Scientific Article

The temporomandibular joint in juvenile rheumatoid arthritis: Part II. Relationship between computed tomographic and clinical findings

Yunn-Sheng Hu, DDS, MS Emet D. Schneiderman, PhD Richard P. Harper, DDS, FRCD

Abstract

A study was undertaken to examine the relationship between the clinical signs and symptoms of temporomandibular joint (TMJ) disorders and computed tomographic (CT) evidence of destruction of these joints in children afflicted with juvenile rheumatoid arthritis (JRA). A thorough clinical examination including determination of the craniomandibular index (CMI) was performed on each of 37 consecutive JRA patients (6–17 years old), who had also received comprehensive evaluations of TMJ morphology by axial CT (see Part I, Pediatr Dent, *17:46-53, 1995). Measures of facial asymmetry (photographic) and mandibular size (cephalometric) also were collected. Published norms for mandibular dimensions and for prevalences of symptoms and signs of TMJ disorders served as control data. Various ANOVA and nonparametric statistical models were used for analysis. Average maximal opening was significantly less in the JRA subjects compared with the controls, and more than 50% of the JRA children manifested chin deviations or vertical disparities between mandibular angle regions, indicating compromised mandibular function and form. With the exception of facial asymmetry, however, none of the clinical signs or symptoms of TMJ dysfunction were remarkable predictors of bony destruction of the TMJ. Subjects with definitive evidence (CT) of TMJ destruction (62%) could not be identified reliably by any of the clinical measures used here. These findings indicate that clinical examination alone is inadequate for detecting condylar degeneration in the TMJ of children with JRA. (Pediatr Dent 18:312–19, 1996)*

Juvenile rheumatoid arthritis (JRA) is a major chronic rheumatic disorder of childhood. The temporomandibular joint (TMJ) can be involved in JRA and destructive changes can result, but the relationship between clinical signs and symptoms and joint abnormalities requires further clarification. Clinical examination of TMJ function in children afflicted with JRA often reveals TMJ sounds, pain on mandibular movement, and/or restricted mandibular opening, which can be interpreted as evidence of TMJ internal derangement. However, clinical examination alone is unreliable for diagnosing degenerative condylar changes.[1–3]

Although plain film radiography generally is regarded as an important tool for detecting degenerative changes of the TMJ in JRA patients,[4–9] computed tomography (CT) may provide additional insight beyond the two-dimensional radiographic methods. This three-dimensional imaging may clarify the relationship between signs and symptoms of TMJ dysfunction and skeletal abnormalities. This paper follows our earlier report on the distribution of bony abnormalities in the TMJ in JRA children as determined by CT (Part I).[10] It was found using CT imaging that nearly two-thirds of the JRA children in our study had incurred varying degrees of condylar degeneration. To establish which of the following diagnostic clinical parameters correlate with joint degeneration, their relationship with the CT findings was investigated: including the craniomandibular index (and its constituent functional and pain measures), measures of facial symmetry from photographs, and cephalometric and demographic variables. The distribution of clinical signs and symptoms of TMJ dysfunction and mandibular deformity in the JRA children also was compared with population norms for healthy children. This study also explored the relationship between mandibular deformity and TMJ degeneration.

Background

Using the combination of panoramic, transcranial, and tomographic methods, Stabrun et al.[2] examined 103 JRA children and found more children with chin deviations and vertical differences between both mandibular angle regions in the group with radiographically detectable TMJ abnormalities than without such abnormalities. In a study of functional capacity of the TMJ in JRA, Larheim and Haanæs[5] reported that all patients had significantly decreased maximum opening, protrusion, and lateral movement. They reported a relationship between mandibular under-development and the degree of deterioration of the TMJ detected radiographically. Garza[11] also found significantly smaller mandibular ramus heights and corpus lengths than in normal children — especially in the systemic onset group — in 42 patients with JRA. Karhulahti et al.[12] reported that reduced maximum opening, maximum protrusion, lateral movement of the mandible, and pain in the TMJ area are reliable signs for predicting TMJ involvement in JRA children. Further, Stabrun et al.[13] concluded that unilateral joint abnormalities resulted in mandibular asymmetry and underdevelopment on the affected side. This group also found arthritis of the TMJ to be negatively correlated with mandibular growth and suggested that radiographically visible changes in the TMJ had the most obvious influence on mandibular length.

Methods and materials

The sample attributes of the 37 JRA children studied here are detailed in Part I.[10] The children were categorized and analyzed according to the distribution of the disease and age of onset: 22% exhibited pauciarticular involvement, 62% polyarticular disease, and 16% systemic mode of onset. The ratio of females to males was 4.3:1, similar to that reported by Barriga et al.[14] and Garza.[11]

A thorough clinical exam was performed to systematically inventory signs and symptoms of TMJ disorders. Facial asymmetry was assessed with a photographic evaluation, mandibular dimensions by means of a cephalometric analysis, and TMJ morphology using computed tomography.

