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Signs of temporomandibular disorders in girls receiving orthodontic treatment. A prospective and longitudinal comparison with untreated Class II malocclusions and normal occlusion subjects

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SUMMARY The aim of this investigation was to prospectively and longitudinally study signs of temporomandibular disorders (TMD) and occlusal changes in girls with Class II malocclusion receiving orthodontic treatment and to compare them with subjects with untreated Class II malocclusions and with normal occlusion subjects.

Three groups of age-matched adolescent girls were examined for clinical signs of TMD and re-examined 2 years later. Sixty-five Class II subjects received orthodontic fixed straight-wire appliance treatment (Orthodontic group), 58 subjects were orthodontically untreated (Class II group), and 60 subjects had a normal occlusion (Normal group).

In the Orthodontic group, the prevalence of muscular signs of TMD was significantly less common post-treatment. The Class II and the Normal groups showed minor changes during the 2-year period. Temporomandibular joint clicking increased in all three groups over the 2 years, but was less common in the Normal group. The Normal group also had a lower overall prevalence of signs of TMD than the Orthodontic and the Class II groups at both registrations. Functional occlusal interferences decreased in the Orthodontic group, but remained the same in the other groups over the 2 years.

In conclusion, orthodontic treatment did not increase the risk for or worsen pre-treatment signs of TMD. On the contrary, subjects with Class II malocclusions and signs of TMD of muscular origin seemed to benefit functionally from orthodontic treatment in a 2-year perspective. The Normal group had a lower prevalence of signs of TMD than the Orthodontic and the untreated Class II groups.

Introduction

Signs of temporomandibular disorders (TMD) are common in children and adolescents, and tenderness to palpation of the masticatory muscles and temporomandibular joint (TMJ) sounds are considered to be the commonest clinical signs of TMD (Nilner, 1992). Longitudinal studies of children and adolescents have shown that clinical signs of TMD increase with age, but are inconsistent over the course of time, showing both improvement and impairment on an individual basis (Magnusson *et al.*, 1985, 1986; Wänman and Agerberg, 1986; Heikinheimo *et al.*, 1990; Könönen and Nyström, 1993).

The aetiology of TMD is usually considered to be multifactorial and the contributing factors discussed are trauma, anatomical, pathophysiological, and psychosocial factors (Okeson, 1996). The roles of morphologic and functional occlusion in the development of TMD have been debated during the last two decades. Different types of occlusal interferences, Angle Class II and III malocclusions, large overjet, anterior open bite, and posterior crossbite have been associated with signs and symptoms of TMD

(Mohlin *et al*., 1980; Nilner, 1985; Riolo *et al*., 1987; Egermark-Eriksson *et al*., 1990; Pullinger *et al*., 1993; Henrikson *et al*., 1997; Sonnesen *et al*., 1998). However, there is still controversy concerning the relative importance of occlusion in relation to other contributing factors (Carlsson and Droukas, 1984; Seligman and Pullinger, 1991a,b,c; Pullinger *et al*., 1993; Luther, 1998b).

Orthodontic treatment as a contributing factor for the development of TMD has been debated. Arguments concerning deleterious effects on stomatognathic function from orthodontic treatment and inducing occlusal interferences have appeared in the literature (Solberg and Seligman, 1985; Thompson, 1986a,b; Wyatt, 1987; Nielsen *et al*., 1990). On the other hand, two recent reviews of the relationship between mandibular dysfunction did not indicate orthodontic treatment to be a risk factor for developing TMD (McNamara *et al*., 1995; Luther, 1998a). Previous studies analysing the role of orthodontic treatment in relation to mandibular dysfunction have often included large age variations and different malocclusions both in the orthodontic treatment group and, if present, also in the control group. There is a need for controlled studies to further investigate this relationship.

