Characteristics of Masticatory Movements and Velocity in Children With Juvenile Chronic Arthritis

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Oral motor function (mandibular displacement and velocity) in individuals with juvenile chronic arthritis was studied by using an optoelectronic method. The children were compared with two asymptomatic groups: one group with Class I occlusion and the other with Class II malocclusion. The results showed that children with juvenile chronic arthritis and condylar lesions had reduced lateral mandibular masticatory movements. In children with Class II malocclusion, a longer three-dimensional closing distance and a slower closing velocity were found. In children with both juvenile chronic arthritis and Class II malocclusion, an interaction between juvenile chronic arthritis and malocclusion resulted in a longer occlusal time, a shorter amplitude, and a slower velocity. It can be concluded that juvenile chronic arthritis and Class II malocclusion, per se, might have minor influences on the chewing characteristics, but the two factors seem to interact, resulting in an altered masticatory pattern. A possible explanation is that children with juvenile chronic arthritis have an increased risk of developing a Class II malocclusion because of the growth disturbances sequelae of condylar lesions. The alteration in occlusion, together with restricted movements in the arthritic condyle, may be the underlying reasons for the findings.
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Studies of masticatory function have shown great individual variation in the chewing pattern, influenced by a number of different factors, such as age, sex, state of dentition, and hardness and size of bolus.[1–16]

Research data also suggest that subjects with altered occlusion, as those with malocclusions like Class II malocclusion (distal occlusion), Class III malocclusion (mandibular prognathism), or lateral crossbite, show a more complicated and irregular pattern than individuals with Class I occlusion.[1,2,15,17] Another factor that seems to influence the chewing pattern is the presence of temporomandibular disorders (TMD). Individuals with TMD likewise show a more irregular pattern and a disturbed and restricted chewing rhythm.[11,13,14,18–20]

Compared to healthy children of the same age, children with juvenile chronic arthritis (JCA) often show a higher frequency of both Class II malocclusion and TMD[21–25] (including radiographically visible condylar lesions in 40% to 55% of the diseased children[23,25]). Previous studies have also found reduction in mandibular border movements[21,23] and reduced translatory capacity of the mandibular condyle in these children.[26]

The aim of this study was to describe the oral motor function in individuals affected by JCA, in comparison with two healthy

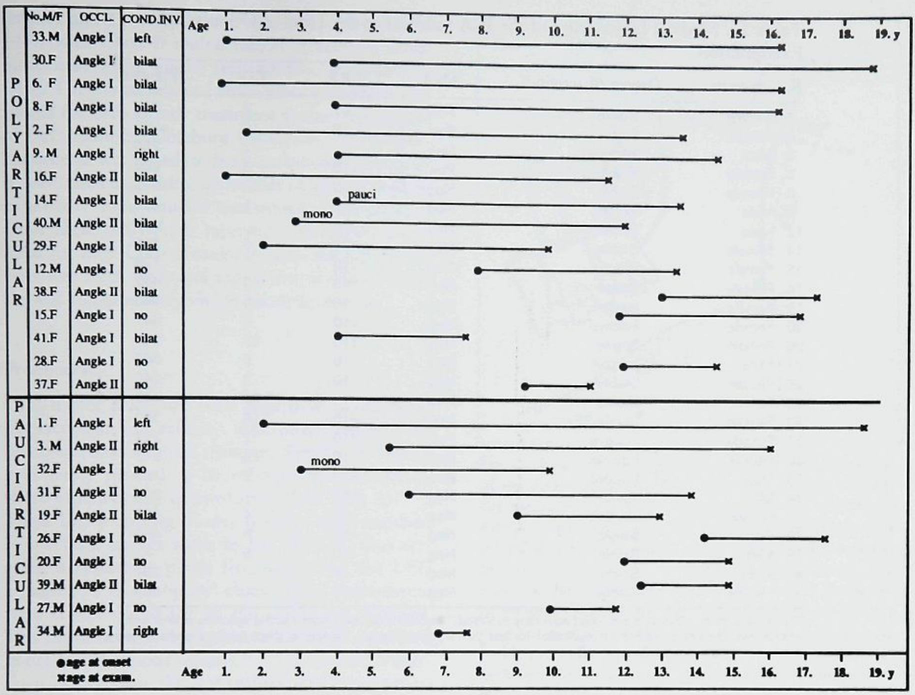

Fig 1 History of JCA in the subjects. Subtype at onset and at examination, occlusion as Class I (neutral) or Class II (distal), and radiographically diagnosed condylar lesions unilaterally or bilaterally. The subjects are presented in relation to the number of joints involved at the examination date. In pauciarticular disease, one to four joints are involved, in polyarticular disease, five or more joints are involved. • = age at onset of the disease, × = selspot examination date.

