

Are signs of temporomandibular disorders stable and predictable in adolescents with headache?

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The aim of the present study was to study changes in signs and symptoms of temporomandibular disorders (TMD) and factors predicting TMD signs in adolescents with and without headache. A population-based sample ($n = 212$) of 13-year-olds with and without headache was re-examined at the age of 16. The study included a questionnaire, face-to-face interview and somatic examination. In addition, a neurological examination, a muscle evaluation and a stomatognathic examination were performed. Significant changes were seen in TMD signs during the follow-up, but TMD signs at the end of the follow-up could not be predicted by baseline headache, sleeping difficulties, depression or muscle pain. TMD signs at the age of 16 were associated with female gender and muscle pain. We conclude that considerable changes in TMD signs occur in the follow-up of adolescents with and without headache. Headache-related TMD are not predictable in adolescents with and without headache. □ *Change, follow-up, headache, predictors, temporomandibular disorders*

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Introduction

Epidemiological studies in children and adolescents have shown that subjects with temporomandibular disorders (TMD) often have concomitant headache (1, 2). Childhood headache has also been associated with neck, shoulder, back and stomach pain (3–6). Different pains seem to aggregate in the same children and in the same families (7). In children, predictors for later headache have been shown to include sleeping and concentration difficulties and behavioural problems before school entry (8), and in our study population, frequent use of analgesics, female gender, non-headache pains and daily neck pain predicted changes in adolescent headache (9, 10).

There are only a few population-based follow-up studies on TMD in children or adolescents. Usually both signs and symptoms of TMD are mild in children and adolescents, and seldom progress to severe pain (11–13). In a longitudinal study by Magnusson et al. (11), TMD signs increased during a 5-year follow-up in the younger age groups of 7- and 11-year-olds, whereas they remained at the same level in the older age group of 15-year-olds. Temporomandibular joint (TMJ) clicking, a typical symptom of TMD, has been reported to fluctuate during a 10-year follow-up (14, 15), but did not show any progression to further problems. Tenderness upon palpation of the masticatory muscles is reported to be the most common sign of TMD (16–18), and the change in all TMD signs has been

shown to be substantial in adolescent years (11, 13, 19, 20).

In a 20-year follow-up study on children from 7 to 15 years of age at the beginning of the study, tooth wear, TMJ clicking, bruxism, oral parafunctions and deep bite were found to predict later TMD signs and symptoms (21). On the other hand, predictors of later TMD signs were found to be open bite, overjet, mesial and distal molar occlusion and occlusal interferences in a 7-year follow-up study on 8-year-old children (22).

In earlier studies on the same study population presented here, significant changes in headache type, predicting factors, and factors associated with headache have been reported (3, 9, 10). The aim of the present study was to examine changes in signs and symptoms of TMD in these 13-year-old adolescents with different types of headache and without headache during a 3-year follow-up, and to focus on factors predicting the occurrence of TMD signs.

Subjects and methods

In 1998, all 12-year-old school children in the city of Turku, South-Western Finland, were selected for the original study population. The questionnaire on headache was acceptably completed by 1135/1409 (81%) children. The study sample and methods have previously been presented in more detail (23, 24).

In 1999, at 13 years of age, 70 children from each primary headache group [migraine; migraine-type not fulfilling the International Headache Society (IHS) criteria; tension-type headache; tension-type not fulfilling the IHS criteria 1988 (25)] and from healthy controls were randomly selected. If the headache group included <70 children, as in the case of tension-type headache not fulfilling the IHS criteria, the entire group was included in the study population. As a result, altogether 311 children participated in a face-to-face interview and somatic examination. A total of 297 of these 311 children came to the Institute of Dentistry, University of Turku, for a thorough stomatognathic examination.

In 2002, at the age of 16 years, the same adolescents were re-examined. The participation rate for the examination by a paediatrician ($n = 228/311$) was 73% (82% for girls and 65% for boys). The number of drop-outs varied from 20 to 27% in the headache groups and 31% in the healthy controls (10). Of those 297 adolescents who had taken part in the stomatognathic examination at the age of 13 years, 212 (81.4%) adolescents participated in the

stomatognathic follow-up study at the age of 16 years.