Clinical analysis

The craniomandibular index (CMI)[15,16] was the primary instrument used to characterize TMJ pain and dysfunction and was recorded for each JRA subject. The CMI is a composite index based on 62 equally weighted items and varies along a scale from 0 to 1. Its two major components are 1) a dysfunction index, which reflects problems in joint function and 2) a palpation index, which reflects muscle and capsular tenderness. The dysfunction index includes limitation in range of motion, deviation in movement, TMJ pain (score signifies number of movements, i.e., opening, protrusion, right or left laterotrusion, in which pain was experienced) and joint sounds (scored from 0–4) during motion. Jaw movements were measured with a Boley gauge to 0.1 mm, and joint sounds were evaluated by palpation and auscultation with a stethoscope. The palpation index includes items related to tenderness on palpation of intraoral and extraoral jaw muscles, neck muscles, and TMJ capsule. Because of the absence of published normative CMI values for children, data derived from adults with and without TMJ disorders[16] were used as reference. Differences between the obtained distributions for the JRA children and the reference values were tested for statistical significance using one-sample t-tests.

Control data for the other clinical and cephalometric parameters were derived from a variety of sources, all based on comparable North American children. Normative information on the incidence and prevalence of clinical symptoms and signs of TMJ disorders was derived from Brandt's epidemiological study,[17] which included 1,342 children from Saskatchewan of the same age range. The cephalometric findings in our sample were compared to the normative values derived from Michigan school children.[18] These age-specific average linear and angular dimensions are based on female subsamples that average 27 subjects each.

Photographic symmetry analysis

Standardized photographs made with the same equipment and camera settings were used to evaluate facial asymmetry and mandibular deviation. Patients were seated 1.5 m from the camera at a standard height of 35 cm in the same chair, in natural head position[19] with eyes at the same level as the camera lens. Four photographs were taken for each child: frontal, rest position; frontal, natural smile; right side view; and left side view.

Canthi and chin points were traced from the 3x5 frontal rest photographs onto acetate paper by the first author (Fig 1). To evaluate chin deviation, a perpendicular line was drawn though the midpoint of the intercanthal line (internasal line). Then, the relative position of the chin point (point C) to the internasal line

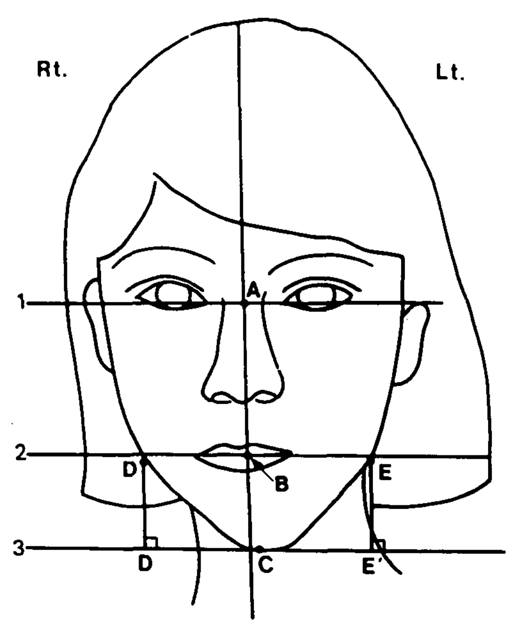

Fig 1. Evaluation of lower facial asymmetry from frontal photographs. Landmarks are: A = midpoint between medial canthi; B = contact point between upper and lower lips; C = chin point; D = right angular point; and E = left angular point. Lines are: 1 = intercanthal, 2 = interlabial, and 3 = tangent to chin point. Lines 2 and 3 are defined so as to be parallel to line 1. Difference between lines DD' and EE' represents vertical disparity in position in mandibular angles. Deviation point C from line AB represents horizontal asymmetry in chin position.

was used to determine chin deviation. The vertical difference between the mandibular angle region of both sides, modified from the method of Stabrun et al.,[2] was evaluated to assess general facial balance. The value of the difference was obtained by comparing the distances from both mandibular angles to the chin line (lines DD' and EE').

Cephalometric analysis

For each patient, a lateral cephalogram was exposed by a single operator using a a single cephalometric X-ray unit (Philips Orolix Pan DC III Ceph, Soredex, Shelton, CT). The patient was seated and directed to bite in centric occlusion. All cephalograms were made at 0.5 sec with the machine set at 70 kilovolt (KV) and 10 milliampere (mA) using Kodak™ T-MAT, G-1 film. Cephalograms were traced manually and the measurements, accurate to 1 mm, were taken for mandibular length (Co-Pg) and ramus height (Co-Go) with a cephalometric protractor (Fig 2). Using Student's *t*-tests, the absolute measures of mandibular length and ramus height were first compared to those for the same age and sex subsamples reported by Riolo et al.[18] The normative means and standard deviations (SD) from these subsamples also were used to compute standardized measures across all ages, of mandibular length and ramus height. These Z scores for each JRA subject were computed by subtracting the normative mean from the observed value and dividing this difference by the normative sample SD.