Signs of TMD can appear, and increase in frequency and severity during the second decade of life (Magnusson *et al*., 1985, 1986; Wänman and Agerberg, 1986; Heikinheimo *et al*., 1990; Könönen and Nyström, 1993). The occurrence of signs of TMD during orthodontic treatment must therefore be seen in the light of normal longitudinal changes in subjects of the same age with similar, but untreated malocclusions and, preferably, also in subjects without malocclusion.

The aim of this investigation was to study signs of TMD and occlusal changes longitudinally, in girls with Class II malocclusions receiving orthodontic treatment, and to compare the same parameters longitudinally in subjects with untreated Class II malocclusions and in those with normal occlusion of the same age,

Subjects and methods

One-hundred-and-eighty-three girls, aged 11–15 years at start of the study, were included. Sixty-five subjects with a Class II malocclusion received orthodontic treatment (Orthodontic group), 58 subjects with Class II malocclusion were orthodontically untreated (Class II group), and 60 subjects had a normal occlusion (Normal group). The subjects in the Normal and the Class II groups were selected by screening school classes attending clinics of the Public Dental Service in the Malmö region of Sweden, while the subjects in the Orthodontic group were consecutively selected among those on the waiting-list for orthodontic specialist treatment in the Public Dental Service of Malmö.

Orthodontic group

Sixty-five girls (mean age at start: 12.8 years; SD 1.1) were included in this group. One subject discontinued orthodontic treatment and did not wish to participate in the re-examination. Subjects with an earlier history of orthodontic treatment were excluded. The inclusion criterion was a bilateral or unilateral Class II relationship of at least half a cusp (Angle, 1899).

Class II group

Fifty-eight girls with Class II malocclusions (mean age at start 12.9 years, SD 1.0) were included in this group. One subject moved away from the region and was not able to participate in the second examination. The inclusion criterion was the same as for the Orthodontic group, but without any planned orthodontic treatment.

Normal group

Sixty subjects with normal occlusion (mean age at start 12.7 years, SD 0.7) were included in this group. The inclusion criteria for the Normal group were a bilateral neutral sagittal relationship for molars, premolars and canines and a normal transverse relationship. The overjet and overbite was between 1 and 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 aplasia of teeth were excluded, as were subjects with an earlier history of orthodontic treatment.

Table 1 Percentage distribution of occlusal characteristics and the mean overjet and overbite (mm) in the three groups at the start of the study and after 2 years.

Morphological occlusion dental relations	Class II Orthodontic group		Class II group		Normal group	
	(*n* = 65) Start	(*n* = 64) 2 years	(*n* = 58) Start	(*n* = 57) 2 years	(*n* = 60) Start	(*n* = 60) 2 years
Sagittal relationship						
Normal	0	94	0	0	100	100
Bilateral Class II	69	3	41	40	0	0
Unilateral Class II	31	3	59	60	0	0
Overjet mean (mm)	6.4 (± 2.3)	2.3 (±1.1)	4.4 (±2.0)	4.2 (±2.0)	2.5 (±1.0)	2.4 (±0.9)
Overjet 1–4 mm	20	95	53	51	100	100
Overjet >4 mm	80	5	47	49	0	0
Overjet ≥6 mm	65	2	22	20	0	0
Vertical relationship						
Overbite mean (mm)	3.1 (±2.1)	1.7 (±0.8)	3.8 (±1.7)	3.7 (±1.3)	3.0 (±0.8)	2.8 (±1.1)
Overbite <0 mm	14	0	7	7	0	0
Overbite 0–4 mm	56	100	52	54	100	98
Overbite >4 mm	30	0	41	39	0	2
Transverse relationship						
Normal	86	100	79	81	100	100
Crossbite	12	0	16	14	0	0
Scissors bite	2	0	5	5	0	0
Midline discrepancies						
≥2 mm	15	3	33	35	0	0
Crowding						
<2 mm/jaw	31	100	62	56	100	95
2–6 mm/jaw	52	0	36	40	0	5
>6 mm/jaw	17	0	2	4	0	0

The occlusal characteristics for the three groups at the start and after 2 years are presented in Table 1.