Questionnaire and face-to-face interview

At the ages of 13 and 16 years, a paediatrician (P.A.) carried out the structured face-to-face interview and neurological examination. Because the current International Classification of Headache Disorders (26) had not yet been published at the time of data collection, the IHS 1988 criteria were used to classify the headache types. At the age of 16 years, the short Beck Depression Inventory (R-BDI) was used to detect depressive symptoms (27, 28). In a detailed questionnaire the children were asked about factors associated with headache, pain and sleep difficulties.

Muscle test by physiotherapist

Muscle tenderness was recorded by manual palpation and pressure dolorimeter as described in more detail earlier (24). A trained physiotherapist (S.V.) carried out a structured manual palpation test on tenderness bilaterally at seven neck sites (frontal and temporal muscles, the suboccipital muscle insertion, anterior aspect of C5-C7, origin of the supraspinatus muscle, midpoint of the upper border of the trapezius muscle, and insertion of the levator scapulae muscle), graded on a four-step scale (0, no pain; 1, no visible reaction but reporting mild pain; 2, reporting pain and distorting the face; 3, reporting considerable pain and withdrawing). Accordingly, the total tenderness score could vary between 0 and 42. A dolorimeter (Fisher) was used for the measurement of the pressure pain threshold from five pericranial/neck sites bilaterally (the frontal and temporal muscle, suboccipital muscle insertion, midpoint of the upper border of the trapezius muscle, insertion of the levator scapulae muscle). Pressure pain was measured in kg/cm² units (29). The mean dolorimeter scores for the pressure pain threshold were calculated. The higher the score, the less muscle tenderness.

Stomatognathic examination

The children were interviewed, examined clinically and scored for TMD signs as described previously (24). A standardized protocol (24, 30) was used according to the general principles of stomatognathic physiology. The stomatognathic examiner was blinded to the results of the earlier examinations and the interview.

In the stomatognathic interview (T.J., Y.L.B.), questions about joint sounds, jaw mobility, pain while chewing, sensation of fatigue in the jaw, pain or sensation in the ear or throat, and parafunctional habits, such as bruxism and nail biting, were asked about.

The clinical stomatognathic examination (M-R.L.) included measurements of mandibular movements and recordings of joint sounds using a stethoscope. Pain, locking or luxation of the joints during movements were examined. The temporomandibular joints were palpated laterally and posteriorly. The following masticatory muscles were palpated bilaterally: anterior and posterior portions and insertion into the coronoid process of the temporal muscle, deep and superficial portion of the masseter muscle, posterior portion of the digastric muscle, and medial and lateral pterygoid muscles. If the subject did not react to palpation, no tenderness was recorded. Mild tenderness was present if the subject verbally reported any pain during palpation. Moderate tenderness gave rise to blink reflex and severe tenderness to withdrawal. Clinical signs were scored from 0 to 2 for every muscle, depending on the degree of tenderness. Joint tenderness was graded depending on whether it was on one or both sides, either lateral or posterior. One point was given for each joint if any sound was registered. Difficulties in guiding the mandible into the centric relation (CR) or pain recorded during this manipulation scored one point. When these points were added together (=sum score for TMD signs, maximum 35) the child was given a score for the severity of TMD signs.

Statistical methods

Altogether, 198 adolescents had recorded data for both ages (13 and 16 years) for the statistical analysis concerning the changes during the 3-year follow-up and the predicting value of the parameters.

