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Is there a relationship between juvenile idiopathic arthritis and periodontitis?

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Abstract

Aim: The aim was to compare the prevalence of periodontal conditions in patients with juvenile idiopathic arthritis (JIA) ($n = 78$, age 14.4 years) with those revealed in a healthy control group ($n = 75$, age 15.5 years).

Material and Methods: In both groups, the approximal plaque index (API), the modified sulcular bleeding index (SBI), and the clinical attachment loss (CAL) were determined. Laboratory parameters for JIA activity included the capsule-reactive protein (CRP) and the immunoglobulins A, G, M.

Results: JIA patients had a significantly higher API (64.6% *versus* 49.9%, $p = 0.004$) and slightly higher mean percentages of sites with CAL > 3.5 mm (0.58% *versus* 0.22%, $p = 0.041$). There was no significant difference in the prevalence of patients and controls who had sites with CAL > 3.5 mm (25.6% *versus* 17.3%, $p = 0.212$). The mean CAL was slightly greater (0.2 mm; $p = 0.030$) in patients with CRP ⩾ 5.0 mg/l compared with patients with CRP < 5.0 mg/l. Patients who took non-steroidal anti-inflammatory drugs (NSAIDs) had a significantly decreased SBI (26.2% *versus* 51.1%, $p = 0.019$).

Conclusion: After adjustment for microbial plaque, JIA is not a risk factor for periodontitis.

Key words: approximal plaque index; attachment loss; CRP; immunoglobulins; juvenile idiopathic arthritis; periodontitis

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In 1997, the term juvenile idiopathic arthritis (JIA) was defined by the International League of Associations for Rheumatology (ILAR) in order to replace the terms juvenile rheumatoid arthritis (JRA) and juvenile chronic arthritis (JCA). The term JIA refers to persistent arthritis, episodes lasting for at least 6 weeks, and with an onset occurring before the 16th year (Petty et al. 1998). Usually, 6 months after the onset of the disease, one of the seven JIA subtypes can be determined depending on the number of affected joints and abarticular symptoms. JIA is the most common systemic autoimmune disease in children and adolescents. In Germany, its prevalence ranges from 14.8 to 20 per 100,000 children, with an annual incidence of 3.5–6.6 per 100,000 children. Females are more frequently affected than males (Kiessling et al. 1998, Koskull et al. 2001). JIA is characterized by synovial inflammation as well as cartilage and bone destruction of the joints. Consequently, JIA elicits systemic signs of inflammation, such as increased levels of acute-phase proteins in the serum (Miranda et al. 2003). When compared with adult rheumatoid arthritis, in JIA movement restrictions or pain occur only rarely.

The cause of JIA is still unknown. It has been assumed that autoimmune mechanisms could be triggered by peptides, for instance from the Epstein–Barr virus (Massa et al. 2002), influenca A virus (Pritchard et al. 1988), herpesvirus 6 (Wiersbitzky et al. 1993), parvovirus (Oguz et al. 2002), mycoplasma pneumoniae (Postepski et al. 2003), and enteric bacterial antigens (Sieper et al. 1992, Braun et al. 1993, Life et al. 1993). Moreover, chlamydia has been identified in the joints of children with arthritis, and the clinical presentation of chlamydial arthritis can be very similar to JCA, including the development of iridocyclitis (Maximov et al. 1992).

Several similar features in the pathophysiology of JIA and periodontitis have been suggested. In both diseases, connective tissue and adjacent bone are affected. Further, in both periodontal inflammation and synovitis neutrophiles are involved (Foell et al. 2004). Non-steroidal anti-inflammatory drugs (NSAIDs) used to treat JIA revealed a decrease in periodontal disease progresssion (Paquette & Williams 2000) by reducing the gingival