groups, divided according to whether they had Class I occlusion or Class II malocclusion. The objective was also to relate radiographically detectable condylar lesions with masticatory characteristics in subjects with JCA.

Materials and Methods

Subjects

The present study comprised three different groups of individuals: the JCA group and two groups of individuals without JCA (one with Class I occlusion, the other with Class II malocclusion).

The JCA Group. This group comprised 26 individuals (18 females and 8 males, mean age 13.4 years, range 7.5 to 18.8) affected with JCA according to the criteria of European League Against Rheumatism (EULAR).[27] The medical history provided information on the age at onset and the different subgroups of the disease at onset and at the time of the clinical dental examination (Fig 1).

The age at onset varied from 8 months to 14.5 years, and the duration of the disease ranged from 1 year to 16.5 years. At the onset of the disease, two patients were suffering from monoarthritis, 10 from pauciarthritis, and 14 from polyarthritis. The monoarthritic patients changed their status to pauciarthritis and polyarthritis respectively, and one of the pauciarthritic children had changed to polyarthritis (Fig 1).

The anamnestic clinical data and results of laboratory tests of the children provided information

Table 1 Medical Description of the JCA Subjects at the Time of Odontologic Examination

JCA patients	Degree of activity*	ANA	CRP	ESR	Platelets
1. Female	Stable	Pos	–	2	280
2. Female	Stable	Pos	19	18	305
3. Male	Inactive	Neg	–	3	250
6. Female	Stable	Pos	<10	3	206
8. Female	Stable	Neg	10	32	323
9. Male	Stable	Neg	–	1	238
12. Male	Inactive	Neg	<5	–	413
14. Female	Stable	Neg	<10	6	306
15. Female	Inactive	Neg	<10	–	196
16. Female	Stable	Neg	13	20	442
19. Female	Inactive $^{\text{HLA B27+}}$	Neg	16	26	260
20. Female	Inactive $^{\text{HLA B27+}}$	Neg	<10	8	347
26. Female	Stable	Neg	<10	22	261
27. Male	Inactive	Neg	<10	5	362
28. Female	Stable	Neg	<10	3	240
29. Female	Stable	Neg	–	15	310
30. Female	Stable RF+	Neg	<10	18	360
31. Female	Inactive	Pos	<10	2	229
32. Female	Inactive	Pos	<10	18	249
33. Male	Inactive	Pos	<10	2	199
34. Male	stable	Neg	<10	–	230
37. Female	Inactive	Neg	<10	4	430
38. Female	Stable	Neg	<10	6	401
39. Male	Stable	Neg	<10	5	–
40. Male	Stable	Neg	<9	–	291
41. Female	Stable	Neg	<10	–	265

*The activity of the disease is described according to Wood.[27] Inactive = No evidence of active synovitis and/or extra-articular manifestations and without medication for less than 2 years. Stable = Number of joints involved is unchanged during medication. RF+ = Rheumatoid factor present.

on the activity of the disease at the dental examination (Table 1). The degree of activity at the dental examination was characterized as inactive (no evidence of active synovitis and/or extra-articular manifestations and without medication for less than 2 years) in 10 of the patients and stable (the number of joints involved is unchanged during medication) in 16 of the patients.

The results from the laboratory tests revealed antinuclear antibodies (ANA), IgM rheumatoid factor (RF), C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and platelets at the clinical dental examination (Table 1). Seven patients were ANA positive, and one patient was RF positive.

Seventeen subjects (65%) showed radiologically visible condylar lesions, five of which were unilateral (Fig 1). Condylar lesions were diagnosed on panoramic radiographs and quantified by a condylar ratio (co'–inc'/inc'–go' for the left and right side) (Fig 2) (for details see Kjellberg et al[28]). Nine patients with JCA (35%) had Class II malocclusion, and 16 patients (62%) had a distal skeletal pattern (ANB > 4 degrees) with a retrognathic mandible at the date of the examination. Five of the patients, all with Class II malocclusion, were orthodontically treated into Class I occlusion before the analysis of masticatory movements.