The sum score for TMD signs was divided into three categories before the analysis due to the high skewness in the distribution. The children were scored as healthy regarding TMD signs if the sum score was 0, having very mild TMD signs when the score was between 1 and 4, and mild or moderate TMD signs when the score was ≥ 5 . The changes in distribution of signs of TMD from the age of 13 to 16 years were tested with the marginal homogeneity test. χ^2 or Fisher's exact test was used to compare the single TMD symptoms between headache groups at the ages of 13 and 16 years. The

changes in TMD symptoms during the 3-year follow-up were tested using McNemar's test. The analysis of associations between the TMD signs classification and other variables was carried out using cumulative logistic regression analysis, which takes into account the ordinal scale in a polytomous response variable (31). In addition to univariate analysis, gender and headache-adjusted analyses were carried out separately for each predicting variable. The results of the cumulative logistic regression analysis were quantified by cumulative odds ratios (COR) and 95% confidence intervals (95% CI). Two multivariate analyses were done for variables measured at the age of 16 years: the first one with variables recorded from all subjects, and the second one with variables recorded only from headache subjects. The statistical computations were performed with the SAS System for Windows, release 9.1 (SAS Institute, Cary, NC, USA).

Approval of the study design

The study design was approved by the Joint Ethics Review Committee of the Turku University Medical Faculty and the Turku University Central Hospital.

Results

Changes in the occurrence of signs and symptoms of TMD from the age of 13 to 16 years

A significant change ($P < 0.001$) was observed in TMD signs from the age of 13 to the age of 16 years (Table 1). There were fewer adolescents with a score of ≥ 5 for TMD signs at the age of 16 compared with the 13-year-olds. Of those with mild or moderate TMD score (≥ 5) at the age of 13, 71% had very mild TMD signs (1–4) at the age of 16. Ten per cent of the subjects were completely free of TMD signs at both examinations.

Table 1 Distribution (*n*) of temporomandibular disorder (TMD) signs in 13- and 16-year-old adolescents with migraine, tension-type headache and without headache

	TMD signs at the age of 16			Total
	0	1–4	≥ 5	
TMD signs at the age of 13				
0	19	22	0	41
1–4	28	79	9	116
≥ 5	7	29	5	41
Total	54	130	14	198

No significant changes were seen in the occurrence of subjective TMD symptoms between the ages of 13 and 16 years.

Signs and symptoms of TMD and headache at the age of 16 years

Girls had significantly more signs of TMD compared with boys at the age of 16 years ($P = 0.001$, $COR = 3.09$, 95% CI 1.68, 5.71) (Table 2). There was a significant difference in TMD signs between migraine and non-headache adolescents ($P = 0.046$, $COR = 3.12$, 95% CI 1.02, 9.55), but after adjusting for gender the difference when comparing the headache groups with non-headache controls was not significant ($P = 0.631$). The overall difference in TMD signs between the headache groups including only headache children was not significant ($P = 0.614$). Of those 14 children who had a mild or moderate TMD sign score (≥ 5) at the age of 16 years, seven had tension-type headache, three migraine, two migraine-type headache not fulfilling the IHS criteria, one tension-type headache not fulfilling the IHS criteria and one was headache-free.

In general, the subjective symptoms were mild at the follow-up examination. At the age of 16, no significant differences in joint sounds, earache, pain in the joints while chewing or reported parafunctional habits were observed between the groups. Regarding other symptoms (fatigue or stiffness of the jaw, pain on opening, difficulties in opening, locking or luxation of the jaw), a significant difference was observed between the groups ($P = 0.027$). Of the children in the migraine-type headache group, not fulfilling the IHS criteria, 21% had these symptoms, while the percentage in the migraine

group was 18%. In the tension-type headache group, not fulfilling the IHS criteria, 17% of the children had these symptoms, whereas the percentage in the tension-type headache group was 8%. Two per cent of the headache-free children had this symptom.

Factors associated with TMD at the age of 16 years

On multivariate logistic regression analysis, the variables were analysed together after adjusting for gender and headache. Neck muscle pain was clearly associated with TMD signs. Sleeping fewer hours during the night almost reached significant association ($P = 0.051$) with TMD signs when both adolescents with headache and healthy controls were considered, but did not reach a significant level ($P = 0.070$) when only adolescents with headache were considered. The association was non-significant regarding dolorimeter values, depressive symptoms, headache intensity, unilateral headache, headache aggravated by bright light and headache frequency (Table 3).