fluid flow (Heasman & Seymour 1990) and alveolar bone resorption (Feldman et al. 1983, Jeffcoat et al. 1993). Moreover, in both diseases cytokines and cytokine receptors such as interleukin 1 Beta (IL-1B), interleukin 2 receptor (IL-2R) and IL-6 (Madson et al. 1994, Yilmaz et al. 2001) are involved in tissue destruction and bone resorption. Polymorphisms of the IL-1A (− 889), IL-1B (+3962/+3953), and IL-4 (− 1098) gene cluster were described for JIA (McDowell et al. 1995, Cinek et al. 2004) as for periodontitis (Kornman et al. 1997, Michel et al. 2001). Common associations of certain HLA–DR4 alleles exist in patients having rheumatoid arthritis (RA) (Tsuchiya et al. 2001, Bongi et al. 2004) as well as in patients with rapidly progressive periodontitis (RPP) (Katz et al. 1987, Bonfil et al. 1999). This finding suggests that the aetiology of both diseases could be influenced in a similar way by factors inherent in the HLA system.

Only a few studies have been reported on dental findings obtained in JIA patients in comparison with healthy controls. Welbury et al. (2003) reported significant increased indexes for both plaque and gingivitis, as well as an increased level of caries in JIA patients aged from 0 to 11 years. Ahmed et al. (2004) obtained a significantly higher gingivitis score in JIA patients, whereas the incidence of dental caries and the mean plaque score were not different. Furthermore, a higher number of JIA patients showed signs of temporomandibular dysfunction. Savioli et al. (2004) reported that in JIA children, the indexes for plaque and gingival bleeding were related to the number of affected joints of the superior limbs. Moreover, in agreement with Ahmed et al. (2004), they showed a higher prevalence of subjects with temporomandibular joint dysfunction in the JIA group. Miranda et al. (2003) revealed, in a group of Brazilian JIA patients, a higher prevalence of subjects with a proximal attachment loss of 2 mm or more as compared with controls, whereas in both groups the mean percentages of visible plaque and marginal bleeding did not differ statistically. The authors concluded that the periodontal destruction in the JIA group is due to an increase in susceptibility.

Based on the findings reported above, we assume that a relation exists between JIA and periodontitis. JIA could be a risk factor for periodontitis, while periodontitis could also influence the aetiology of JIA. Therefore, the aim of this study is to examine this putative relation between both diseases through the comparison of the periodontal conditions in patients with JIA and in healthy controls. Our hypothesis is that the influence of rheumatic diseases on periodontal findings could be better revealed in adolescent cohorts as, in general, they have a lower prevalence of attachment loss in comparison with adult populations. Furthermore, the influence of the JIA subtype and immunological findings obtained in the JIA group on periodontal parameters should be investigated.

Material and Methods

Patients and controls

The patient group consisted of 78 individuals (ages 12–19, 57.7% females), who were patients at the Department of Pediatrics of the Martin-Luther University, Halle-Wittenberg, Germany. The mean value of the duration of the disease was 5.4 years, with a range from 1 to 16 years. The patients were examined by the same physician according to the ILAR classification (Petty et al. 1998). The control group included 75 subjects (ages 13–19, 45.3% females) who were examined during school evaluations. Patients and controls were matched with respect to age. The minimum age was restricted to 12 years as at this time, the period of mixed dentition is almost complete. The maximum age was restricted to 19 years because we assume that the influence of rheumatic diseases on attachment loss could be better revealed in adolescent cohorts. There were no statistically significant differences in age and gender between cases and controls (Table 1). During the anamnesis, the study participants were questioned regarding the occurrence of other general diseases, the onset of JIA, drug consumption, and smoking status. A person who smoked at least one cigarette per day was considered a smoker. In order to assess differences between patients and controls regarding oral hygiene behaviour and interest in oral health in general, all subjects were asked about both the frequency of toothbrushing per day and dentist visits per year. Both parameters could influence periodontal conditions (Reich et al. 1996). All of the patients and controls were Germans of Caucasian descent and were not related to each other. The exclusion criteria for all subjects were pregnancy, use of antibiotics in the last 6 months, and general diseases with known associations to periodontitis. The periodontal assessment of the patients and controls was performed by the same examiner, and included the following parameters: approximal plaque index (API) (Lange et al. 1977), modified sulcular bleeding index (SBI) (Mühlemann & Son 1971), and clinical attachment loss (CAL). The maximum CAL values for each tooth were determined by measuring the distance between the cemento-enamel junction and the bottom of the pocket on six sites around each tooth. The maximum values were recorded. Teeth that were in eruption were not investigated. CAL values > 3.5 mm were considered as pathological (WHO report 1978). For risk factor analysis, a ''periodontitis case'' was defined as a subject who had at least one site with CAL > 3.5 mm. CAL as a consequence of causes other than periodontitis, such as traumatic toothbrushing, overhanging dental fillings, orthodontic therapy, etc. was not considered as a case of periodontitis. In order to assess both the severity of CAL and the treatment demand the highest Community Periodontal Index of Treatment Needs (CPITN) code of each participant was taken into account. All examinations were made with a probe with a controlled force of 0.2 N (TPS-probe Vivacare, Vivadent, Schaan, Liechtenstein). All of the patients, the control subjects, and their parents were informed about the aims and methods of this investigation and gave their written consent to participate.