Individuals With Class I Occlusion. This group comprised 90 asymptomatic subjects, (45 females and 45 males, mean age 14.7 years, range 8.9 to 22.0). The subjects were selected consecutively from the patients visiting the Department of Orthodontics, Göteborg University, Göteborg, Sweden, during the regular check-ups for occlusal development. The adult group consisted of undergraduate students at the Department of Prosthetic Dentistry, Göteborg University. All individuals had Class I occlusion with a harmonious profile indicating a normal skeletal pattern. For ethical reasons, no cephalometric radiographs or panoramic radiographs were taken, and hence the skeletal patterns could not be studied. Condylar lesions could also not be radiographically diagnosed in this group, but all subjects were free from signs and symptoms of TMD. Presence of condylar destructions were assumed to be zero.

Individuals With Class II Malocclusion. This group comprised 30 asymptomatic subjects (19 females and 11 males, mean age 10.4, range 8.4 to 14.4) with Class II malocclusion, a skeletal distal pattern in 93%, and a retrognathic mandible in 70%. They were selected from among children registered for orthodontic treatment at the Department of Orthodontics, Göteborg University. The following criteria were used: a distal molar relationship of at least one cusp width, an overjet of greater than or equal to 7 mm, and no transversal discrepancies. Later these individuals received orthodontic treatment for their Class II malocclusion. All individuals were free from signs and symptoms of TMD. None showed radiologically visible condylar lesions.

Procedure

Oral motor function, with regard to mandibular displacement and velocity, was monitored with an optoelectronic method (Selspot, Partille, Sweden), previously proved to be reliable for measuring three-dimensional quantitative data (Fig 3).[7,29,30] Three light-emitting diodes (LEDs) were attached to spectacle frames worn by the subjects, thus creating a reference plane for measuring the LED attached to the subjects' chins. Head movements were compensated for by the computer program. This movement analysis system has been described in detail in previous reports.[6,7,30,31] To record a masticatory sequence, the test subject was requested to sit upright in a dental chair and chew peanuts (1.5 ± 0.2 g). Two masticatory sequences from start to swallowing, omitting the first incomplete masticatory cycle in each sequence, were recorded and analyzed for each subject, for a mean of 38 analyzed cycles per subject. Subjects were allowed to change the bolus from side to side at random.

For the computer analysis, a masticatory cycle was divided into three separate phases (Fig 4): mandibular opening, mandibular closing, and an occlusal level phase. The occlusal level phase is defined as an arbitrary position of the mandible, from maximum intercuspation to a level 0.5 mm inferior to that position. A quantitative analysis was performed of the following variables:

1. Time variables: the total duration of a masticatory cycle (TCD) as well as the subdivision of it, the occlusal phase (OP), the closing phase (CP), and the occlusal level phase (OLP)
2. Distance variables: the mean spatial mandibular displacement in the OP and CP phases, the maximal linear lateral distances and linear vertical opening amplitude ($a = [y^2 + z^2]^{1/2}$ = maximum amplitude in the vertical/anteroposterior position) (Fig 4)

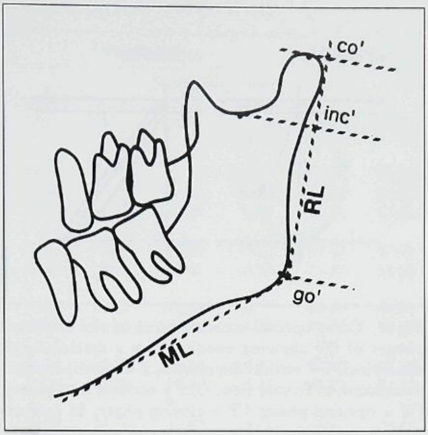

Fig 2 Reference points and lines used for calculation of the condylar ratio co'–inc'/inc'–go' percent. The linear measurements were condylar height (co'–inc') and ramus height (inc'–go'). The right and left joints were recorded separately. ML = mandibular line; RL = ramus line; co' = the projection of condylion (the most superior point on the condylar head) on RL; inc' = the projection of incisura mandibulae (the deepest point between processus coronoideus and processus condylaris) on RL; go' = the projection of gonion (the point of intersection between ML and RL on the mandibular contour) on RL.

