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Original Article

Dentistry Section

Effect of Juvenile Idiopathic Arthritis on the Temporomandibular Joint and Occlusion in Children and Young Adolescents: A Descriptive Cross-sectional Study

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ABSTRACT

Introduction: Juvenile Idiopathic Arthritis (JIA) is a chronic rheumatic disease, with a prevalence of 1 in 1000 children under the age of 16 years. The clinical symptoms include inflammation of joints, swelling of synovial membrane resulting in growth disturbances and loss of bone density.

Aim: To assess the effect of JIA on the development of Temporomandibular Joint (TMJ) and occlusion in children and young adolescents in the age group of 8-16 years and to evaluate the effect of TMJ arthritis on the growth of maxilla and mandible.

Materials and Methods: This is a descriptive cross-sectional study with a study and control group. A total of 44 children with JIA attending the Department of Rheumatology, Nizam Institute of Medical Sciences (NIMS), within the age group of 8-16 years were screened and enrolled in study from May-July 2014. A gender and sex-matched healthy control group were enrolled from Paediatric Dentistry outpatient specialty. For the measurement and comparison of arch perimeters of mandible and maxilla, the JIA and control group were divided into sub-groups 1 (8-10 y), 2 (11-13 y), and 3 (14-16 y). All the parameters were recorded and subjected to statistical analysis. An Independent sample t-test was used to find a significant difference for maxillary and mandibular arch perimeters among both the groups. Chi-square test was used to know the difference for TMJ parameters, occlusion and occlusal abnormalities. The level of significance was set at $p<0.05$ for all tests.

Results: Children in the JIA group had reported TMJ pain on movement (40.9%), clicking sounds (36.4%), and dislocation (22.7%). Angle's class II malocclusion was seen in 36.4% compared to the control group (4.5%). The mean arch perimeter of the mandible was significantly less among JIA children in subgroups 2 (73.00±3.03 mm), and 3 (71.77±6.27 mm) when compared to healthy controls. Other occlusal abnormalities such as increased overjet (34.1%), decreased overbite (31.8%), and crowding (54.5%) were reported in significant percentages compared to healthy controls.

Conclusion: The mean arch perimeter of the mandible in the JIA group is less when compared to children of the same age in the control group. There is increased predilection of developing Angle's class II Malocclusion in the JIA group. From a paediatric dentist perspective, it's important to understand the overall impact of JIA on stomatognathic system, and an early intervention is recommended.

Keywords: Arch perimeter, Condyle, Mandible

INTRODUCTION

JIA is a chronic rheumatic disease of childhood causing significant growth disturbance and joint destruction [1]. The definition of JIA is based on the diagnostic criteria described by the International League Against Rheumatism, (ILAR), which states that JIA is defined as persistent inflammatory arthritis, which begins before the age of 16, for which no specific cause can be found [2]. The cardinal clinical features include persistent swelling of one or more joints, limited range of motion in the joints and pain during movement lasting at least 6 weeks [2]. The clinical features and types of JIA are explained in [Table/Fig-1].

The most important clinical feature of systemic arthritis involves increase in ferritin, serum transaminases, decrease in platelet count and fibrinogen. These changes in blood lead to Macrophage Activation Syndrome (MAS). Based on this, recently a new classification criterion has been proposed by Ravelli A et al., [3]. The following criteria should be met to confirm the diagnosis of MAS. The criteria include, Ferritin >684 ng/mL and any of the 2 from the below:

1. Platelet count ≤181 × 109/l
2. Aspartate aminotransferase >48 units/l
3. Triglycerides >156 mg/dL
4. Fibrinogen ≤360 mg/dL