Serological markers obtained within the JIA group

Based on the immunological agglutination principle, commercial test kits were used in order to determine the capsule-reactive protein (CRP), immunoglobulin M–rheumatoid factor (IgM–RF), immunoglobulin A (IgA), immunoglobulin G (IgG), and immunoglobulin M (IgM) according to the manufacturer's instructions (Roche Diagnostics GmbH, Mannheim, Germany). A CRP level of $\geqslant 5$ mg/l was considered to be indicative of active rheumatic disease (Schmidt et al. 2000). The normal values for the immunoglobulins were defined in accordance with the German Society for Laboratory Medicine (Hafner et al.

1995). They are gender independent, but age specific (Lockitch et al. 1988).

Statistical analyses

Clinical variables such as API, SBI, and CAL were described in terms of means. The equality of variances was verified using Levene test. *t*-tests were performed to compare the mean values between patients and controls. One-factor variance analysis (ANOVA) was used to compare the mean values for API, SBI, CAL and the mean percentages of sites with CAL > 3.5 mm between the varying JIA subgroups. In case of in homogeneity of variances, the Kruskal–Wallis test was performed. Differences in categorical variables were determined by χ^2 test or Fisher's exact test (if $n < 5$). Correlations were calculated with Pearson's correlation coefficient. Logistic regression (backwards) was used in order to determine adjusted odds ratio (OR) of the diagnosis JIA for CAL > 3.5 mm, including the cofactors API, gender, age, and smoking. *p*-values $\leqslant 0.05$ were accepted as being statistically significant.

Results

Demographic and clinical values

The number of smokers was significantly higher in the control group in comparison with the JIA group. All the other demographic parameters were not significantly different between both groups (Table 1). In comparison with healthy controls (Table 2), JIA patients had significantly higher values for mean percent API (64.6% *versus* 49.9%, $p = 0.004$). Furthermore, the mean percentages of sites with CAL > 3.5 mm were significantly higher in the JIA group (0.58%) than in the control group (0.22%, $p = 0.041$).

Although slightly higher, there was no statistically significant difference between patients and controls for mean percent SBI (35.3% *versus* 29.0%) and mean CAL (2.31 *versus* 2.27 mm). There was no statistically significant difference between patients and controls in the number of subjects who had at least one site with CAL > 3.5 mm. Moreover, there was no statistically significant difference in the distribution of CPITN codes. Neither in the JIA cohort nor in the healthy control group there were any patients with aggressive periodontitis. Only one subject in the control group had sites with CAL > 5 mm (CPITN code 4). In both the JIA and the control group, there was a significant positive correlation ($p < 0.05$) between API and CAL (*r*: 0.311 *versus* 0.283), API and SBI (*r*: 0.697 *versus* 0.529), and API and CPITN (*r*: 0.493 *versus* 0.303). After exclusion of smokers there were no significant differences between JIA patients and the control group with regard to all measured periodontal conditions. Logistic regression for pathological attachment loss (presence of at least one site with a CAL value > 3.5 mm in an individual or not) including the cofactors age, gender, smoking, API and the diagnosis JIA revealed a significant OR only for API (OR = 1.027, 95% confidence interval (CI) 1.013–1.042, $p = 0.0001$), but not for JIA (Table 3).