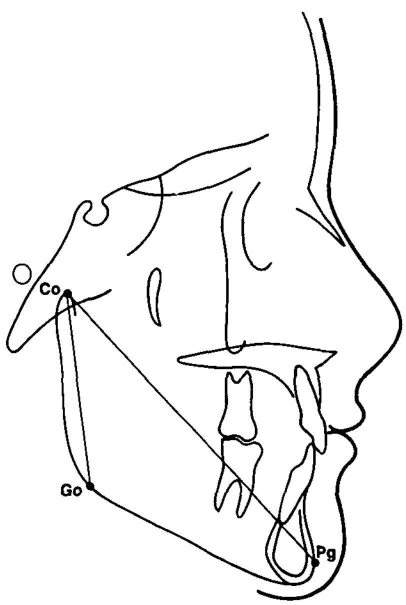

Fig 2. Mandibular linear measurements made from tracings of lateral cephalograms. Points are: Co = Condylion; Pg = Pogonion; Go = Gonion. Mandibular length is defined as Co–Pg, ramus height as Co–Go.

Computed tomography analysis

A pathosis score was assigned to each CT radiograph based on a qualitative evaluation of the axial CT images of the TMJs. The details of this scoring system, based on earlier radiographic schemes,[7, 20] is outlined in Part I.[10] Additionally the largest condylar dimension, condylar angulation, constructed joint space, and condylar cross-sectional area were measured.

A calibration session was held to ensure that the TMJ pathosis scoring system was applied in a valid and reliable fashion; it served to calibrate the rater with individuals more experienced in the interpretation of TMJ morphology (a craniofacial biologist, a maxillofacial radiologist, and an oral and maxillofacial surgeon). Films were first rated individually and then discussed. Subsequent films were rated until the first author was consistently in agreement with the others. After the calibration session, the CT images for all of the subjects were rated blindly by the first author.

Statistical analysis

Means and SDs for all continuous variables were calculated for both JRA samples and the controls. ANOVA with Tukey tests were used to compare the differences among the three JRA groups; in the case of non-normally distributed variables, Kruskal-Wallis tests were used. Fisher's exact test was used to test for differences in prevalences of clinical signs and symptoms between the JRA sample and the control sample and for an association between chin deviation and greater TMJ involvement on the same side. Spearman correlations were used to test for associations between pairs of ordinal variables (e.g., that between the grade of left TMJ lesions and the CMI). Pearson correlations were employed to analyze the relationships between continuous variables.

Results

The mean age and duration of disease for the patients in this JRA sample were 11 and 3.6 years respectively. Five patients (13.5%) were rheumatoid factor (RF) positive and 14 patients (37.8%) were antinuclear acid (ANA) positive.

Clinical examination

The mean CMI value in this JRA sample was 0.18 (SD = 0.14; median = 0.14) with an observed range from 0 to 0.63. The mean value indicates about 11 positive responses out of a total of 62 potential, with a SD of 9. When compared with a reference value of 0.07 for normal adults,[16] the mean value for these JRA children was significantly greater ($t = 4.6$, $P < 0.001$). When compared with reference values for groups of adults diagnosed with craniomandibular disorders[16] (of nonarthritic origin) that range from 0.34 to 0.48, the total sample of JRA children had a profoundly lower CMI score. Even when compared with the lowest reference value for these adults, 0.34 (early stage TMJ internal derangement group), the CMI was significantly lower ($t = -5.22$, $P < 0.001$). Only the systemic-onset group of JRA patients exhibited a CMI (0.21) statistically indistinguishable from the reference value of 0.34 (t = -1.43, P = 0.213). The mean mandibular opening value in this study sample was 34 mm. Twelve (32.4%) subjects reported pain upon opening, protrusion, or during lateral excursions.

Twenty-one patients (56.8%) had various types of joint noise, such as reciprocal or nonreciprocal clicking or popping. For mild joint noise, significant differences were found between the JRA subjects and control children younger than 13 years of age (Table 1); for severe joint noise and joint pain, there were significant differences between the JRA and control values for age groups 6–8, 11–12, and 15–17. In the 11- to 14-year-old JRA children, there were significantly higher frequencies of muscle tenderness than in controls. Among the 6- to 8-year-old, and 11- to 14-year-old age groups, significantly more JRA children had decreased opening (i.e., < 34 mm) than did controls. None of these clinical symptoms/signs (CMI, opening, joint pain, and joint noise) was associated with the duration or diagnostic category of JRA. In addition, none of these variables was related to the age of the patient.