Types of JIA	Clinical features
Systemic arthritis	Onset age: throughout childhood, Number of joints affected: variable Systemic features: quotidian fever + one or more of the following: erythematous rash, myalgias, lymphadenopathy, hepatosplenomegaly or serositis.
Oligoarthritis	Onset age: early childhood, peak 2-4 years, Number of joints affected: persistent: ≤4; extended: ≥4 joints after the first 6 months
RF*-positive polyarthritis	Onset age: late childhood, adolescence, Number of joints affected: ≥5 joints, Serological test: IgM RF-positive.
RF*-negative polyarthritis	Onset age: biphasic distribution, early peak, 2-4 years, later peak 6-12 years, Number of joints affected: ≥5 joints Serological test: IgM RF-negative
Enthesitis-related arthritis	Onset age: late childhood or adolescence, Number of joints affected: variable, usually ≤4.
Psoriatic arthritis	Onset age: biphasic distribution, early peak at 2-4 years, late peak at 9-11 years, Number of joints affected: variable, usually ≤4 Other diagnoses: psoriatic rash, family history of psoriasis, dactylitis or nail pitting.
Undifferentiated arthritis	Onset age: Not Applicable, Patients who do not satisfy inclusion criteria for any other category

[Table/Fig-1]: Types of Juvenile Idiopathic Arthritis (JIA) and clinical features [1,2].
*RF: Rheumatoid Factor

Owing to the chronic autoimmune nature, JIA has significant impact on stomatognathic system. An increased prevalence of TMJ arthritis

in patients with JIA was reported in the literature and aetiology was ascribed to many factors [4,5]. When the joint inflammation involves the TMJ, there is impact on mandibular growth, development of occlusion and masticatory function.

The existing studies were performed in different population groups. The present study is first of its kind cross-sectional original study in states of Andhra Pradesh and Telangana with a considerable sample size.

MATERIALS AND METHODS

Ethical clearance for the study was obtained from the Institutional Ethical Committee of both the institutions, where the study was conducted. The study was conducted at the Department of Rheumatology, NIMS, Hyderabad, India from May-July 2014. The Ethical Clearance number is EC/NIMS/1482/2014. All participants and their guardians were explained the purpose of the study verbally and written approval was taken on an informed consent form. The informed consent form was drafted in English and Telugu for the participants and guardians to understand.

This is a descriptive cross-sectional study with a total sample size of 88. A total of 44 children with JIA undergoing treatment at NIMS were examined. There was one examiner for the various groups irrespective of the type of JIA. A control group of 44 children with the same age and gender were randomly selected from the outpatient specialty, Department of Pedodontics, Government Dental College, Hyderabad, India.

Sample size estimation was calculated using the GPower 3.1 computer program. A pilot study was conducted to determine the sample size prior to the main study. Sample size determination revealed that for an independent sample t-test for two different sample means, with an effect size of 0.60 for the changes in arch length among two groups, an alpha level of 0.05, and a power of 0.80, a minimum of 44 subjects in each group was required, thus giving a total sample of 88.

JIA Group Criteria

Inclusion criteria: Children of age group 8-16 years diagnosed with JIA treated by the Department of Rheumatology, NIMS, Hyderabad, India were included in the study. All the JIA children were known to have chronic and autoimmune disease activity in nature. The diagnosis, nature and aetiology were confirmed with the examining Rheumatologist and patient case book.

Exclusion criteria: Children suffering from other systemic diseases such as diabetes mellitus, heart diseases, organ transplantations, neurological disorders, infectious disorders, and renal disorders were excluded.

Control Group Criteria

Inclusion criteria: Healthy subjects of matched age and gender attending department of Pedodontics, Government Dental College, Hyderabad.

Exclusion criteria: Subjects with behaviour management problems and underlying medical problems were excluded.

