# Symptoms and signs of temporomandibular disorders in girls with normal occlusion and class II malocclusion

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Mandibular function, headaches, and symptoms and signs of temporomandibular disorders (TMD) were studied in one group of girls with a well-defined normal occlusion ($n$ = 60) and another group with class II malocclusion ($n$ = 123). Frequent headaches and temporomandibular joint clicking, muscle tenderness to palpation, pain on mandibular movement, awareness of tooth clenching, and grinding were commoner in the class II malocclusion group. Awareness of tooth clenching had the largest influence on the odds for symptoms and signs of temporomandibular disorders (TMD) in a logistic regression analysis. Occlusal variables that increased the odds for symptoms and signs of TMD were large overjet, frontal open bite, few occlusal contacts, lateral sliding retruded–intercuspal contact position, crowding, and non-working side interferences. We concluded that normal occlusions have lower odds for symptoms and signs of TMD, whereas some occlusal characteristics, more frequently found in the class II malocclusion group, increased the odds for symptoms and signs of TMD. □ *Bruxism; facial pain; headache; temporomandibular joint*

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Epidemiologic cross-sectional investigations have shown that symptoms and signs of temporomandibular disorders (TMD) are common among children and adolescents (1). Longitudinal studies of these age groups have shown an increase in the prevalence of symptom and signs of TMD with age (2–5), confirming the prevalence figures obtained in cross-sectional studies of different age groups. A somewhat higher prevalence of headaches and clicking from the temporomandibular joint (TMJ) in girls compared with boys has been reported (6–9).

Specific etiologic factors for TMD have not been found, and today it is believed that the etiology is multifactorial (10). Contributing factors discussed are trauma and anatomic, pathophysiologic and psychosocial factors. The controversy at present mainly deals with the importance of each of the different contributing factors.

Malocclusion, including class II malocclusion, has been associated with symptoms and signs of TMD (5, 11–14). However, Seligman & Pullinger (15, 16) and Pullinger et al. (17) do not support the role of occlusion as a major etiologic factor.

Morphologic malocclusion was found in 74% in an epidemiologic study of Swedish children and adolescents (18). Among the occlusal anomalies, class II malocclusion was the one most commonly found, with a prevalence of 27% in the mixed dentition and 14–17% in the permanent dentition of children and adolescents (18, 19). Class II malocclusion is often an indication for orthodontic treatment.

The aim of the present study was to investigate the prevalence of symptoms and signs of TMD, and the relation between occlusal factors and mandibular function, in subjects with well-defined normal occlusion and in subjects with class II malocclusion.

## Materials and methods

### *Subjects*

A total of 183 girls, aged 11–15 years, were included in this study; 123 subjects had class II malocclusion (mean age, 12.9 years; standard deviation ($s$), 1.1), and 60 subjects had normal occlusion (mean age, 12.7 years; $s$, 0.7). The subjects were selected by screening school classes attending the Public Dental Clinics in the Malmö region and consecutively selecting from among those on the waiting list for orthodontic treatment in the Public Dental Specialist Clinic of Malmö, Sweden. Subjects with a history of orthodontic treatment were excluded.

*Normal occlusion group.* The selection criteria for the normal occlusion group (normal group) were a bilateral neutral sagittal relationship for molars, premolars, and cuspids and a normal transverse relationship. The overjet and overbite should be 1–4 mm. Less than 2 mm of crowding or spacing in each jaw and midline discrepancies of less than 2 mm were accepted. Subjects with tooth aplasia were excluded.