Photographic symmetry analysis

Twenty-one patients (56.8%) had vertical differences between their mandibular angle regions, and 24 patients (64.9%) revealed chin deviations on photographs.

Table 1. Frequency counts of positive signs of TMJ disorders for different age groups

Age (Years)	*6–8*			*9–10*			*11–12*			*13–14*			*15–17*		
Variables	*JRA N = 9*	*Control N = 352*	*P*	*JRA N = 5*	*Control N = 254*	*P*	*JRA N = 8*	*Control N = 364*	*P*	*JRA N = 7*	*Control N = 364*	*P*	*JRA N = 7*	*Control N = 90*	*P*
Noise (mild)	3	14	0.006*	2	7	0.010*	4	26	0.002*	2	37	0.161	2	8	0.152
Noise (severe)	1	1	0.049*	0	1	1.000	3	0	0.0001*	1	3	0.074	3	1	0.001*
Joint pain	3	0	0.0001*	1	3	0.075	4	11	0.0001*	0	4	1.000	4	4	0.001*
Muscle tender	2	46	0.341	1	23	0.388	4	14	0.002*	2	8	0.013*	2	6	0.102
Open	7	56	0.0001*	2	30	0.117	4	55	0.025*	4	43	0.006*	3	35	1.000

* Probabilities for Fisher's exact test for differences between the JRA subjects and control data in five age groups are shown ($P < 0.05$).

Table 2. Relationship between facial asymmetry and laterality of TMJ lesions

Variables	*Pauciarticular N = 8*		*Polyarticular N = 23*		*Systemic N = 6*		*All N = 37*	
	Frequency Right	*Left*	*Frequency Right*	*Left*	*Frequency Right*	*Left*	*Frequency Right*	*Left*
Chin deviation & unequal TMJ involvement†	0	2	3	4	1	0	4	6
Chin deviation w/o unequal TMJ involvement	1	2	2	5	0	3	3	10
Unequal TMJ involvement w/o chin deviation	0	1	4	0	0	0	4	1
P	NA	1.000	0.142	0.014*	0.167	NA	0.027*	0.029*

* Probabilities of Fisher's exact test for the association between chin deviation (from frontal photographs) and the same side more severe joint involvement (from CTs) are shown.

† Unequal involvement of TMJ lesion indicates subjects with the grade of one TMJ higher than the other side ($P < 0.05$).

Table 3. Summary statistics for mandibular length (ML), ramus height (RH), and their standardized counterparts

	Pauciarticular N = 8		*Polyarticular* N = 23		*Systemic* N = 6		*All groups* N = 37		
Variables	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*P*
ML	113.563	8.496	107.804	10.501	115.500	14.167	110.297	10.961	0.251
SML	0.313	2.642	-0.757	1.757	-1.267	2.460	-0.657	2.070	0.492
RH	60.688	7.056	53.661	5.782	59.333	9.806	56.100	7.327	0.042•
SRH	0.288	1.840	0.657	1.853	-0.250	1.387	0.430	1.772	0.549

• Probabilities for ANOVA tests for differences among the three JRA groups are shown ($P < 0.05$).

ML = absolute mandibular length, measured in mm; SML = standardized mandibular length; RH = absolute ramus height; SRH = standardized ramus height.

Sixteen patients (43.2%) had both manifestations of facial asymmetry.

Four patients (10.8%) manifested chin deviations to the right side and also had more severe lesions of the right TMJ (the grade of right TMJ was higher than that of the left). Also, six patients (16.2%) showed analogous left-side manifestations (Table 2). In addition, there was a significant association between chin deviation and the severity of the same-sided TMJ lesions in the total JRA sample as revealed by Fisher's exact test ($P < 0.030$). When analyzed by JRA type, this association was only significant for the polyarticular group, for the left side ($P = 0.14$).

Chin deviation was highly correlated with the CMI value according to the Spearman correlation (= 0.502, $P < 0.05$). Chin deviation also was correlated with the vertical difference of the mandibular angle regions in the photographic evaluation (= 0.356, $P < 0.05$). Chin deviation and TMJ noise also were correlated with each other (= 0.340, $P < 0.05$).

Computed tomography

On a scale of 0 to 5, the average pathosis grade for both condyles was 0.74. In 62.2% of the total JRA sample, the grade was 1 for at least one joint and exhibited radiographically detectable lesions. There was a trend in which grades of TMJ lesions were lowest in the pauciarticular, highest in the systemic, and intermediate in the polyarticular group. Twenty-seven percent of the JRA children exhibited unilateral TMJ involvement.[10] Apparent differences among the three JRA groups in CMI, opening, pain, or joint noise did not attain statistical significance when tested with the Kruskal-Wallis analyses. There was, however, a significant correlation between the CMI value and the pathosis index for the left joint as indicated by the Spearman correlation (= 0.376, $P < 0.05$). The correlation also was relatively high between the vertical difference in mandibular angle regions and the average grade of the TMJ (= 0.303, $P < 0.05$).