Clinical examination

All subjects were examined at the beginning of the study and re-examined 2 years later. All patients in the Orthodontic group were out of active treatment at the examination at 2 years. The clinical examination included measurement of mandibular mobility and pain on movement of the mandible. TMJ sounds were registered by palpation and auscultation at opening and closing (without a stethoscope). Pain on palpation of the TMJs and the masticatory muscles was registered if a subject showed a palpebral reflex (grade 2) or a defence reaction (grade 3). The origin and insertion of the temporal, the profound and superficial masseter, and the medial pterygoid muscles were palpated bilaterally. The clinical examination also included registration of functional occlusal interferences, the slide and distance between the retruded contact position (RCP), and the intercuspal contact position (ICP), and the number of occlusal contacts during light and maximal biting pressure. The clinical registration of signs of TMD, mandibular function and functional occlusal interferences were standardized methods as described by Carlsson and Helkimo (1972), and reported in further detail by Henrikson *et al.* (1997, 1998).

The clinical examination was performed by two certified specialists in stomatognathic physiology (M N and EC E). The subjects were examined by the same examiner at both registrations. To calibrate the examination technique between the two specialists regarding registration of clinical signs, mandibular movements, occlusal interferences, and contacts, eight subjects were examined by both examiners before and during the study. The calibration of

the two examiners, showed a uniformity in 75–90 per cent of registered signs and occlusal interferences. Mandibular movements were registered without statistical difference between observers. In addition, the intra- and inter-observer reliability for registrations of occlusal interferences for the two examiners has been presented (Valon *et al*., 1989; Valon, 1997). In an attempt to avoid possible bias, the examiners were not aware of the results of the first examination when performing the second after 2 years and they were not informed to which group the subjects belonged. The extra-oral examination was performed before the intra-oral one. The type of morphological occlusion was registered by an orthodontist (TH) according to Egermark-Eriksson (1982) and Henrikson *et al*. (1997).

Orthodontic treatment

The treatment goal was to normalize the sagittal, vertical and transversal dental relationships, and to eliminate crowding or spacing. This was achieved in most treated subjects, as shown in Table 1. All the subjects in the Orthodontic group were treated with a modified straight-wire technique. Fifty-three subjects wore Class II elastics and nine subjects extra-oral traction to enforce the anchorage and/or to correct the sagittal relationships. Eight subjects were, in addition, treated with an activator. Thirty subjects (46 per cent) were treated without any extractions, while 35 subjects (54 per cent) underwent extraction of two maxillary or four premolars. The active treatment period varied between 14 and 23 months. Retention was performed with upper Hawley plates or bonded upper retainers. In the lower jaw bonded canine to canine retainers were used.

Statistical methods

Differences within the groups between the first and second measurement were calculated as follows: for binary variables, the McNemar's test was used, for ordinal data the Wilcoxon's matched pairs signed rank test, and for numerical variables the paired *t*-test. Differences between the groups were calculated as follows; for binary variables the Pearson's chi-square test with Yates' correction for continuity was used, for ordinal data the Mann–Whitney rank sum test, and for numerical variables the analysis of variance (ANOVA). *P*-values below 0.05 were considered as statistically significant. The actual *P* values are given in the text.

Results

Mandibular movement

No differences in maximal mandibular movements on opening capacity, laterotrusion and protrusion, were found between the groups at the two registrations. The whole sample had a mean maximal opening capacity of 53 mm (40–66 mm) at the start and 54 mm (43–75 mm) 2 years later.