Table 1. Demographic parameters in all investigated cohorts

	JIA ($n = 78$)	Controls ($n = 75$)	*p*-values
Age median (range)	14.4 (12–19)	15.0 (13–19)	0.161
Females (%)	57.7	45.3	0.091
Smoker (%)			
Total	21.8	42.7	0.006
M/F	21.2/22.2	34.1/52.9	
Tooth care/day			
Total	1.8	1.9	0.099
M/F	1.6/1.9*	1.8/2.0*	
Dentist visits/year			
Total	1.9	2.0	0.152
M/F	1.8/2.0*	1.9/2.1	

*Indicates significant differences ($p \leqslant 0.05$) between males (M) and females (F).
JIA, juvenile idiopathic arthritis.

Table 2. Clinical values in patients with JIA and controls

	JIA ($n = 78$)	Controls ($n = 75$)	*p*-values
API (SD)			
Total	64.6% (30.8%)	49.9% (30.9%)	0.004
M/F	71.5%/59.6%	57.8%/40.6%*	
SBI (SD)			
Total	35.3% (30.5%)	29.0% (22.6%)	0.147
M/F	43.2%/29.4%*	31.2%/26.2%	
CAL (mm) (SD)			
Total	2.31 (0.35)	2.27 (0.33)	0.449
M/F	2.36/2.27	2.33/2.19	
Mean percentages of sites with CAL > 3.5 mm			
Mean (SD)	0.58% (1.38%)	0.22% (0.69%)	0.041
Subjects with CAL > 3.5 mm			
Number	20 (25.6%)	13 (17.3%)	0.212
CPITN			
Number of subjects			
Code 0	11 (14.1%)	7 (9.3%)	
Code 1	36 (46.2%)	38 (50.7%)	
Code 2	11 (14.1%)	17 (22.7%)	0.270
Code 3	20 (25.6%)	12 (16.0%)	
Code 4	0 (0.0%)	1 (1.3%)	

*Marks significant differences ($p \leqslant 0.05$) between males (M) and females (F).
SD, standard deviation; JIA, juvenile idiopathic arthritis; M, males; F, females; API, approximal plaque index; SBI, sulcular bleeding index; CAL, clinical attachment loss; CPITN, Community Periodontal Index of Treatment Needs.

Results within the JIA group

There were no significant differences between the JIA subtypes with regard to all measured periodontal conditions (Table 4). Within the JIA group (Table 5), patients with an increased CRP level ($\geqslant 5$ mg/l) showed a significantly higher mean for CAL (2.4 *versus* 2.2 mm, $p = 0.030$) in comparison with JIA subjects who had a CRP level within the normal range (< 5 mg/l), whereas the values for API and SBI did not differ significantly. Moreover, there was a

positive correlation between CRP and CAL ($r = 0.240$, $p = 0.018$). There were no statistically significant differences for all measured periodontal conditions depending on serum concentrations for IgA, IgG, and IgM (Table 5). Patients who took NSAIDs had a significantly decreased mean value for SBI in comparison with those who did not use drugs, whereas the values for API and CAL were not significantly different (Table 6). In the present JIA group, the duration of the disease had no significant effect on any of the periodontal parameters (data not shown).

Discussion

The demographic data show that the frequency of regular smokers was twice as high in the control group in comparison with the JIA group (42.7% *versus* 21.8%). In the control group, the percentage of smokers was far beyond the percentage found in a nationwide survey of the German Federal Statistical Office that included 0.45% of the population. There, 20.3% of the individuals between the ages of 15 and 20 years identified themselves as regular smokers (URL http://www.destatis.de/basis/d/gesu/gesutab7.php (assessed on 5 July 2005)). In the present study, we did not find a significant effect of smoking on CAL after regression analysis and, therefore in our cohorts, smoking was not a significant factor in the prevalence of CAL.