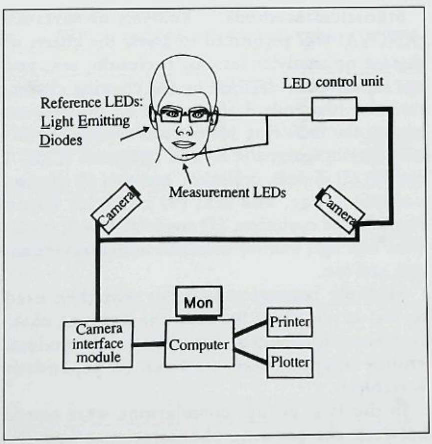

Fig 3 Components of the movement analysis system.

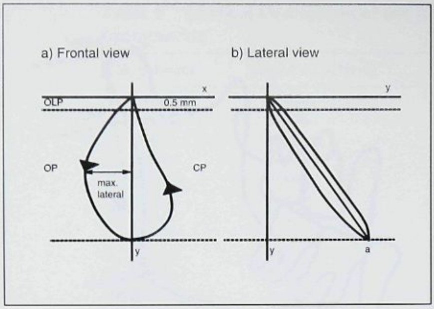

Fig 4 Computerized measurements of the different phases of the chewing envelopes. x = mesiolateral dimensions, y = vertical dimensions, z = anteroposterior dimensions. a) Frontal view: OLP = occlusal level phase; OP = opening phase; CP = closing phase. b) Lateral view: a = amplitude = $(y^2 + z^2)^{1/2}$. (All measurements, except amplitude and maximal lateral measurements, were based on three-dimensional recordings.)

3. Velocity variables: the mean velocity measured three-dimensionally in the OP and CP divisions

Error of the Method. The technical and spatial error of the method has been studied previously[29,30] and was found to be less than 1% of the recorded variables: the magnitude of mandibular displacement, mandibular velocity, and masticatory cycle duration.

Statistical Methods. Analysis of variance (ANOVA) was performed to assess the effects of disease or condylar lesions, occlusion, sex, and age (independent factors) on the chewing characteristics (dependent factors). The interaction among the following factors was tested: *(1)* disease (asymptomatic/JCA) and occlusion (Class I and II); *(2)* disease, occlusion, and age; *(3)* disease, occlusion, age, and sex; *(4)* condylar lesion (yes/no) and occlusion; *(5)* condylar lesion, occlusion, and age; and *(6)* condylar lesion, occlusion, age, and sex.

Multiple regression analysis was then used to test correlations between the chewing characteristics (dependent variables) and maximal mouth opening, age, and sex (independent variables).

In the JCA group, correlations were tested between the chewing characteristics and the condylar ratio (co'–inc'/inc'–go').

Results

The mean values for the chewing characteristics and the mean values for the interacting combinations between disease or condylar lesions and occlusion are presented in Table 2. The statistically significant values found for the interactions between disease or condylar lesions, occlusion, age, and sex are listed in Table 3.

Masticatory Cycle Duration

For the total cycle duration as well as for the different phases, no statistically significant differences were found either between asymptomatic subjects and JCA subjects or between Class I occlusion and Class II malocclusion. However, a statistically significant interaction was found between disease and occlusion, resulting in a longer occlusal phase duration (P = .028) in JCA subjects with Class II malocclusion (Tables 2 and 3). Interactions were also found between age, disease, and occlusion, but these results must be interpreted with caution because there were few individuals in each subgroup.

Magnitude of Masticatory Mandibular Displacement

The maximal lateral distance was significantly shorter in the JCA subjects compared with asymptomatic subjects (P = .0003) and also significantly shorter in individuals with condylar lesions compared with individuals without lesions (P = .0002) (Tables 2 and 3).

A smaller condylar ratio (co'–inc'/inc'–go') (Fig 2), indicating bony destructions of the condylar head, was positively correlated to a reduced maximal lateral chewing distance (P = .016).