Clinical signs of TMD

The prevalence of clinical signs of TMD at the first and second registration is presented in Table 2. In the Normal group the overall prevalence of signs of TMD was lower than in the other two groups at both registrations. The general trend was an increased prevalence of signs of TMD over the 2 years. The exceptions to this trend were in the Orthodontic group, where pain on maximal mandibular movements ($P = 0.03$) and muscle tenderness to palpation grade 2–3 ($P = 0.004$) were significantly less common after 2 years. The individual longitudinal changes of tenderness to palpation of the masticatory muscles and statistical differences between the groups are shown in Figure 1. At the first examination the Normal group had significantly fewer subjects with muscle tenderness to palpation than the Orthodontic group ($P = 0.0007$) and the Class II group ($P = 0.009$), while no differences were found between the Orthodontic and the Class II groups. After 2 years, muscle tenderness to palpation was significantly more frequent in the Class II group than in the Orthodontic ($P = 0.009$) and the Normal group ($P = 0.005$), while no difference was found between the Orthodontic and Normal groups.

Table 2 Prevalence of clinical signs of TMD in per cent of the three groups at the start of the study and 2 years later.

Clinical signs of TMD	Class II Orthodontic group %		Class II group %		Normal group %	
	Start	2 years	Start	2 years	Start	2 years
Muscles tender to palpation grade 2 and 3						
One or more sites	45	20	38	44	15	18
Two or more sites	26	14	21	21	5	10
Pain on mandibular movement						
At least one movement	31	16	26	23	3	8
Joint sounds						
TMJ clicking at opening and/or closing	15	20	12	18	3	10
Reciprocal clicking	9	9	2	5	2	2
Crepitations	2	2	2	3	0	0
TMJ tender to palpation grade 2–3	2	3	3	5	2	3

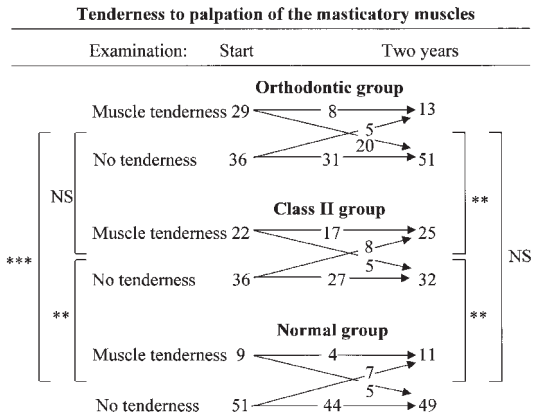

Figure 1 Individual longitudinal changes over the 2 years in subjects with muscle tenderness to palpation grade 2–3. The figures indicate the number of subjects. The vertical bars show statistical differences between the groups at the first and second examination. NS, $P > 0.05$; *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

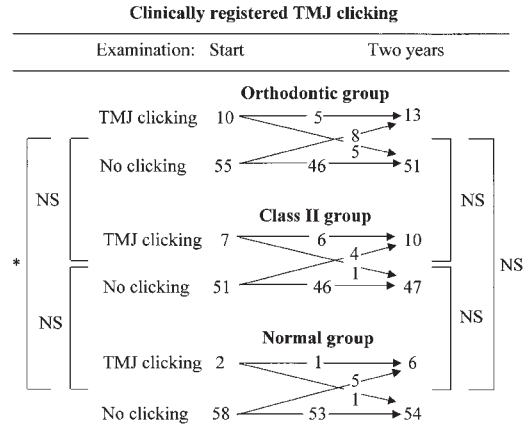

Figure 2 Individual longitudinal changes over the 2 years in subjects with clinically registered TMJ clicking. The figures indicate the number of subjects. The vertical bars show statistical differences between the groups at the first and second examination. NS, $P > 0.05$; *$P < 0.05$.

Tenderness to palpation of the TMJ grade 2–3 was rare and showed no differences between the groups or between the first and second examination within the groups.

Initially, 3 per cent of the subjects in the Normal group had audible and/or palpable TMJ clicking. This prevalence was lower than in the Orthodontic (15 per cent, $P = 0.047$) and the Class II groups (12 per cent, $P = 0.075$) at the start. All three groups showed an increased prevalence of TMJ clicking after 2 years, but without significant differences between the groups. The individual longitudinal changes of registered TMJ clicking are shown in Figure 2.