The present study revealed a significantly higher mean value for API and slightly higher mean percentages of sites with CAL > 3.5 mm in patients with JIA. There was no statistically significant difference between patients and controls in the number of individuals who had at least one site with CAL > 3.5 mm (periodontitis case). The data of the regression analyses in the total study group (JIA+controls) suggest that if the cofactors age, gender, and smoking are included, the microbial plaque, but not the diagnosis of JIA, is related to periodontitis.

Our results differ in part from previous studies. Whereas Welbury et al. (2003) confirmed a significantly increased plaque score, there was no significance in other reports (Miranda et al. 2003, Ahmed et al. 2004, Savioli et al. 2004). These deviating results could contribute to the number of patients with a poor manual dexterity with the brush because of upper limb disability. This idea is supported by the following findings of the present study.

Firstly, there was a significantly higher plaque index in patients with JIA, even though there was no significant difference in the frequency of toothbrushing per day when compared with controls. These results suggest that patients with JIA have a more ineffec-

Table 3. Logistic regression (backwards) for the prevalence of attachment loss (CAL > 3.5 mm) in an individual in the total study group (JIA+controls). Only the API, but not JLA, increased the adjusted OR for CAL

	Regression coefficient *B*	Standard error	Wald	df	Significance	Exp(B)
Step 1*						
Age	0.169	0.130	1,686	1	0.194	1.184
Gender (1)	0.517	0.452	1,311	1	0.252	1.677
Smoking (1)	− 0.567	0.509	1,240	1	0.265	0.567
API (%)	0.029	0.008	14,690	1	0.000	1.030
JIA (1)	− 0.011	0.455	,001	1	0.980	0.989
Constant	− 5.766	2.000	8,310	1	0.004	0.003
Step 2*						
Age	.169	0.130	1,687	1	0.194	1.184
Gender (1)	.514	0.439	1,373	1	0.241	1.673
Smoking (1)	− 0.565	0.503	1,262	1	0.261	0.569
API (%)	.029	0.007	15,522	1	0.000	1.030
Constant	− 5.769	1.997	8,345	1	0.004	0.003
Age	0.113	0.121	,876	1	0.349	1.120
Step 3*						
Gender (1)	0.536	0.438	1,497	1	0.221	1.709
API (%)	0.029	0.007	15,383	1	0.000	1.029
Constant	− 5.107	1.903	7,207	1	0.007	0.006
Gender (1)	0.614	0.430	2,039	1	0.153	1.848
Step 4*						
API (%)	0.028	0.007	15,112	1	0.000	1.029
Constant	− 3.458	0.648	28,490	1	0.000	0.031
Step 5*						
API (%)	0.027	0.007	13,809	1	0.000	1.027
Constant	− 3.016	0.554	29,677	1	0.000	0.049

*In step 1 input variables: age, gender, smoking, API (%), JIA.
Wald statistic, ratio of *B* to standard error; Exp(B:), predicted change in odds for a unit increase in the predictor; API, approximal plaque index.

Table 4. Distribution of JIA patients ($n = 78$) according to the ILAR classification of 1997 in the present study and their differences in API, SBI, CAL, the number of patients who had sites with CAL > 3.5 mm, and the mean percentages of sites with CAL > 3.5 mm

JIA subtype	N (%)	Mean (SD)			Patients with CAL > 3.5 mm (N) (%)	Sites with CAL > 3.5 mm (%) (SD)
		API (%)	SBI (%)	CAL (mm)		
Systemic	6 (7.7)	72.5 (30.3)	42.2 (32.2)	2.4 (0.3)	2 (33.3)	0.92 (1.51)
Polyarthritis RF −	17 (21.8)	65.3 (29.3)	36.2 (30.4)	2.3 (0.4)	4 (23.5)	0.33 (0.80)
Polyarthritis RF+	9 (11.5)	74.3 (23.9)	59.9 (36.4)	2.6 (0.4)	5 (55.6)	2.09 (2.95)
Oligoarthritis	13 (16.7)	45.8 (33.8)	20.2 (22.1)	2.2 (0.2)	2 (15.4)	0.33 (0.92)
Enthesitis-related arthritis	16 (20.5)	72.1 (30.6)	40.4 (30.2)	2.3 (0.4)	4 (25.0)	0.41 (0.85)
Psoriasis-related arthritis	6 (7.7)	67.0 (27.1)	27.2 (15.3)	2.3 (0.3)	1 (16.7)	0.10 (0.24)
Unclassified arthritis	11 (14.1)	61.3 (34.7)	24.6 (30.7)	2.2 (0.4)	2 (18.2)	0.32 (0.90)
p-values		0.568	0.324	0.645	0.452	0.248