Cephalometric analysis

The mean absolute mandibular length of this sample was 110.3 mm and the mean absolute ramus height was 56.1 mm (Table 3). There were 22 patients (60.7%) whose mandibular lengths were less than the normative mean values, and 19 patients (51.4%) whose ramus heights were less than the norms.[18] Totally, 17 patients (45.9%) had both mandibular length and ramus height values that were less than their normative counterparts. Though smaller mandibular lengths were observed in the JRA sample when compared with the controls, none of these mean differences attained statistical significance, nor were there significant differences among the three JRA groups for mandibular length. A significant difference in absolute ramus height was found among the three JRA groups as indicated by ANOVA test ($P < 0.042$, Table 3). Ramus height was considerably smaller in the polyarticular group than in the other two groups. The mean standardized mandibular length and ramus height for the JRA sample were -0.66 and +0.43, respectively. The systemic group had the lowest mean standardized mandibular length, the polyarticular group had an intermediate value, and the pauciarticular group had the highest value (however, these differences were also not significant).

Mandibular length was negatively correlated with age in all JRA subjects ($r = -0.395$, $P < 0.016$). Spearman correlations demonstrated moderately strong inverse relationships between average grade of the TMJ with mandibular length as well as with ramus height in both the pauciarticular and polyarticular groups (= -0.446, = -0.694; $P < 0.05$). The standardized (age-adjusted) measures of mandibular length and ramus height also were significantly negatively correlated with the average grades of TMJ lesions (= -0.505, $P < 0.005$; = -0.329, $P < 0.05$). Also, the duration of JRA was negatively correlated with standardized mandibular length ($r = -0.361$, $P < 0.028$). No associations could be found between RF or ANA and the various indicators of mandibular growth (i.e., absolute or standardized mandibular length and ramus height).

Discussion

The JRA children evaluated here exhibited a higher percentage of polyarticular and lower percentage of pauciarticular patients than reported by Calabro.[21, 22]

The rate of 62% TMJ involvement based on the CT morphological evidence in our sample is at the high end of the range of 5–65% reported in JRA.[2,6,12,14,23-25] Based on these findings, one might also expect relatively high rates of signs and symptoms of TMJ disorders, but the craniomandibular index of this sample was relatively low (0.18), and the majority of patients had no palpation tenderness. This CMI is substantially lower than that typical of the clinical population of adults with craniomandibular disorders (0.42).[16] Present findings also contrast those of Forsburg et al.,[26] who found a high rate of palpation tenderness in the posterior aspect of the TMJs in JRA patients. They also found a high prevalence of reduced TMJ mobility and crepitations, which were low in this study. They focused on a severely afflicted group of JRA patients, while our group represents a broader spectrum of JRA patients.

The systemic-onset group of JRA patients had the highest CMI and the pauciarticular group had the lowest value, which is consistent with Garza,[11] whose systemic patients had more severe signs and symptoms than the other two groups. Also, only the mean CMI (0.21) for systemic group could not be distinguished statistically from that typical of adults with early stage craniomandibular disorders. This failure to find a difference may be more reflective of the small systemic-onset sample size (N = 6) and attendant lack of statistical power rather than any real comparability between these two groups.

The reliability and validity of the CMI has been established in the scientific literature for the adult population[15,16] and therefore was chosen for this study from the many diagnostic indices available. However, it should be understood that further work is needed to calibrate this index for children. The low CMI values found here may reflect this need.

In three of the five age groups examined, disproportionately more JRA children had limited opening (< 35 mm) than normal age counterparts reported by Brandt.[17] The mean opening value of 34.02 mm for the total JRA sample does not differ significantly from the normative value of 35 mm. However, mandibular opening in the JRA patients may be achieved primarily by means of condylar rotation with restricted translation. Further investigation of condylar movement in these patients is indicated. The negative correlation between the average grade and maximal opening showed that the opening was more limited as the TMJ was more severely involved. However, the lack of an association between diagnostic category and the extent of opening suggests that limited opening was not confined to any particular type of JRA.

No association between diagnostic category and joint pain could be found in this study. The average grade of TMJ lesions was not related to joint pain upon opening, protrusion, or during lateral excursions. Several explanations for these findings regarding pain have been offered. JRA children may have a high threshold for pain, perhaps limiting their complaints.[27] Also, pain is a subjective experience and depends on an individual's tolerance; tolerance in JRA children may be greater than in healthy children for whom pain is an infrequent experience. Also, many of these JRA patients receive nonsteroidal anti-inflammatory drugs that may ameliorate or mask TMJ pain.