The three-dimensional closing distance was significantly longer in the subjects with Class II malocclusion than in subjects with Class I occlusion (P = .027). The interaction between disease and occlusion was evident in the sagittal amplitude, which was found to be shorter in subjects with Class II malocclusion (P = .041) (Tables 2 and 3).

Mandibular Velocity

The closing velocity was significantly slower in the Class II group than in the Class I group (P = .033). An indication of interaction between occlusion and disease was found both for opening and closing velocity because subjects affected with JCA who also had Class II malocclusion had a slower veloc-

Table 2 Mean Values of the Chewing Characteristics

	No. of individuals	Duration for the different phases (s): Total	Opening	Closing	Occlusal	Distance (mm): Opening (3D)	Closing (3D)	Amplitude max linear	Max lateral linear	Velocity (mm/s): Opening	Closing
Age											
7–10	57	0.66	0.18	0.32	0.17	14.76	14.72	13.16	6.61	89.20	60.08
11–14	52	0.69	0.21	0.31	0.17	14.42	14.62	13.04	6.32	79.36	61.26
15–21	38	0.68	0.23	0.28	0.17	13.64	13.42	13.07	6.07	74.02	67.56
Sex											
Male	83	0.67	0.21	0.31	0.16	15.07	14.98	13.99	7.02	87.20	67.97
Female	64	0.69	0.20	0.30	0.18	13.80	13.86	12.41	5.86	77.62	58.16
Disease											
Healthy	121	0.68	0.21	0.31	0.16	14.44	14.29	13.35	6.71	83.95	64.01
JCA	26	0.68	0.20	0.29	0.20	13.95	14.62	11.90	4.77	71.74	55.08
Occlusion											
Class I	108	0.68	0.21	0.32	0.16	14.21	13.79	13.44	6.59	82.50	62.82
Class II	39	0.66	0.19	0.28	0.20	14.76	15.89	12.14	5.73	79.83	61.35
Condylar lesion											
Lesion	17	0.68	0.20	0.28	0.20	14.40	14.77	12.49	4.37	73.21	54.84
No lesion	130	0.68	0.21	0.31	0.17	14.35	14.29	13.17	6.63	82.92	63.42
Interacting combination											
Healthy/Cl I	91	0.69	0.21	0.32	0.15	14.39	13.80	13.83	7.00	85.32	64.50
Healthy/Cl II	30	0.65	0.19	0.27	0.20	14.59	15.76	11.89	5.82	79.80	62.53
JCA/Cl I	17	0.66	0.19	0.27	0.20	13.20	13.72	11.33	4.41	67.40	53.85
JCA/Cl II	9	0.70	0.20	0.31	0.20	15.34	16.31	12.99	5.44	79.94	57.41
No lesion/Cl I	97	0.68	0.21	0.32	0.15	14.26	13.77	13.60	6.87	83.98	64.17
No lesion/Cl II	34	0.65	0.19	0.27	0.20	14.57	15.80	11.88	5.91	79.99	61.12
Lesion/Cl I	11	0.67	0.19	0.28	0.20	13.74	13.96	11.98	4.14	69.50	50.94
Lesion/Cl II	5	0.73	0.22	0.29	0.22	16.08	16.44	13.90	4.48	78.80	62.88

3D = Three-dimensional distance.

Table 3 Factors Influencing the Masticatory Characteristics and their Interaction

Independent variables	Duration for the different phases (s): Total	Opening	Closing	Occlusal	Distance (mm): Opening (3D)	Closing (3D)	Amplitude max linear	Max lateral linear	Velocity (mm/s): Opening	Closing
Age	↓young**	↓young**								
Disease								↓JCA***		
Condylar lesions								↓cond. les***		
Occlusion						↑Class II*				↓Class II*
Disease/ occlusion				↑JCA/ Class II*			↓JCA/ Class II*		↓JCA/ Class II	↓JCA/ Class II
Condylar lesions/ occlusion										↓cond. les/ Class II*
Age/disease/ occlusion	↓young/ JCA/ Class I**	↓young/ JCA/ Class II*	↓elder/ JCA/ Class II*							
Age/condylar lesion/ occlusion	↑elder/ cond. les/ Class I**	↓young/ cond. les/ Class II**	↓elder/ cond. les/ Class II**						↓elder/ cond. les/ Class II*	
Age/sex/ disease occlusion		↓young/ girl/JCA Class II**								

3D = Three-dimensional-distance, ↑ = increase, ↓ = decrease.
$^{*}P < .05$; $^{**}P < .01$; $^{***}P < .001$.

ity for both the OP and CP phases (P = .053 and P = .052). The results for the interaction between age, occlusion, and condylar lesions pointed in the same direction (Tables 2 and 3).