A thorough family and medical history of subjects were taken. Clinical evaluation of facial, oral and dental structures was done. The ethical committee at NIMS has not provided approval for radiographic analysis. Owing to the difficulty in finding the required sample size and unique clinical features of JIA patients, this study was carried out even though ethics approval was not obtained for radiographs. Hence, the study has been limited to oral examination followed by dental impressions. Alginate impressions (Zelgan: Dentsply) were made, and dental stone (Kalabhai) was used for preparing the study casts. The dental casts were used to assess the characteristics such as occlusion, overbite, overjet, crowding and for determining arch perimeter (millimetres). Angle's classification of malocclusion was used as a standard for analysing the occlusal findings. Arch perimeter was measured as per the method illustrated by Al-Ansari NB et al., [6]. A brass wire was used to measure the arch perimeter (millimetres). The wire was contoured from the mesial marginal ridge of the right first permanent molar to the mesial marginal ridge of the left permanent molar [6]. The wire was then straightened and the length was measured on a scale in millimeters. The TMJ was examined by inspection and palpation of the joint by an another experienced rheumatologist (Examiner 2) for the presence of tenderness, deviation, and dislocation.

STATISTICAL ANALYSIS

Data analysis was carried out using the SPSS version 21. Descriptive statistics were presented in the form of mean, standard deviation, frequency and percentages. An Independent sample t-test was used to find a significant difference for maxilla and mandible arch perimeters among both the groups. Chi-square test was used to know the difference for TMJ parameters, occlusion, and occlusal abnormalities. The level of significance was set at $p<0.05$ for all tests. Kappa statistics used to evaluate inter-examiner reliability (K=0.08).

RESULTS

In the JIA group, TMJ pain on movement was reported in 18 children (40.9%), clicking sounds were reported in 16 children (36.4%) and dislocation of the TMJ was reported in 10 children (22.7%). None of the children in the control group presented any TMJ pain signs and symptoms, showing a statistically significant difference among the two groups [Table/Fig-2].

Parameters	Yes	No	Degree of freedom	χ^2 value	p-value
TMJ Tenderness					
JIA	18 (40.9)	26 (59.1)	1	22.629	**<0.001***
Control	0 (0)	44 (100)			
Clicking Sounds					
JIA	16 (36.4)	28 (63.6)	1	19.556	**<0.001***
Control	0 (0)	44 (100)			
Dislocation					
JIA	10 (22.7)	34 (77.3)	1	11.282	**0.001***
Control	0 (0)	44 (100)			

[Table/Fig-2]: Temporomandibular Joint (TMJ) parameters in Juvenile Idiopathic Arthritis (JIA) and control group.
Chi Square Test: *p<0.05 (significant)

Angle's Class II malocclusion was reported in 16 (36.4%) children in JIA group and 2 (4.5%) children in control group accounting for a high tendency for JIA children to develop Class II malocclusion whereas Angle's class I occlusion was reported in 28 children in JIA group (63.6 %) and 42 (95.5%) children in control group [Table/Fig-3].

Parameter	Class I	Class II	Degree of freedom	χ^2 value	p-value
Occlusion					
JIA	28 (63.6)	16 (36.4)	1	13.689	**<0.001***
Control	42 (95.5)	2 (4.5)			

[Table/Fig-3]: Occlusion in JIA and control group.
Chi-Square Test: *p<0.05 (significant)

The occlusal abnormalities reported in the study group were increased overjet, decreased overbite and crowding in 15 children (34.1%), 14 children (31.8%), and 24 children (54.5%) respectively. In the control group, only crowding was reported in 5 children (11.4%) showing a statistically significant difference among the two groups [Table/Fig-4].

Parameters	Yes	No	Degree of freedom (df)	χ^2 value	p-value
Increased overjet					
JIA	15 (34.1)	29 (65.9)	1	18.082	**0.001***
Control	0 (0)	44 (100)			
Decreased overbite					
JIA	14 (31.8)	30 (68.2)	1	16.649	**0.001***
Control	0 (0)	44 (100)			
Crowding					
JIA	24 (54.5)	20 (45.5)	1	18.567	**0.001***
Control	5 (11.4)	39 (88.6)			

[Table/Fig-4]: Occlusal abnormalities.
Chi-Square Test: *P<0.05 (significant)

The JIA and control groups were divided into 3 sub-groups based on age 8-10 years (sub group-1); 11-13 years (subgroup-2) and 14-16 years (subgroup-3) for measurement and comparison of arch perimeters of maxillary and mandibular arches. The mean arch perimeter values of the maxilla in all the sub-groups in the JIA group were not statistically significant in comparison with mean values in sub-groups of the control group [Table/Fig-5].