Predicting factors

Before adjusting for gender and occurrence of headache, headache intensity ($P = 0.036$) and dolorimeter values of neck muscles ($P = 0.023$) at the age of 13 years predicted later TMD signs in the logistic regression analysis. Neck muscle pain, unilateral headache, depressive symptoms, headache frequency, photosensitivity or sleeping difficulties were not predicting factors for later TMD signs. However, after adjusting for gender and headache, no single predictive factor remained as a significant predictor for later TMD signs (Table 4). Headache type at the age of 13 years did not predict signs of TMD at the age of 16 years ($P = 0.658$). No TMD symptoms emerged as predictors for later TMD signs.

Discussion

Signs and symptoms of TMD and headache

Although a significant change in the occurrence of TMD signs was observed in these adolescents during follow-up, we did not see any increase in the signs. On the contrary, there were fewer adolescents with mild or moderate TMD signs at the age of 16 than at the age of 13 years. This finding is in accordance with the results of the studies by

Table 2 Temporomandibular disorder (TMD) signs by gender and headache at the age of 16 years

	TMD signs		
	0 <i>n</i> (%)	1–4 <i>n</i> (%)	≥ 5 <i>n</i> (%)
Gender			
Girls (<i>n</i> = 109)	19 (17)	79 (72)	11 (10)
Boys (<i>n</i> = 89)	35 (39)	51 (57)	3 (4)
Headache group (<i>n</i> = 198)			
Migraine	3 (14)	16 (73)	3 (14)
Migraine-type	9 (27)	22 (67)	2 (6)
Episodic tension-type	21 (28)	48 (63)	7 (9)
Tension-type	7 (30)	15 (65)	1 (4)
Controls	14 (32)	29 (66)	1 (2)

Table 3 The associations between signs of temporomandibular disorders and factors associated with headache in multivariate cumulative logistic regression analysis at age 16 years, adjusted for gender and headache

Factors associated with headache	A (<i>n</i> = 180)			B (<i>n</i> = 139)		
	<i>P</i> -value	COR	95% CI	<i>P</i> -value	COR	95% CI
Neck muscle palpation pain	0.002	1.42	1.18, 1.71	0.008	1.43	1.16, 1.77
Dolorimeter value	0.208	0.85	0.66, 1.09	0.721	0.94	0.68, 1.30
Depressive symptoms	0.476	1.04	0.93, 1.15	0.941	1.00	0.89, 1.11
Sleeping difficulties	0.070	0.76	0.56, 1.02	0.051	0.71	0.50, 1.00
Headache intensity				0.725		
Moderate vs. mild					0.75	0.33, 1.73
Severe vs. mild					1.46	0.09, 23.5
Unilateral headache				0.948	1.03	0.38, 2.84
Headache aggravated by bright light				0.301	1.60	0.65, 3.90
Nausea or fainting sensation during headache attack				0.711	0.76	0.17, 3.32
Headache frequency				0.171	1.12	0.95, 1.31

Part A includes both headache and control children, whereas part B includes only headache children.
COR, cumulative odds ratio; CI, confidence interval.

Table 4 Factors associated with headache at the age of 13 years predicting signs of temporomandibular disorders (TMD) at the age of 16 years. Cumulative logistic regression analysis adjusted for gender and headache

Factors at the age of 13	TMD signs at the age of 16		
	<i>P</i> -value	COR	95% CI
Neck muscle palpation pain (<i>n</i> = 198)	0.201	1.03	0.99, 1.07
Dolorimeter value (<i>n</i> = 198)	0.065	0.77	0.58, 1.02
Depressive symptoms (<i>n</i> = 193)	0.473	1.03	0.95, 1.11
Sleeping difficulties (<i>n</i> = 193)	0.140	1.06	0.98, 1.15
Headache intensity (<i>n</i> = 157)	0.257		
Moderate vs. mild		0.95	0.42, 2.16
Severe vs. mild		3.94	0.60, 25.99
Unilateral headache (<i>n</i> = 157)	0.652	1.21	0.53, 2.75
Headache frequency (<i>n</i> = 198)	0.537	0.96	0.86, 1.08

COR, cumulative odds ratio; CI, confidence interval.