At the first registration, in all three groups, eight subjects had registered TMJ clicking at both opening and closing (reciprocal clicking), while the corresponding number was 10 subjects at the second registration. Only two subjects had reciprocal clicking at both the first and second

registration. No subjects developed a closed lock during the 2-year period. TMJ crepitation was found in a few subjects in the Orthodontic and the Class II groups (Table 2).

Occlusal interferences and the number of occlusal contacts

The overall prevalence of occlusal interferences showed only small changes over the 2 years in the Class II and the Normal groups. All types of registered occlusal interferences decreased over the 2 years within the Orthodontic group (Table 3). The decrease in the Orthodontic group of non-working side interferences was significant ($P = 0.004$). At the first registration non-working side interferences were more prevalent in the Orthodontic group than in the Class II ($P = 0.005$) and the Normal groups ($P = 0.004$). At the second registration there was no significant difference in non-working side interferences between the groups.

The sagittal distance between RCP and ICP showed only minor differences within and between the groups at the two examinations. Lateral sliding between RCP and ICP ≥ 0.5 mm was more frequent in the Orthodontic than in the Normal group ($P = 0.007$) at the first examination. A difference still existed after orthodontic treatment, but it was somewhat smaller ($P = 0.16$).

All three groups had more occlusal contacts during light ($P < 0.03$) and maximal biting pressure ($P < 0.0001$) at the second registration compared with the first (Table 4). The Normal group had significantly more occlusal contacts than both the Orthodontic and the Class II groups at both registrations. After 2 years, the Orthodontic group had fewer occlusal contacts than the Class II group during light biting pressure ($P = 0.005$), while there were no statistical differences between the two groups when comparing the number of occlusal contacts during maximal biting pressure.

Table 3 Prevalence of occlusal interferences as a percentage of the three groups at the start of the study and 2 years later. ICP: intercuspal contact position; RCP: retruded contact position.

Functional occlusal interferences	Class II Orthodontic group %		Class II group %		Normal group %	
	Start	2 years	Start	2 years	Start	2 years
Working side interferences	14	9	5	9	3	7
Non-working side interferences ≤3mm lateral excursion	31	13	9	9	8	10
Protrusion interferences	11	6	3	4	5	7
Sagittal distance between RCP and ICP >1 mm	6	3	5	3	7	5
Lateral sliding between RCP and ICP ≥0.5 mm	26	14	17	14	7	5

Table 4 The number of occlusal contacts in the three groups at the start of the study and 2 years later.

Number of occlusal contacts	Class II Orthodontic group		Class II group		Normal group	
	Start	2 years	Start	2 years	Start	2 years
Light biting pressure Mean (SD)	9 (4.1)	10 (4.3)	10 (4.7)	14 (6.6)	11 (4.7)	15 (6.5)
Maximal biting pressure Mean (SD)	15 (5.0)	19 (5.3)	16 (4.7)	20 (6.1)	19 (4.6)	25 (7.1)

Discussion

The results of this study show that the orthodontic treatment with fixed appliance did not increase the risk for signs of TMD. On the contrary, subjects with Class II malocclusions and signs of TMD of muscular origin seem to benefit functionally from orthodontic treatment over a 2-year perspective. The Normal group had a lower overall prevalence of signs of TMD than both the Orthodontic and the untreated Class II group.

This study was performed by analysing an orthodontic treatment group, age matched to control subjects with similar but untreated Class II malocclusions, as well as matched subjects with normal occlusion (Thilander and Myrberg, 1973). This model made it possible to control the influence of age, occlusal factors, and orthodontic treatment on mandibular dysfunction when comparing the three groups. Previous studies analysing the role of orthodontic treatment in relation to mandibular dysfunction have often included subjects with large age variations and different malocclusions, both in the orthodontic treatment group and, if present, in the control group.