RF, rheumatoid factor positive (+) or negative (−); API, approximal plaque index; SBI, sulcular bleeding index; CAL, clinical attachment loss; SD, standard deviation.

Only the API, but not JIA, increased the adjusted OR for CAL.

Table 5. Clinical parameters within JIA patients depending on CRP, IgA, IgG, and IgM

	n	API (%) (SD)	SBI (%) (SD)	CAL (mm) (SD)
CRP				
Normal	35	62.1 (35.8)	38.9 (32.9)	2.2 (0.3)
Increased	36	66.8 (27.3)	32.8 (29.3)	2.4 (0.4)
p-values		0.619	0.458	0.030
IgA				
Normal	60	63.0 (32.5)	36.1 (31.8)	2.3 (0.3)
Increased	11	72.3 (26.6)	33.9 (28.1)	2.4 (0.4)
p-values		0.502	0.912	0.237
IgG				
Normal	50	64.4 (32.4)	37.5 (30.4)	2.3 (0.4)
Increased	21	64.5 (30.5)	31.9 (32.9)	2.4 (0.3)
p-values		0.944	0.352	0.122
IgM				
Normal	60	65.2 (30.6)	38.4 (31.9)	2.3 (0.4)
Increased	11	60.5 (38.0)	21.7 (21.9)	2.1 (0.3)
p-values		0.622	0.106	0.162

CRP, capsule-reactive protein; IgA, G, M, immunoglobulins A, G, M; API, approximal plaque index; SBI, sulcular bleeding index; CAL, clinical attachment loss; SD, standard deviation.

Table 6. Clinical parameters within JIA patients depending on medication

Drugs	*N*	API (%) (SD)	SBI (%) (SD)	CAL mm (SD)
No drugs	11	75.2 (26.7)	51.1 (32.7)	2.27 (0.29)
NSAIDs	30	59.9 (32.9)	26.2 (27.8)	2.26 (0.36)
p-values		0.142	0.019	0.961
No drugs	11	75.2 (26.7)	51.5 (32.7)	2.27 (0.29)
NSAIDs+basis drugs	37	65.3 (30.2)	37.8 (30.2)	2.36 (0.36)
p-values		0.336	0.202	0.488

NSAIDs, non-steroidal anti-inflammatory drugs: indomethacin, diclofenac, naproxen, meloxicam. Basis drugs: sulphasalazine, gold salts, methotrexate

API, approximal plaque index; SBI, sulcular bleeding index; CAL, clinical attachment loss; SD, standard deviation.

tive oral hygiene as compared with controls.

Secondly, in the present study it was demonstrated that in RF-positive polyarthritis patients, there was a tendency towards higher mean values for API, SBI and CAL. In RF seropositive patients with polyarthritis the joints of the hands and fingers are affected early on (Heiligenhaus et al. 2003). For this reason, oral hygiene could be more restricted than in other JIA subtypes.