The circumpubertal age group (11–12) reported significantly more symptoms than controls,[17] which agrees with the studies by Forsburg et al.[26] and Olson et al.[28] Collectively, these findings suggest that hormonal changes during puberty (primarily in females) may either exacerbate active disease in the TMJ and/or result in heightened perception of pain and discomfort in this and other joints.

Lower facial asymmetry was a positive indicator of joint deterioration: the vertical difference of mandibular angle regions, expressed as the difference in ramus height between the two sides, was found to be associated with the average grade of TMJ lesions. Stabrun et al.[2] also indicated that the vertical difference between the two mandibular angles was associated significantly with the presence of TMJ abnormalities and the most sensitive indicator of TMJ involvement in JRA. However, they did not describe exactly how reference lines were constructed. This is important, as the location of the mandibular angles may be difficult to determine, especially in children with chubby cheeks. We offer a simple and repeatable method for making this assessment of facial asymmetry.

Unequal TMJ involvement, defined in this study as one TMJ having a higher grade than the other, was investigated for its relationship with chin deviation to the same side. Greater destruction of the left TMJ was found to be associated with same-sided chin deviations in all JRA subjects. This has potential clinical value in the early and noninvasive detection of TMJ pathosis. We found 35.1% of the JRA subjects had chin deviations. Stabrun et al.[2] reported a lower prevalence of asymmetry (25.7%), but did not differentiate between deviation to the right and left sides. However, they later reported a strong association between facial asymmetry and TMJ abnormalities and concluded that the vertical difference between the mandibular ramus heights caused a deviation to one side at maximal opening or protrusion and that this would indicate unilateral TMJ involvement.[13]

Although the *significance* of these correlations clearly demonstrates the *presence* of real relationships between sign/symptoms and TMJ disease (i.e., that evidenced by the CT variables), they are for the most part, of insufficient *magnitude* to reliably predict degenerative changes in an individual child. Variance in the most predictive clinical variables (nonradiographic) explain only 9–13%* of the variance in destructive

* If simple linear regressions (rather than Spearman correlations) of the CT variables on the clinical variables are computed, the R^2 values, which reflect the percentage of variance in the outcome variable that is explained by that in the predictor variable, fall in this approximate range.

changes in the mandibular condyle. The linear mandibular measures (cephalometric) predict somewhat better, explaining from 10 to 50% of the variance in TMJ destruction.

Clinical symptoms and signs by themselves were not reliable indicators of TMJ condylar destruction, agreeing with previous studies that some type of radiographic evaluation is required.[2,4,6,13,24] Although our subjects had more limited mandibular opening than did unaffected children, the functional deficit was not correlated with the extent of TMJ condylar destruction, as evaluated from CTs. Pain was not a reliable indicator for TMJ condylar degeneration in this study. This finding contrasts the reports of Karhulahti et al.[12] and Muir and Goss.[7]

Clinical examination has been reported to have high diagnostic sensitivity and specificity with regard to TMJ internal derangement.[29-31] These reports are not inconsistent with our study. TMJ dysfunction in the majority of patients is manifest in the soft tissues of the extracapsular and intracapsular structures. Clinical exam is reliable in quantifying dysfunction and soft tissue derangement. However, our study suggests that it has limited value in predicting the extent of bone degeneration in the joint.

Mandibular growth and TMJ abnormalities

In all, 17 patients (45.9%) manifested micrognathic tendencies as defined by smaller than normal absolute mandibular lengths and ramus heights. The ongoing secular trend may have some bearing on the normative cephalometric data used in this study, collected approximately 25–40 years ago. Children in a contemporaneous control group would be larger than those in this study, making the findings of diminished linear measurements more profound (Garza[11]).

The negative correlation between the average grade of TMJ lesions and standardized mandibular length showed that mandibular length is smallest in those individuals in whom TMJ lesions are most severe. The standardized mandibular length measurements (Z score) had the effects of age and sex removed by reference to the normative data of Riolo et al.,[18] yielding even higher correlations with other variables than with absolute mandibular length. This significant relationship between the radiographic evidence of TMJ lesions and deficient mandibular size supports the conclusion that TMJ destruction contributes to reduced mandibular growth and agrees with Stabrun et al.,[13] who found a strong negative correlation between radiographic evidence of arthritis in the TMJ and mandibular growth.

Among the three JRA groups, systemic subjects exhibited the most deficient mandibular length values with a Z score of -1.27, which indicates that on average, these children were slightly more than 1 SD below the population norm for healthy children.[18] The mean of standardized ramus height was 0.43 in this JRA sample, and the systemic group had a Z score of -0.25. This suggests that deficient mandibular growth was not reflected in ramus height, at least in the pauciarticular and polyarticular groups. Such a finding might be explained by compensatory growth resulting in the development of exostosis.[32] Björk and Skieller[33] interpreted this to be the result of a pronounced posterior rotation of the mandible in JRA children. They also suggested that these children exhibit significantly accentuated antegonial notches as a result of excessive bone apposition in the gonial region. In the view of Seymour et al.,[34] this accentuation of the antegonial notch occurs in conjunction with a reduced ramus height and a shortened mandibular body.