For ethical and practical reasons, it was not possible to randomize subjects with Class II malocclusion into orthodontic treatment and non-treatment groups. The registrations of symptoms and signs of TMD in all three groups were merely a passive observation, and the decision whether the subjects were offered orthodontic treatment or not was beyond our control. When performing the screening procedure for untreated Class II malocclusions, the inclusion criterion was solely the presence or absence of a Class II malocclusion. A closer comparison of occlusal characteristics between the Orthodontic and the Class II groups revealed (Table 1) that the Orthodontic had more subjects with severe crowding and a larger mean overjet than the untreated Class II group. This raises the question of whether the comparison between the Orthodontic and the Class II groups was valid? An overjet ≥6 mm and crowding increased the odds for some of the registered symptoms and signs of TMD at base line in this sample (Henrikson *et al*., 1997). Although these findings may have influenced the functional status in certain individuals, it was valuable to include a control group with similar, but not identical malocclusions.

The patients in this study asked for orthodontic treatment of their malocclusion and not treatment of their TMD. No special attempts were made to individualize the orthodontic treatment in those subjects who had pre-treatment TMD.

Orthodontic treatments were performed as uniformly as possible. However, for obvious reasons, individual considerations were taken into account when planning and performing the treatment in each subject. All patients were treated with fixed straight-wire appliances since most had other malocclusions combined with the Class II relationship, such as transverse or vertical discrepancies, crowding or spacing. In addition, eight subjects were also treated with activators during the treatment period. Class II elastics were used in most subjects, but in those with a tendency to open bite, high-pull headgear was used in order to control the vertical relationship.

The reliability of the registration of traditional clinical measurements of TMD, such as muscle and joint tenderness to palpation, can be achieved with acceptable reliability (Dworkin, 1992). In this study, the two examiners were experienced specialists in stomatognathic physiology who were calibrated before starting the investigation and recalibrated during the ongoing study in accordance with the recommendations of Dworkin (1992). The variability in the assessment of functional occlusal variables for the two examiners (M N and EC E) in this study, has been investigated (Vallon *et al*., 1989; Vallon, 1997). They found, in agreement with Carlsson *et al*. (1980), that clinical assessment of functional occlusion could be recorded with good agreement between observers, although the intra-examiner agreement was still better. It was therefore considered that the recordings in this study were reliable.

A slightly increased prevalence of muscular signs of TMD was found in the Class II and in the Normal groups over the 2 years. This

corroborates previous findings in longitudinal studies of similar age groups (Magnusson *et al*., 1985, 1986; Heikenheimo *et al*., 1990). The decreased prevalence of muscular signs of TMD in the Orthodontic group diverged from normal longitudinal changes. An explanation for this could be that hyperactivity of masticatory muscles decreases during orthodontic tooth movement because of sensitive teeth. This explanation was discussed by Egermark-Eriksson and Rönnerman (1995), who in agreement with Olsson and Lindquist (1995) found a decreased prevalence of muscle tenderness to palpation after orthodontic treatment. A recent study (Rodrigues-Garcia *et al*., 1998) also reported that subjects with severe Class II malocclusions had less muscular signs of TMD after surgical-orthodontic treatment. Another explanation could be improved occlusal stability with less occlusal and functional interferences, and more occlusal contacts.

Although individuals showed both improvement and impairment of clinically registered TMJ clicking, all three groups in this study showed a similar increase in the prevalence of TMJ clicking over the 2 years (Table 2). Since this increase was seen in all three groups, it can be concluded that orthodontic treatment did not have any influence on TMJ clicking. This increased prevalence of TMJ clicking over the 2-year period was expected, since other studies have reported that TMJ clicking increased from childhood to adolescence and that the prevalence is even higher in adults (Solberg *et al*., 1979; Magnusson *et al*., 1985, 1986; Wänman and Agerberg, 1990a; Könönen *et al*., 1996; Pilley *et al*., 1997). In contrast to our findings, Sadowsky *et al*. (1991) found a lower prevalence of joint sounds post-treatment. Their sample consisted, however, of children, adolescents, and adults. Our finding of a lower prevalence of TMJ clicking in those with normal occlusion than in subjects with malocclusion remains to be explained. Solberg *et al*. (1986) found in autopsy material (mean age 26.4, SD 6.8 years) condylar and temporal deviation in form associated with a Class II malocclusion and also a greater overjet associated with disc displacement. Dibbets and van der Weele (1991) reported a higher frequency of TMJ clicking in subjects who had undergone orthodontic treatment with extraction of four first premolars compared with those treated by non-extraction. They concluded, however, that it was the original growth pattern that selected these subjects for extractions, rather than the extractions themselves that was the explanation for the higher prevalence of clinically registered TMJ clicking.