Magnusson et al. (11), where the clinical signs of TMD increased during the first 5 years in the 7- and 11-year age groups, but remained unchanged during the first 10 years in the 15-year age group. In the present study, we did not see any significant changes in the occurrence of subjective TMD symptoms during the 3-year follow-up. In the study by Magnusson et al. (11), symptoms increased during the first 10 years in all three age groups (7, 11 and 15 years), but there was no subsequent further increase in any age group. On the other hand, Wänman (13) observed an increase in TMD symptoms during a 10-year follow-up of 17-year-old adolescents to adulthood.

There was no significant association between TMD signs and different headache types at the age

of 16 years, contrary to the association between TMD signs and migrainous headaches seen at the age of 13 in these same children (24). In our other study sample of 13-year-old children, TMD signs were also associated with both migraine and tension-type headache (32). The lack of association in the present study of 16-year-olds could reflect the changes in headache characteristics and type in these adolescents as reported by Laimi et al. (9, 10). Considerable changes in headache have also been reported in other studies on children (33). The lack of association between headache and TMD signs could also reflect the difficulty in classifying children's headache according to IHS criteria, which may be more suitable for adults (34, 35). Different types of headache could represent a continuum,

and not clear single entities. It is possible that TMD was not associated with migraine because the changes from migraine to other types of headache were common in the follow-up, and the number of migrainous adolescents was too small at the age of 16 years to have statistical power in the analysis.

Girls had more TMD signs than boys, which is in line with earlier studies (12, 13, 32, 36). Generally, TMD signs and symptoms are known to be mostly mild and fluctuating in children and adolescents (11, 14). Therefore, the clinical scoring system we used (24) was originally designed to enable the detection of different degrees of TMD signs for the analysis.

Predicting factors for TMD signs

No subjective symptoms of TMD at the age of 13 years emerged as predictors of later TMD signs. In the study by Magnusson *et al.* (11), reported TMJ clicking predicted TMD symptoms 20 years later, whereas clinically recorded TMJ clicking predicted later TMD signs. Bruxism was a predictor of both TMD signs and symptoms. In our study, this could not be confirmed, but our follow-up was shorter than that of Magnusson. Nor did headache-associated variables (sleeping difficulties, depressive symptoms, headache intensity or frequency, unilateral headache and headache aggravated by bright light) predict later TMD signs. Tenderness on manual palpation has been reported to be a sensitive and specific test for disorders of pericranial muscles (37). It could have been expected that neck muscle pain and dolorimeter values would have had a predicting value for TMD signs, because there was a clear association between TMD signs and neck muscle pain in both our cross-sectional studies. However, we could demonstrate only a tendency ($P = 0.065$) for dolorimeter values to predict later TMD signs. In the report by Laimi *et al.* (9), measured neck muscle tenderness did not have predictive value for the outcome of headache. Instead, neck pain intensity (neck pain which interferes with daily activities) could exacerbate headache frequency, especially in boys. Neck pain was not shown to predict change in headache type. There is still uncertainty about whether muscle tenderness is primary or secondary to headache (3, 38, 39).

The co-occurrence of headache, TMD and neck pain could suggest a common pathogenesis, a causal association, or a common confounding factor. However, it seems that these findings may be of a temporary or changing character because of

the not yet permanent structural changes in the muscles of 13-year-old children (9). The results of the present study and other reports on children and adolescents have shown associations between single variables, but no clear causal trends have been shown.

Conclusions

In adolescence, considerable changes in TMD signs occur both in headache sufferers and those without headache. Headache-related temporomandibular disorders are not predictable in adolescents with or without headache.

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