*Class II malocclusion group.* The selection criteria for the class II malocclusion group (class II group) were bilateral or unilateral distal displacement of the lower first molar and canine of at least half a cusp (20). The group also included subjects with other occlusal

Table 1. Distribution of some occlusal characteristics in percentage of the class II group

| Morphologic occlusion | Class II group ($n$ = 123), % |
|---|---|
| Sagittal dental relationship | |
| Bilateral class II | 56 |
| Unilateral class II | 44 |
| Overjet, mean, mm | 5.5 ($s$, 2.4) |
| Overjet, 1–4 mm | 37 |
| Overjet, >4 mm | 63 |
| Overjet, ≥6 mm | 45 |
| Vertical dental relationship | |
| Overbite mean, mm | 3.5 ($s$, 2.0) |
| Overbite, <0 mm | 11 |
| Overbite, 0–4 mm | 54 |
| Overbite, >4 mm | 35 |
| Transverse dental relationship | |
| Normal | 83 |
| Crossbite | 14 |
| Scissors bite | 3 |
| Midline discrepancies ≥2 mm | 24 |
| Crowding | |
| <2 mm/jaw | 45 |
| 2–6 mm/jaw | 45 |
| >6 mm/jaw | 10 |

characteristics combined with the class II relationship, such as transverse and vertical discrepancies, crowding, or spacing (Table 1).

*Questionnaire*

The subjects answered a standardized questionnaire concerning their state of general health, medication, awareness of oral parafunction, and frequency, duration, and location of symptoms of TMD and headaches. The subjects assessed the severity of their subjective symptoms by means of a visual analogue scale (21) and by a verbal scale including the following 5 grades: 0 = no or minimal discomfort, 1 = slight discomfort, 2 = moderate discomfort, 3 = severe discomfort, and 4 = very severe discomfort.

The subjects also rated themselves on a visual analogue scale with regard to their level of anxiousness.

*Clinical examination*

A clinical examination of mandibular function and symptoms and signs of TMD was performed by either one of two specialists in stomatognathic physiology. The examiners were not informed of which group the subjects belonged to and performed the extra-oral examination before the intra-oral one. To calibrate the examination technique between the two specialists with regard to the registration of clinical signs, mandibular movements, occlusal interferences and contacts, eight subjects not included in the study were examined by both examiners before and during the study.

The clinical examination included measurement of mandibular mobility and pain on movement of the mandible. Mandibular deviation ≥2 mm on opening was registered. TMJ clicking and crepitations were registered by palpation and auscultation of the TMJs at opening and closing of the mandible. Tenderness to palpation of the TMJs laterally and posteriorly and tenderness to palpation of the masticatory musculature were registered bilaterally as follows: grade 1 = the palpation was described as painful; grade 2 = the palpation gave rise to a palpebral reflex; and grade 3 = the palpation gave rise to a defense reaction (guarding reflex).

The muscles palpated were 1) the origin and the insertion of the temporal muscles, 2) the superficial and deep portion of the masseter muscles, and 3) the insertion of the medial pterygoid muscles (extraorally) (22).

The occlusion was examined by methods previously described and investigated for observer error (23, 24). Non-working side interferences within a lateral excursion ≤3 mm, working side interferences, protrusion interferences, and the distance and the direction of the slide between retruded contact position (RCP) and the intercuspal contact position (ICP) were registered. The number of occlusal contacts in habitual intercuspal contact position during light and maximal biting force was registered. The indication of contacts was registered in the upper jaw by means of a thin double-folded plastic foil (GHM, 8 μm). The degree of occlusal wear was registered on the basis of a 3-grade scale: 0 = no or slight wear, 1 = wear in the enamel, and 2 = wear into the dentin.

The type of morphologic occlusion was registered by an orthodontist in accordance with Egermark-Eriksson (19). In addition, midline discrepancies ≥2 mm were registered. The amount of crowding in each jaw was registered as 1) <2 mm of space deficiency, 2) 2–6 mm of space deficiency, or 3) >6 mm space deficiency.

*Groupings of data*

Before statistical analysis the following groups were constructed:

The reported frequencies of headaches, TMDs, TMJ clicking, and jaw tiredness were grouped as: 1) less than once a week or 2) at least once a week. 'At least once a week' is referred to as 'frequent' in the text and tables.

The number of occlusal contacts during light and maximal biting pressure were grouped as 1) 1–10, 2) 11–20, or 3) >20 occlusal contacts.

Overjet was grouped as 1) <6 mm or 2) ≥6 mm.

Overbite was grouped as 1) <0 mm, 2) 0–4 mm, or 3) ≥5 mm.