Parameters	Minimum	Maximum	Mean±SD	Total df	t Value	p-value
Sub-group 1: 8-10 years						
JIA Group	80.00	90.00	84.27±3.71	20	0.145	0.86
Control group	74.00	89.00	84.54±4.98			
Sub-group 2: 11-13 years						
JIA Group	81.00	94.00	85.09±3.80	20	1.457	0.1
Control Group	85.00	90.00	87.00±2.09			
Sub-group 3: 14-16 years						
JIA Group	74.00	95.00	85.72±6.00	42	0.453	0.6
Control Group	82.00	87.00	85.13±1.20			

[Table/Fig-5]: Arch perimeter (millimetres) of the maxillary arch in comparison with control group.
Independent Sample t-Test, p-value <0.05 to be significant

The mean arch perimeter of the mandible in sub-group 1 was 73.72±3.46 (mm) is not statistically significant when compared to sub-group 1 in the control group 75.45±3.61 (mm). However, the mean values 73.00±3.03(mm), 71.77±6.27 (mm) in sub-groups 2 and 3 in JIA group, respectively were statistically significant on comparison with values in sub-groups 2 (75.18±1.40 mm) and 3 (74.72±1.42 mm) of control group [Table/Fig-6]. Kappa statistics showed a good (K=0.8) intra-examiner reliability.

Parameters	Minimum	Maximum	Mean±SD	Total df	t value	p-value
Sub-group 1: 8-10 years						
JIA Group	67.0	78.00	73.72±3.46	20	1.144	0.266**
Control Group	68.0	80.00	75.45±3.61			
Sub-group 2: 11-13 years						
JIA Group	70.0	78.0	73.00±3.03	20	2.166	**0.043***
Control Group	73.0	78.0	75.18±1.40			
Sub-group 3: 14-16 years						
JIA Group	60.0	85.0	71.77±6.27	42	2.155	**0.037***
Control Group	72.0	78.0	74.72±1.42			

[Table/Fig-6]: Arch perimeter (millimetres) of the mandibular arch in comparison with control.
*p<0.05 (Significant), **p>0.05 (Not significant)

DISCUSSION

The aetiology of JIA is still unknown and multifactorial. Padmini A et al., reported genetic factor may be one of the factors [7]. Other factors include autoimmune, environmental factors and shift in bacterial spectrum [7]. In this study, parents and siblings didn't report history of JIA and Rheumatoid arthritis. According to the rheumatologist, who performed the examination, the aetiology of the TMJ disease was found to be autoimmune. No correlation with genetic factors and family history was established. Out of 7 types of JIA, 3 types of JIA were reported in the present study. Systemic, Oligoarthritis and rheumatoid factor negative polyarthritis were seen in 6, 30 and 16 JIA patients respectively. The JIA nature was chronic in nature. A note of type of JIA was made based on the diagnosis mentioned in patient's case sheet. Comparative studies are included in the [Table/Fig-7], which has concluded in similar lines, as the present study [8-19].

In the present study, tenderness of TMJ, crepitations, dislocation were reported in 40.9%, 36.4% and 22.7% of children, respectively [20]. These results are in agreement with various studies [8-15,19] discussed in [Table/Fig-7]. According to Walton AG et al., the inflammation of the synovium of the TMJ is a key pathological feature of JIA. The authors postulated that an immune response in the joint triggers B lymphocytes and it activates the serum complement cascade and recruits the phagocytic arm of the immune response that eventually aggravates the inflammation of the synovium. This mechanism leads to edema, vasodilatation, and infiltration of activated T cell and results in TMJ tenderness [20].