In this study, eight subjects at the first registration and 10 at the second registration had reciprocal TMJ clicking, which has been suggested to be a clinical sign of disc displacement (Dolwick *et al*., 1983; Westesson, 1983). Noteworthy, however, is that only two subjects had reciprocal TMJ clicking at both registrations, which implies that natural fluctuations also exist in adolescents with reciprocal TMJ clicking. Sadowsky *et al*. (1991) found less reciprocal clicking after orthodontic treatment than before on a group basis, but reported individual fluctuations of reciprocal clicking similar to the findings in this study. It has been suggested that TMJ clicking is progressive (Dolwick *et al*., 1983; Brooke and Grainger, 1988). Our finding of individual fluctuation over time together with the fact that none of the subjects developed a closed lock of the TMJ during the 2-year period is more in line with those of Wänman and Agerberg (1990a) and Könönen *et al*. (1996). In view of the fluctuations over time of both TMJ and reciprocal clicking found in this and previous studies, it is recommended that both general practitioners and orthodontists should inform patients with TMJ clicking that treatment is seldom necessary.

In the Orthodontic group, a decreased prevalence of all registered functional and occlusal interferences was found, while the prevalence in the other two groups remained unchanged over the 2 years. The overall prevalence of functional interferences in the Orthodontic group post-treatment was lower than that reported by Milosevic and Samuels (1998), and Sadowsky and Polson (1984) in orthodontically treated samples. The occurrence of interferences in our three groups did not differ substantially to those found in girls aged 10–16 years (Könönen *et al*., 1987). Lateral sliding between RCP and

ICP ≥ 0.5 mm, however, was less common in our Normal occlusion group compared with the Orthodontic and Class II groups, and to that reported by Könönen *et al*. (1987). An asymmetric slide between RCP and ICP has been suggested to be more harmful than a symmetric slide (Solberg *et al*., 1979; Egermark-Eriksson and Ingervall, 1982). The clinical relevance of occlusal and functional interferences, and the relationship between interferences and mandibular dysfunction is, however, debatable (Carlsson and Droukas, 1984; Seligman and Pullinger, 1991b; Pullinger *et al*., 1993).

Few occlusal contacts have been associated with signs and symptoms of TMD (Wänman and Agerberg, 1990b; Henrikson *et al*., 1997). In addition, Bakke (1993) claimed that occlusal stability and a large number of occlusal contacts maintain the masticatory muscles. An increased number of occlusal contacts were registered in all three groups in this investigation over the 2 years. This increase was probably due to further eruption of teeth and the general development of the masticatory system. A further increase in the number of occlusal contacts in the Orthodontic group might be expected when the occlusion settles during the retention period.

Conclusions

All three groups in this study included subjects with more or less pronounced signs of TMD, which showed individual fluctuation over the 2-year period. Therefore, it was concluded that it is not possible on an individual basis to predict the risk of mandibular dysfunction based on the presence or absence of a malocclusion. On a group basis however, since the Normal occlusion group had a lower prevalence of signs of TMD than the other two groups, the type of occlusion may play a role as a contributing factor for the development of mandibular dysfunction, although this influence is difficult to quantify and predict. In addition, the orthodontic treatment performed did not increase the risk for or worsen pre-treatment signs of TMD in comparison with the untreated Class II malocclusion group. Subjects with Class II malocclusions and pre-treatment signs of TMD of muscular origin appeared to benefit functionally from orthodontic treatment in a 2-year perspective.

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