*Statistical methods*

Pearson's chi square test with the Yates correction for continuity was used when 2 × 2 cross-tabulations were applicable. When the expected cell value in a 2 × 2

Table 2. Prevalence of reported headaches, symptoms of temporomandibular disorders (TMD), and oral parafunctions in percentage of the normal group and the class II group

| Symptoms of TMD | Normal group ($n$ = 60), % | $P$ value | Class II group ($n$ = 123), % |
|---|---|---|---|
| Frequent headaches | 13 | 0.04 | 28 |
| Frequent TMJ clicking | 2 | 0.01 | 16 |
| TMJ pain at wide opening | 2 | 0.06* | 10 |
| TMJ locking | 10 | 0.8 | 12 |
| Muscular pain at wide opening | 0 | 0.1* | 6 |
| Sore teeth | 0 | 0.02* | 9 |
| Tooth grinding | 9 | 0.03 | 23 |
| Tooth clenching | 3 | 0.003 | 22 |

The $P$ value tests the independence between the groups with Pearson's chi-square test or (*) Fisher's exact test. TMJ = temporomandibular joint.

table was less than 5, Fisher's exact test was used.

To compute the difference between ranks and groups with ordinal data, the Mann–Whitney rank sum test was used. When means were used in numerical variables, analysis of variance (ANOVA) was used.

For multivariate comparison a logistic regression with a likelihood ratio test was used. This test was used to check the level of significance of the odds ratio. The odds ratio was calculated as a factor of the increased odds of finding a specific symptom or sign in the presence of a given independent variable. To prevent too great an uncertainty, the logistic regression analysis was only performed when the dependent variable existed in more than 10 subjects.

$P$ values below 0.05 were required to accept the differences as statistically significant.

## Results

### *General health*

No general joint or muscle diseases were reported in any of the groups. A total of 17% in the class II group and 10% in the normal group occasionally took medication for headaches and pain in the orofacial region.

### *Symptoms of TMD, headaches, and oral parafunctions*

The prevalence of symptoms of TMD, reported headaches, and awareness of oral parafunctions are presented in Table 2. Frequent headaches were the most commonly reported variable and were, with statistical significance, commoner in the class II group than in the normal group. Frequent TMJ clicking was also commoner in the class II group, as was the awareness of tooth clenching and grinding. Awareness of any other oral parafunctions did not show statistically significant differences between the groups.

The self-rating of overall symptoms of TMD verbally (Fig. 1) and by means of a visual analogue scale showed that the subjects in the class II group estimated their symptoms to be more severe than the normal group did ($P$ = 0.009 by the verbal scale and $P$ = 0.007 by the visual analogue scale). When the self-estimated level of anxiousness was compared on a visual analogue scale, there was no statistically significant difference between the groups.

### *Clinical findings*

*Mandibular movements.* No statistically significant differences were found between the groups when comparing mandibular movements. The whole sample had a mean maximal mouth opening capacity of 53.3 mm (40–66 mm), mean lateral movements of 9.7 mm (5–15 mm), and mean protrusive movement of 8.7 mm (3–13 mm).

*Signs of TMD.* The prevalence of signs of TMD are presented in Table 3. TMJ tender to palpation grade 1–3, pain on mandibular movement, and muscle tender to palpation grade 2–3 were, with statistical significance, commoner in the class II group. The commonest muscle site tender to palpation was the insertion of the

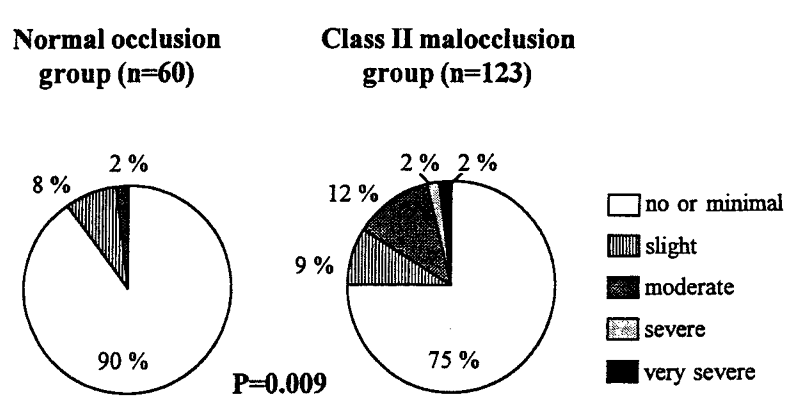


Fig. 1. The subjects in the class II group estimated their symptoms to be more severe than the normal group did ($P$ = 0.009).