Our findings and those of others indicate that destruction of the mandibular condyle is related to an overall reduction in mandibular size. Two possible explanations, not necessarily mutually exclusive, account for this phenomenon. The first may involve an acute catastrophic event. If inflammation and destruction of the TMJ from the JRA is intense, a rapid alteration of condylar structure could occur, accompanied by a decrease in vertical support and mandibular length. The second mechanism may involve a more protracted effect on growth. Ongoing endochondral bone formation in the condyle is key to the mandibular enlargement that occurs normally during maturation. If cellular activity within the condylar head is disturbed by the JRA disease process, growth of the mandible may be compromised, resulting in facial deformity.

The relationship between clinical signs and symptoms of TMJ dysfunction and CT evidence of bone destruction in the TMJs of these children was examined. The CT methods used here detected a prevalence of TMJ destruction sufficiently high to warrant concern. The magnitude of condylar degeneration was not correlated strongly with any of the clinical examination findings; those subjects with definitive CT evidence of TMJ destruction (62%) could not be identified reliably using any of the clinical parameters. These results suggest that the TMJ should be assessed thoroughly by clinical examination in conjunction with imaging techniques that might provide additional information about the level of intracapsular bone involvement. This information would be helpful for early treatment intervention, potentially reducing the devastating degenerative effects of this disease on masticatory function and growth of the facial skeleton.

Conclusions

1. The circumpubertal group of JRA children (11–12 years) exhibited significantly higher frequencies of joint noise and pain and muscle tenderness and decreased opening than those found in unaffected children.
2. The craniomandibular index (CMI) was generally low in this sample, and not a good predictor of bony destruction of TMJ.
3. More than 50% of the patients showed chin deviation or vertical difference between mandibular angle regions, and the latter was correlated with the aver-

age grade of the TMJ lesions. This manifestation may be of some value in detecting TMJ abnormalities.

4. When mandibular length was standardized (age and sex effects removed), it was found to have a negative association with the extent of TMJ pathosis, that is, those with the most severe joint abnormalities tended to have the shortest mandibular lengths.
5. In general, none of the clinical signs and symptoms examined here were consistently reliable indicators of osseous TMJ degeneration in children with JRA.

This research was supported by Texas Scottish Rite Hospital for Children and Baylor College of Dentistry, Dallas, Texas.

Dr. Hu is in private practice in Taipei, Taiwan. Dr. Schneiderman is associate professor and director of research, Department of Oral and Maxillofacial Surgery and Pharmacology, and director of academic computing. Dr. Harper is assistant professor, Department of Oral and Maxillofacial Surgery and Pharmacology, both at Baylor College of Dentistry, Dallas, Texas.