Savioli et al. (2004) uncovered increased plaque and gingival bleeding indexes only in JIA children with three to eight affected joints, whereas there was a lack of such a result in JIA patients with zero to two affected joints. Moreover, Miranda et al. (2003) reported that the percentage of JIA subjects with CAL$\geqslant$ 2 mm has been influenced by the mean number of joints with movement limitations. Welbury et al. (2003) assumed that because of a restricted ability of mouth opening, patients with temporomandibular joint dysfunction could have reduced access for toothbrushing. However, in this context a relation of temporomandibular dysfunctions to the oral hygiene was not checked. Besides RF-positive polyarthritis, we obtained a tendency towards increased plaque and bleeding indexes as well as CAL values both in patients having systemic arthritis and in patients having enthesitis-related arthritis. In these subtypes, a polyarticular course is possible. In systemic arthritis, there are symptoms such as fever, hepatosplenomegaly, polyserositis, exanthema, and lymphadenosis. Enthesitis-related arthritis is characterized by uveitis anterior and ankylosing spondylitis (Heiligenhaus et al. 2003). On the one hand, these symptoms could exacerbate the general condition of the patient. On the other hand, they could indicate a generally increased susceptibility to inflammation. Oral hygiene, gingivitis and attachment loss could be influenced by both causes.

The present study found no significant relation of JIA to both gingivitis assessed as SBI and periodontitis assessed as the presence of CAL$>$3.5 mm in a given subject. Consequently, our findings are different compared with the results of Miranda et al. (2003) and Ahmed et al. (2004). The following two main reasons could be responsible for these differences.

Firstly, periodontal conditions in the control subjects of the previous studies were different from those in the present study. For example, we found a higher percentage of control subjects who had at least one site with CAL$>$3.5 mm (17.3%) as compared with the control group of Miranda et al. (4.2%). Moreover, in the present study control subjects were examined during school evaluations, while Ahmed et al. (2004) included control patients from a trauma clinic in a department of paediatric dentistry. The kinds of dentoalveolar trauma and treatment were not mentioned, and there is a possibility that both could have influenced plaque accumulation and gingivitis.

Secondly, the choice of drug treatment could mask a possible relation between JIA and periodontal findings. As shown within our JIA group, NSAIDs reduce gingival inflammation whereas the values for API and CAL were not significantly different. As 85% of our JIA patients took NSAIDs, it is clear why JIA patients have a significantly higher API, but only slightly increased values for SBI compared with the controls. Although NSAIDs are the most common drugs used in the treatment of JIA (Horneff 2005), their influence on periodontal parameters was not taken into account in all previous reports about the relationship between JIA and oral findings (2003).

The positive association between CAL and CRP revealed among the JIA patients of the present study was also verified in another JIA cohort (Miranda et al. 2003), in patients with polyarthritis (Willershausen-Zönnchen 1998), and in patients having RA (Mercado et al. 2001). These findings could mean that the acute-phase response in patients with active rheumatic diseases influences the aetiology of periodontal attachment loss. However, in the present study there was only a slight difference of 0.2 mm in the means of CAL between JIA patients with a CRP$\geqslant$5.0 mg/l and patients with a CRP$<$5.0 mg/l. From a clinical point of view, this difference has little, if any, significance.

Elevated serum concentrations for immunoglobulins could be an indication of an increased humoral response to arthritogenic antigens. Tolo & Jorkjend (1990) reported that the total serum IgG as well as specific IgG antibodies to *Bacteroides gingivalis* and *Eubacterium saburreum* influenced the degree of alveolar bone loss in patients with RA. In the present study, there was no significant difference between the means of SBI and CAL depending on the serum levels for IgA, IgG and IgM. Therefore, the influence of immunoglobulins on periodontal conditions could not be confirmed in patients having JIA.

In sum, this study shows that patients with JIA had a significantly higher plaque index and a slightly higher mean percentage of sites with CAL > 3.5 mm. However, there was no statistical difference between JIA and controls in the number of individuals who had periodontitis. JIA did not increase the OR for CAL > 3.5 mm, when adjusted for age, gender, smoking, and API.

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Clinical Relevance

Scientific rationale for the study: On the basis of the pathophysiology of JIA and periodontitis having similar features, we assumed that there may be a relation between JIA and periodontitis. *Principal findings:* We found a significantly higher plaque index and a few more sites with attachment loss in patients with JIA as compared with healthy controls.

Practical implication: JIA patients with compromised oral hygiene because of impediment of manual dexterity may require more frequent professional tooth cleaning to avoid early loss of periodontal attachment.