Table 3. Prevalence of clinical signs of temporomandibular disorders (TMD) in percentage of the normal group and the class II group

| Clinical signs of TMD | Normal group ($n$ = 60), % | $P$ value | Class II group ($n$ = 123), % |
|---|---|---|---|
| TMJ clicking at jaw opening and/or closing. Audible or palpable | 3 | 0.05 | 14 |
| TMJ tender to palpation grade 1–3 | 3 | 0.02 | 16 |
| TMJ tender to palpation grade 2–3 | 2 | 1.0* | 2 |
| Pain on mandibular movement (at least one movement) | 2 | 0.00004 | 29 |
| Muscle tender to palpation grade 2 and 3 (at least one site) | 13 | 0.0003 | 42 |
| Deviation on mandibular opening ≥2 mm | 12 | 0.07 | 24 |

The $P$ value tests the independence between the groups with Pearson's chi-square test or (*) Fisher's exact test. TMJ = temporomandibular joint.

temporal muscle, followed by the superficial portion of the masseter muscle. TMJ clicking at both opening and closing of the mandible was found in eight subjects, of whom seven had class II malocclusion. Two subjects, both with class II malocclusion, had crepitations during mouth opening.

*Occlusal interferences, number of occlusal contacts, and occlusal wear.* When the sagittal and vertical distance between RCP and ICP was compared, there was no statistically significant difference between the groups. Lateral sliding ≥0.5 mm between RCP and ICP was with statistical significance commoner in the class II group. There were no other statistically significant differences between the groups with regard to the prevalence of occlusal interferences (Table 4).

During maximal biting pressure the normal group had more occlusal contacts (mean, 19; $s$, 4.6), than the class II group (mean, 16; $s$, 4.8). However during light biting pressure there was no statistical difference between the groups. There was no statistical difference in the degree of occlusal wear between the two groups.

Table 4. Prevalence of occlusal interferences in percentage of the normal group and the class II group

| Type of occlusal interferences | Normal group ($n$ = 60), % | $P$ value | Class II group ($n$ = 123), % |
|---|---|---|---|
| Lateral sliding between RCP and ICP ≥0.5 mm | 7 | 0.02 | 22 |
| Working side interferences | 3 | 0.1* | 10 |
| Non-working side interferences | 8 | 0.07 | 21 |
| Protrusion interferences | 5 | 0.8* | 7 |

The $P$ value tests the independence between the groups with Pearson's chi-square test or (*) Fisher's exact test. RCP = retruded contact position; ICP = intercuspal contact position.

### *Factors influencing the prevalence of headaches and symptoms and signs of TMD*

*Multivariate analysis.* All registered variables, including age, awareness of oral parafunctions, dental wear, and occlusal factors were analyzed together against headaches and symptoms and signs of TMD in a logistic regression analysis with a likelihood ratio test. The multivariate analysis was performed on the whole material simultaneously. Six subjects did not answer their questionnaire concerning awareness of oral parafunctions. They were excluded from the analysis. The odds ratio was calculated as a factor of the increased odds of finding a specific symptom or sign in the presence of a given independent variable (Table 5). Awareness of tooth clenching was the single variable that had the largest influence on the odds of both symptoms and signs of TMD. The occlusal variables that increased the odds for headaches and different symptoms and signs of TMD were 1) overjet ≥6 mm, 2) anterior open bite, 3) ≤10 contacts during maximal biting pressure, 4) lateral sliding ≥0.5 mm between RCP and ICP, 5) crowding, and 6) non-working side interferences.