Maximal Mouth Opening

A single slight correlation was found, namely between a small maximal lateral position and a restricted mouth opening capacity (P = .013).

Discussion

The comparison of chewing characteristics between subjects with JCA and asymptomatic subjects showed one single difference, namely in measurement of the chewing cycle expressing the maximal lateral masticatory movement. In subjects with Class II malocclusion, a significantly longer three-dimensional closing distance and a slower closing velocity were found. However, the interaction between JCA and Class II malocclusion resulted in statistically significant differences in the chewing duration, distances, and velocity, compared to asymptomatic subjects with Class I occlusion. This is not surprising because the progressive destruction of the condylar cartilage and bone in children with arthritis in the condyles leads to growth disturbances of the mandible resulting in a higher frequency of Class II malocclusion in these children.

Orthodontic activator treatment performed in some of the JCA subjects may have influenced the results when the occlusion was changed from Class II malocclusion to Class I occlusion. However, in a study of Thüer et al,[32] alteration in mandibular function was not found as an effect of similar treatment. If the masticatory pattern had changed among the treated subjects in the present study, it likely would have changed to values resembling those from Class I subjects, resulting in less statistically significant differences between the groups.

In studies on TMD in JCA children, a reduction in mandibular border movements[21–23] and reduced translatory capacity of the mandibular condyle have been shown.[26] However, according to the findings in the present study, restrictions were found, not only for border movements, but also for the mandibular movements during normal chewing. Furthermore, there was a correlation between a small maximal mouth opening and small lateral mandibular movements during chewing. This is in agreement with studies by Ozaki et al[14] and Mongini et al,[20] who observed a decreased movement capacity in healthy adults with TMD, both for border and for masticatory movements.

Temporomandibular dysfunction, including radiographically visible condylar changes, thus seems to be correlated with an altered masticatory pattern in adults.[12–14,18,20] This seems to be true also for children with JCA as seen in the present study. One can assume that the deviations in the masticatory pattern would have been even larger if the activity of the disease had been in a more active phase than was the case among the investigated subjects. Whether an active inflammation in the condylar joints can influence the masticatory movement pattern needs to be studied. In healthy individuals, the movement pattern seems to be fairly constant if measurements are made under identical conditions.[29,30]

The shorter amplitude found in JCA subjects with Class II malocclusion may be explained by the decreased joint mobility following the arthritic destruction of the joint tissue and/or probably by smaller dimensions of the mandible in Class II cases.[25] Pröschel et al[15] found significantly smaller chewing distances in Class I and Class II individuals than in Class III individuals, who normally have a larger mandible. However, if this is due to the skeletal pattern, the occlusion or other factors remain to be studied.

The mean mandibular velocity was slower in JCA subjects with Class II malocclusion. A reduced velocity has also been previously found in adults with TMD,[20] indicating more careful chewing due to possible tenderness in the condylar region. Statistically significant differences in velocity were also found between Class I occlusion and Class II malocclusion, which is in contrast to results from previous studies by Ahlgren,[1] who found no statistically significant differences in velocity between different malocclusions. This is possibly because the method available at that time for that study was less sensitive and not based on three-dimensional measurements.

No statistically significant differences in the total masticatory cycle duration or for the opening and closing phases were found between the groups in the present study. Although no unambiguous differences could be found, there seems to be a rearrangement between the phases. The prolonged occlusal phase duration in JCA subjects with Class II malocclusion may be explained by a more unstable and irregular occlusion often found in both JCA and Class II subjects, or in the pain or discomfort that the JCA subjects may feel in the occlusal phase when the inflamed or destructed joints are loaded.

The slight disparities between previous studies[14–20] and the present study may possibly be explained by the differences between growing and adult individuals. Results from studies of growing individuals indicate that changes in masticatory movements, particularly for time and velocity variables, will occur during growth.[10,33] These changes may be explained by both central and peripheral neurophysiologic maturation and by changes in occlusion during exfoliation of the deciduous teeth.