1. Riolo ML, ten Have TR, Brandt D: Clinical validity of the relationship between TMJ signs and symptoms in children and youth. ASDC J Dent Child 55:110–13, 1988.
2. Stabrun AE: Mandibular morphology and position in juvenile rheumatoid arthritis. a study on postero-anterior radiographs. Eur J Orthod 7:288–98, 1985.
3. Tallents RH, Catania J, Sommers E: Temporomandibular joint findings in pediatric populations and young adults: a critical review. Angle Orthod 61:7–16, 1990.
4. Larheim TA: Comparison between three radiographic techniques for examination of the temporomandibular joint in juvenile rheumatoid arthritis. Acta Radiol Diagn (Stockh) 22:195–201, 1981.
5. Larheim TA, Haanæs HR: Micrognathia, temporomandibular joint changes and dental occlusion in juvenile rheumatoid arthritis of adolescents and adults. Scand J Dent Res 89:329–38, 1981.
6. Larheim TA, Höyeraal HM, Stabrun AE, Haanæs HR: The temporomandibular joint in juvenile rheumatoid arthritis. Radiographic changes related to clinical and laboratory parameters in 100 children. Scand J Rheumatology 11:5–12, 1982.
7. Muir CB, Goss AN: The radiologic morphology of painful temporomandibular joint. Oral Surg Oral Med Oral Pathol 70:355–59, 1990.
8. Katzberg RW, Keith DA, Guralnick MC, Manzione JV, ten Eick WRT: Internal derangement and arthritis of the temporomandibular joint. Radiology 146:107–12, 1983.
9. Bibb CA, Pullinger AG, Baldioceda F, Mukakami K, Ross JB: Temporomandibular joint comparative imaging: diagnostic efficacy of arthroscopy compared to tomography and arthrography. Oral Surg Oral Med Oral Pathol 68:352–59, 1989.
10. Hu YS, Schneiderman ED: The temporomandibular joint in juvenile rheumatoid arthritis: I. Computed tomographic findings. Pediatr Dent 17:46–53, 1995.
11. Garza RJ: Dental and skeletal malocclusion in juvenile rheumatoid arthritis. MS Oral Biology, Baylor University, 1992.
12. Karhulahti T, Rönning O, Jämsä T: Mandibular condyle lesions, jaw movements, and occlusal status in 15-year-old children with juvenile rheumatoid arthritis. Scand J Dent Res 98:17–26, 1990.
13. Stabrun AE, Larheim TA, Höyeraal HM, Rosler M: Reduced mandibular dimensions and asymmetry in juvenile rheumatoid arthritis: pathogenetic factors. Arthritis Rheum 9:602–11, 1988.
14. Barriga B, Lewis TM, Law DB: An investigation of the dental occlusion in children with juvenile rheumatoid arthritis. Angle Orthod 44:329–35, 1974.
15. Fricton JR, Schiffman EL: Reliability of a craniomandibular index. J Dent Res 65:1359–64, 1986.
16. Fricton JR and Schiffman EL: The craniomandibular index: validity. J Prosthet Dent 58:222–28, 1987.
17. Brandt D: Temporomandibular disorders and their association with morphological malocclusion in children. In: Developmental Aspects of Temporomandibular Joint Disorders. DS Carlson, JA McNamara, KA Ribbens, Eds. Ann Arbor: The University of Michigan, 1985.
18. Riolo ML, Moyers RE, McNamara JA, Hunter WS: An Atlas of Craniofacial Growth. Monograph No. 2. Ann Arbor: University of Michigan, Center for Human Growth and Development, 1974.
19. Viazis AD: A cephalometric analysis based on natural head position. J Clin Orthod 25:172–81, 1991.
20. Rohlin M, Petersson A: Rheumatoid arthritis of the temporomandibular joint: radiologic evaluation based on standard reference films. Oral Surg Oral Med Oral Pathol 67:594–99, 1989.
21. Calabro JJ: Juvenile rheumatoid arthritis: mode of onset as key to early diagnosis and management. Postgraduate Medicine 70:120–33, 1981.
22. Calabro JJ: Rheumatoid arthritis: diagnosis and management. Clin Symp 38:3–32, 1986.
23. Rönning O, Väliaho M, Laaksonen A: The involvement of the temporomandibular joint in juvenile rheumatoid arthritis. Scand J Rheumatol 3:89–96, 1974.
24. Larheim TA, Dale K, Tveito L: Radiographic abnormalities of the temporomandibular joint in children with juvenile rheumatoid arthritis. Acta Radiol Diagn (Stockh) 22:277–84, 1981.
25. Mayne JG, Hatch GS: Arthritis of the temporomandibular joint. J Amer Dent Ass 70:125–30, 1969.
26. Forsburg M, Agerberg G, Persson M: Mandibular dysfunction in patients with juvenile rheumatoid arthritis. J Craniomandib Disord 2:201–08, 1988.
27. Calabro JJ, Holgerson WB, Sonpal GM, Khoury MI: Juvenile rheumatoid arthritis: A general review and report of 100 patients observed for 15 years. Semin Arthritis Rheum 5:257–98, 1976.
28. Olson L, Eckerdal O, Hallonsten A, Helkimo M, Koch G, Gare BA: Craniomandibular function in juvenile chronic arthritis. a clinical and radiographic study. Swed Dent J 15:71–83, 1991.
29. Bezuur JN, Habets LL, Hansson TL: The recognition of craniomandibular disorders: condylar symmetry in relation to myogenous and arthrogenous origin of pain. J Oral Rehabil 16: 257–60, 1989.
30. Nitzan DW, Dolwick FM, Marmary Y: The value of arthrography in the decision-making process regarding surgery for internal derangement of the temporomandibular joint. J Oral Maxillofac Surg 49: 375–79, 1991. [Discussion 379–80.]
31. Romanelli GG, Harper RP, Mock D, Pharoah MJ, Tenenbaum HC: Evaluation of temporomandibular joint internal derangement. J Orofacial Pain 7:254–62, 1993.
32. Jämsä T, Rönning O: The facial skeletal in children affected by rheumatoid arthritis — a roentgen-cephalometric study. Eur J Orthod 7:48–56, 1985.
33. Björk A, Skieller V: Normal and abnormal growth of the mandible. A synthesis of longitudinal cephaolometric studies over a period of 25 years. Eur J Orthod 5:1–46, 1983.
34. Seymour RL, Crouse VL, Irby WB: Temporomandibular ankylosis secondary to the rheumatoid arthritis: report of a case. Oral Surg 40:584–89, 1975.