Table 5. Multivariate comparison with a logistic regression to analyze the dependence between headaches, symptoms and signs of temporomandibular disorders (TMD), and all registered independent variables. Age was included as a continuous independent variable

| Dependent variable: symptoms and signs of TMD<br>Independent variable: influencing variable(s) ($n$ = 177) | Odds ratio | $P$ value |
|---|---|---|
| Symptoms | | |
| Frequent headaches ($n$ = 42) | | |
| 1) Overjet ≥6 mm | 2.2 | 0.04 |
| Frequent TMJ clicking ($n$ = 20) | | |
| 1) Midline discrepancy ≥2 mm | 5.0 | 0.003 |
| TMJ pain on wide opening ($n$ = 13) | | |
| 1) Tooth clenching | 27.0 | 0.0000 |
| TMJ locking ($n$ = 11) | | |
| 1) Open bite | 5.7 | 0.009 |
| Overall symptom at least moderate ($n$ = 20) | | |
| 1) Tooth clenching | 8.9 | 0.0000 |
| Signs | | |
| TMJ clicking, audible or palpable ($n$ = 19) | | |
| 1) ≤10 contacts during maximal biting pressure | 6.6 | 0.004 |
| 2) Lateral sliding RCP–ICP ≥ 0.5 mm* | 4.7 | 0.009 |
| 3) Increasing with age (11–15 years) | 1.9 | 0.02 |
| TMJ tenderness to palpation grade 1–3 ($n$ = 22) | | |
| 1) Open bite | 3.9 | 0.05 |
| 2) Crowding | 3.1 | 0.02 |
| Pain on mandibular movement ($n$ = 36) | | |
| 1) Tooth clenching | 5.0 | 0.003 |
| 2) Overjet ≥6 mm | 3.4 | 0.006 |
| 3) Crowding | 3.1 | 0.01 |
| 4) Tooth grinding | 2.7 | 0.05 |
| Muscle tenderness to palpation grade 2–3 ($n$ = 58) | | |
| 1) Tooth clenching | 5.1 | 0.0005 |
| 2) Non-working side interferences | 2.9 | 0.02 |
| 3) Tooth grinding | 2.7 | 0.03 |
| 4) Crowding | 2.4 | 0.02 |

* RCP = retruded contact position; ICP = intercuspal contact position.

## Discussion

The class II group in this study reported more headaches and had more symptoms and signs of TMD than the normal group. The overall prevalence of symptoms and signs of TMD was in rather good agreement with other epidemiologic studies of the same age groups (7, 25). The fact that we only included girls in our study could influence the prevalence of headaches and symptoms and signs of TMD and must be taken into considerations when comparing our results with other investigations. The differences between the groups in our study were probably due to the relatively low prevalence of symptoms and signs of TMD in the normal group. The normal group had lower prevalences of several symptoms and signs of TMD and oral parafunctions than the girls in the same age groups, selected on the basis of the presence of malocclusion (26, 27).

In this study the most influential registered variable for symptoms and signs of TMD was the reported awareness of tooth clenching. Nilner (12) found statistical correlations between tenderness to palpation of the TMJ and temporomandibular muscles and tooth clenching in 7- to 14-year-olds. DeBoever & Carlsson (28) established that parafunctions are important as initiating and perpetuating factors in the muscular subtypes of TMD. They also stated that bruxism is more related to stress than to faulty occlusion. In a longitudinal study Magnusson et al. (2) reported clenching or grinding in 19% in a group of 11-year-olds and 29% when re-examining the same group at the age of 15 years. In our study the reported awareness of clenching and grinding was higher in the class II group (22% clenching, 23% grinding) than in the normal group (3% clenching, 9% grinding), which suggests a relationship between parafunctions and malocclusion. In contrast, no association between reported bruxism and occlusal factors was reported in 240 Swedish children over a 4-year period (29). In our study it was not possible to state whether the subjects with symptoms and signs were merely more aware of grinding or clenching their teeth more frequently and more intensely or whether they actually did so. No data concerning the frequency and intensity of parafunctions were available in our study. Furthermore, reporting of clenching and grinding could be unreliable data that are difficult to interpret (2).