In the present study, age and sex were included as independent variables, since the age and sex distribution differed between the three groups studied. In particular for the displacement variables, females have smaller values than males.[10] The interpretation of the interaction between all four factors (disease, occlusion, age, and sex) is done very carefully because of the few individuals and imbalance between the number of individuals tested.

It can be concluded that JCA and altered occlusion, per se, have a minor influence on the chewing characteristics. However, the interaction between both factors seems to result in changes in the normal masticatory pattern. The JCA subjects with Class II malocclusion are frequently exposed to both orthodontic treatment and to mandibular movement exercises to stabilize the occlusion and to increase restricted mandibular movement capacity. The effects of this on the masticatory pattern, however, are still unknown, and therefore, further studies on this subject are needed to clarify these questions.

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Resumen

Características de los movimientos y velocidad masticatoria en niños con artritis crónica juvenil

Se estudió la función motor oral (desplazamiento y velocidad mandibular) en individuos que sufrían de artritis crónica juvenil, por medio del uso de un método optoelectrónico. Los niños fueron comparados con dos grupos asintomáticos, un grupo con oclusión Clase I y el otro con oclusión Clase II. Los resultados demostraron que los niños con artritis crónica juvenil y lesiones condilares tenían los movimientos masticatorios mandibulares laterales disminuidos. En los niños con oclusión Clase II, se encontró que la distancia de cierre tridimensional era mas larga y que la velocidad de cierre era mas lenta. En los niños que tenían tanto artritis crónica juvenil como oclusión Clase II, la interacción entre la artritis crónica juvenil y la maloclusión trajo como resultado un tiempo oclusal mas largo, una amplitud mas corta, y una velocidad mas lenta. Se puede concluir que la artritis crónica juvenil y la oclusión Clase II, por si mismas, podrían tener influencias menores sobre las características masticatorias, pero los dos factores parecen interactuar, lo que trae como resultado un patrón masticatorio alterado. Una posible explicación puede ser que los niños con artritis crónica juvenil tienen un mayor riesgo de desarrollar oclusión Clase II debido a las secuelas de las alteraciones de crecimiento de las lesiones condilares. La alteración de la oclusión, junto con los movimientos limitados en el cóndilo artrítico, pueden ser las razones implícitas de estos hallazgos.

Zusammenfassung

Eigenschaften von Kaubewegungen und Geschwindigkeit bei Kindern mit juveniler chronischer Arthritis

Die orale motorische Funktion (Unterkieferbewegung und Geschwindigkeit) wurde bei Kindern mit juveniler chronischer Arthritis untersucht mittels einer optoelektronischen Methode. Sie wurden mit zwei asymptomatischen Gruppen verglichen: einer Gruppe mit einer Angle-Klasse I verzahnung und einer zweiten Gruppe mit einer Klasse II. Die Resultate zeigten, dass Kinder mit juveniler chronischer Arthritis und kondylären Läsionen kleinere laterale Kaubewegungen aufwiesen. Bei Kindern mit Klasse II wurde eine längere dreidimensionale Schliessdistanz und eine kleinere Schliessgeschwindigkeit gefunden. Bei Kindern mit einer juvenilen chronischen Arthritis und einer Klasse II verzahnung ergab sich eine Wechselwirkung zwischen juveniler chronischer Arthritis und Malokklusion, die sich in einer längeren Schliesszeit, einer kleineren Amplitude, und einer kleineren Geschwindigkeit auswirkte. Es kann daraus gefolgert werden, dass eine juvenile chronische Arthritis oder eine Klasse II per se geringfügige Einflüsse auf die Kaubewegungen haben können, jedoch scheinen diese zwei Faktoren zusammen eine Wechselwirkung zu besitzen, welche das Kaumuster verändert. Eine mögliche Erklärung ist, dass Kinder mit juveniler chronischer Arthritis ein erhöhtes Risiko für eine Klasse II-Entwicklung besitzen aufgrund von Wachstumsstörungen als Folge von kondylären Läsionen. Die Veränderungen der Okklusion zusammen mit eingeschränkten Bewegungen des arthritischen Kondylus können die zugrundeliegenden Ursachen für diese Resultate sein.