The pathological changes begin as an inflammatory synovitis characterised by cellular infiltration, with proliferation and congestion of the blood vessels. The lining cells elongate and the synovial villae become hypertrophied at this stage and the proliferative inflammatory changes may resolve during remission of the articular disease. However, in long-standing inflammation infiltrating granulation tissue (pannus) gradually extends over the surface of the articular cartilage. Lysosomal enzymes released from cells of this invading pannus erode areas of cartilage and sub-chondral bone leading to articular destruction and joint deformity [21,22].

In a study by Leksell E et al., panoramic radiographs were analysed for deviations in TMJ structure ranging from a small abnormality of the condyle deviating slightly from the convex shape (usually flattened) to a completely absent or short flat condyle and found out that 77% of JIA children have shown structural condylar changes on OPG [23].

Prevalence of Class II malocclusion is found to be much higher in children with JIA compared to healthy control group. Reduced overbite, frontal open bite, crowding, especially in the lower incisor region has been reported. During growth, a decrease in overbite and an increased lower anterior crowding as well as changes from a Class I to a Class II molar relation are observed by Kjellberg H [24]. In the present study, 34.1% of JIA children have shown increased overjet, 31.8% showed decreased overbite and 54.5% have shown crowding of teeth. Angel's Class II malocclusion was reported in 36.4% of JIA children, which is in accordance with results of studies [9,15-18] discussed in [Table/Fig-7].

The arch perimeter of the mandible in the present study, in subgroups 2 and 3 of JIA group were 73.00±3.03 mm and 71.77±6.27 mm, respectively, which is significantly less compared to the arch perimeter values in the subgroups 2 (75.18±1.40 mm) and subgroup 3 (74.72±1.42 mm) of the healthy control group. This result is in accordance to the studies in [Table/Fig-7] who reported that in JIA children the dentofacial morphology deviates from that of normal children especially due to changes in mandibular morphology and position resulting in overall small dimensions of the mandible, a steep mandibular plane and anterior apposition of bone at the chin point [15,16,18]. Signs of absolute shortening of the ramus height and the total mandibular length during growth have also been observed. A lack of forwarding growth of the mandible initiates an increased extension of the head in relation to the cervical