Several occlusal characteristics in our study increased the odds for different signs and symptoms of TMD in the logistic regression analysis. Subjects with $\leq 10$ contacts during maximal biting pressure had an increased odds for clinically registered TMJ clicking, whereas Wänman & Agerberg (30) found an association between signs and symptoms of TMD and the number of occlusal contacts when recorded during light biting pressure. Bakke (31) established that occlusal stability and a large number of occlusal contacts keep the masticatory muscles fit. This conclusion is in accordance with our findings.

Subjects with class II malocclusion have been presented as having a larger than average sagittal distance between RCP and ICP (32, 33). This finding was not confirmed in our study. However, more subjects in the class II group had a lateral slide between RCP and ICP than in the normal group. An asymmetry of the slide between RCP and ICP has been considered more harmful than a symmetric slide (6, 33, 34). We found a higher prevalence of TMJ clicking in subjects with asymmetric RCP–ICP slides than with symmetric slides.

Anterior open bite has been associated with symptoms and signs of TMD in both adults (35) and children (14). Seligman & Pullinger (36) reported an association between anterior open bite and TMJ osteoarthrosis in TMD patient groups. Anterior open bite was the variable with the greatest influence on the presence of TMJ tenderness to palpation and reported TMJ locking in our study; however, the number of subjects with anterior open bite was small ($n = 13$).

An overjet of $\geq 6$ mm increased the odds for reported frequent headaches and pain on mandibular movement in our study. Riolo et al. (14) found an association between reported TMJ clicking and overjet $\geq 7$ mm, in a cross-sectional study of 1342 subjects 6–17 years of age. Egermark-Eriksson et al. (5) reported that extreme maxillary overjet in combination with class II malocclusion was a risk factor for the development of TMD in a longitudinal perspective. On the other hand, Seligman & Pullinger (37) stated that in spite of their finding of an association between large overjet and TMJ arthroses, large overjet is also common in non-patient populations and therefore lacks specificity in defining a patient group.

Clinical assessment of occlusal variables could be recorded with rather good agreement between observers, although the intra-examiner agreement was still better (23, 38). Dworkin (39) concluded that traditional clinical measurements of TMD such as muscle and joint tenderness to palpation can be achieved with acceptable reliability. The reliability may, however, be improved by calibrating and training experienced examiners together (39). In our study the two examiners were experienced specialists in stomatognathic physiology. Furthermore, the examiners were calibrated before starting this study and re-calibrated during the ongoing study, which is why our results can be regarded as reliable.

Symptoms and signs of TMD are not disease states (16) and do not describe the need for treatment of TMD. Twenty-one subjects (12%) in our study, who rated their symptoms as moderate or severe, were judged by the examiners to be in some need of treatment of their TMD. Of these subjects, 12 were diagnosed as having myalgia, 2 as having myalgia and disk displacement, 4 as having arthritis and 3 as having tension headache. A treatment need of 12% in our study is well in accordance with other studies suggesting that 5–27% of a population of young adults would need treatment of their TMD (8, 9, 40, 41).

The most striking result in this study was the relatively low prevalence of symptoms and signs of TMD in the normal group. The normal group was selected in accordance with well-defined inclusion criteria that are similar to the criteria used for occlusion without anomaly, described by Thilander & Myrberg (18). Since this type of occlusion was present in only 26% of their population, it could be discussed whether the definition 'normal occlusion' in our study is appropriate or is closer to the definition 'ideal occlusion' proposed by Lundström (42).

The explanation for the differences between the groups in our study could be that the normal group was homogeneous, consisting of subjects with a close to ideal occlusion. Other studies have often compared malocclusion groups with groups with an Angle I relationship (43–45), which only implies that the sagittal occlusion is normal but contains some other type of malocclusion (20).

We concluded that subjects with a normal occlusion have less chances of having symptoms and signs of TMD, whereas some occlusal characteristics, more frequently found in the class II group, increased the odds for symptoms and signs of TMD.

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