritis is asymptomatic because of a delay in its detection (19, 29). This highlights the importance of CBCT examinations in the detection TMJ osseous destruction, and it should not only provide additional data for the physical examination but also confirm or exclude pathologic findings obtained by the clinical evaluation (30).

To further examine possible relation between clinical signs or its absence and TMJ destruction, all subgroups, including JIA patients with asymptomatic TMJ involvement should be investigated, and the severity of clinical symptoms and signs and degree of TMJ destruction should be considered. A

separate pain assessment in each of the masticatory muscles would also provide more information about this relationship.

## CONCLUSIONS

There was no conclusive evidence found regarding correlation between TMJ clinical signs and radiological features of osseous destruction in patients with JIA – only weak correlation between pain and condyle surface flattening was observed. The number of clinical TMJ signs does not correlate with number of radiological features. For the clinical decision both clinical examination and CBCT would be useful in the early detection of osseous destruction of the TMJ in JIA patients.

## STATEMENT OF CONFLICTS OF INTEREST

The authors state no conflict of interest.

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