Studies	Age (years)	Sample size	Results
Ahmed N et al., 2004 [8]	4-16	JIA group: 55 Control group: 55	Dysfunction and reduced mobility of both left and right TMJ were reported.
Savioli C et al., 2004 [9]	5.4-14	JIA group: 36 Control group: 13	Anterior open bite was reported in 5 children. TMJ clicking sounds was reported in 8 JIA patients. TMJ dysfunction, decreased mandibular opening, and mobility were reported by 94%, 80% and 33% of JIA children respectively.
Santos D et al., 2015 [10]	6-14	JIA Group: 14 Control group: 15	Temporomandibular joint disorders were seen in 50% of JIA patients
Al-Shwaikh H et al., 2016 [11]	<17	JIA Group: 65 Control group: 30	Right and left TMJs showed 81.5% and 90.8% surface flattening respectively. Condylar surface erosion was seen in 58.7% and 63% for the right and left side respectively for JIA females. Condyle osteophyte with a 39.1% prevalence in the right condyles and 30.4% in the left condyles in JIA females.
Abdul-Aziez OA et al., 2010 [12]	8-17	JIA Group: 20 Control group: 10	TMJ arthritis was seen in 80% JIA. Serum S100A12 levels was significantly high in JIA group. Systemic and polyarthritis group children showed higher serum levels compared to Oligoarticular JIA. The increase in level of S100A12 in serum and MRI scores were correlated to TMJ inflammation.
Mohammed Y et al., 2012 [13]	8.5-17	JIA Group: 40 Control group: 10	TMJ tenderness, crepitations, decreased mouth opening were seen in 10 (25%), 8 (20%) and 10 (25%) patients respectively. Contrast enhanced MRI showed synovial inflammation of involved joints.
Leksell E et al., 2012 [14]	10-19	JIA Group: 41 Control group: 41	33 JIA patients reported TMJ pain. JIA group significantly showed pain on palpation of jaw muscles and reduce mouth opening.
Sidiropoulou-Chatzigianni S et al., 2001 [15]	6-19	JIA Group: 66 Control group: 37	The cephalometric findings showed mandibular retrognathism, vertical pattern of growth with a tendency towards open bite.
Synodinos PN and Polyzois I 2008 [16]			Reported TMJ arthritis in JIA children result in decreased mandibular length, class 2 division 1 malocclusion, facial asymmetry, open bite tendency.
Hu Y et al., 2009 [17]	1.7-19.4	JIA group: 100 Control group: 41	JIA patients showed significantly higher prevalence of anterior open bite and class 2 malocclusion.
Fjeld MG et al., 2009 [18]	6,9,12,35 y follow-up study	JIA group: 54 Control group: 54	A more retrognathic position of mandible was found in children at 12 yrs of age. The length of mandible was significantly smaller in JIA patients.
Merle CL et al., 2020 [19]	6-18	JIA group: 59	Osteoarthrosis, osteoarthritis, arthralgia were reported in 21, 3, 3 patients respectively. As per Helkimos Clinical dysfunction index, DI: Light clinical symptoms of dysfunction were reported in 27 patients.
Present study	8-16	JIA group: 44 Control group: 44	Aetiology of JIA has been reported to be Auto immune in nature. Genetic factor as aetiology is not proven in this study. TMJ Pain on movement, clinical sounds and dislocation were reported in 18, 16 and 10 children. Control group didn't present any TMJ dysfunction. Class 2 malocclusion and tendency for open bite was seen with higher prevalence in JIA patients compared to control group.

[Table/Fig-7]: Studies with Temporomandibular Joint (TMJ) and Occlusion parameters [8-19].
*TMJ: Temporomandibular joint; JIA: Juvenile idiopathic arthritis; MRI: Magnetic resonance imaging

column in order to maintain an adequate airway. This may result in stretching of the soft tissue which has a restraining effect on facial development [18].

There is no significant difference in the arch perimeter of the maxilla in the JIA group when compared to that in children of the same age groups in the control group. This result is in accordance with Barriga B et al., who stated that in JIA, maxilla remains intact and continues its normal growth because the primary sites for maxillary growth are at the sutures and propagate through the proliferation of fibrous connective tissue which is not affected by the arthritic condition [25]. Thus, the present study demonstrates a definitive detrimental effect of JIA on occlusion and TMJ.

Based on factors such as skeletal maturity, active/ inactive disease progression, various treatment methods have been proposed. Some of them include optimise systemic treatment with orthopaedic treatment in cases were skeletal maturity is not reached. In cases of facial asymmetry, bilateral sagittal osteotomy with genioplasty and chin advancement is suggested. For condyle erosion and surface flattening, joint reconstruction with costo-chondral graft is proven to be successful. Other TMJ surgeries include synovectomy, meniscectomy and bilateral condylectomy [26].

Limitation(s)

The present study had a small sample size. It didn't include radiographic assessment of the TMJ and dental arches as the ethics approval was limited to oral examination and dental impressions.

CONCLUSION(S)

The present study mainly focuses on the occlusal abnormalities and TMJ dysfunction reported in JIA children. There is a necessity of further radiographic evaluation of TMJ as the signs and symptoms worsen with age and it is important to diagnose the condition at a very earlier stage. From a paediatric dentist perspective, it's imperative to understand the nature of JIA, the treatment regimen provided and the overall impact on the stomatognathic system. Hence, paediatric dentist should be part of the multidisciplinary team of JIA.

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