Prevention of temporomandibular disorder-related signs and symptoms in orthodontically treated adolescents

A 3-year follow-up of a prospective randomized trial

Mikko Karjalainen, Yrsa Le Bell, Tapio Jämsä and Sára Karjalainen
Public Health Center of Turku and Section of Postgraduate Education, Department of Oral Development and Orthodontics, and Department of Pediatric Dentistry, Institute of Dentistry, University of Turku, Turku, Finland

Karjalainen M, Le Bell Y, Jämsä T, Karjalainen S. Prevention of temporomandibular disorder-related signs and symptoms in orthodontically treated adolescents. A 3-year follow-up of a prospective randomized trial. Acta Odontol Scand 1997;55:319–324. Oslo. ISSN 0001-6357.

Recommendations about the need for occlusal adjustment after malocclusion therapy are inconclusive. A total of 123 orthodontically treated healthy adolescents (88 girls, 35 boys; 14.8 ± 1.7 years old) agreed to participate in the present study. The subjects were interviewed and examined for signs and symptoms related to temporomandibular disorder (TMD) and were randomly allocated to intervention ($n = 63$) and control ($n = 60$) groups. At base line, occlusal adjustment was carried out for the intervention group and repeated every 6 months thereafter as needed. Mock adjustments were performed for the control group. At the end of the 3rd year 118 subjects (96%) turned up for re-examination. The number of subjects with palpatory pain of the masticatory muscles, and with occlusal centric slides decreased significantly in the intervention group but not in the control group ($P < 0.001$). In conclusion, occlusal adjustment therapy may prevent the occurrence of TMD signs in orthodontically treated healthy adolescents. □ *Dental occlusion; occlusal adjustment; prevention; temporomandibular disorders*

Sára Karjalainen, Department of Pediatric Dentistry, Institute of Dentistry, University of Turku, Lemminkäisenkatu 2, FIN-20520 Turku, Finland

Controversial opinions exist on the associations between symptoms and signs related to temporomandibular disorders (TMD) and malocclusions. Distal occlusion, posterior crossbite and deep bite may have associations with the development of TMD (1, 2), but the overall correlation between TMD symptoms and malocclusions is low (2). This may partly be due to problems in the study designs conventionally applied (3). Subjects who have been treated for malocclusions have lower clinical dysfunction indexes than those who have untreated malocclusions (4, 5). TMD-related symptoms and signs occur irrespective of the pattern of orthodontic treatment (6–8). On the other hand, long-term relapse after orthodontic treatment is commoner than is generally believed (9). Methods to prevent treatment relapse in orthodontic treatment, other than 'overcorrecting', surgery of transseptal fibers (10), or modifying the period of retention, are few (11). Occlusal interferences may have a traumatic effect on the dentition (12) and seem to be associated with TMD-related signs and symptoms even in 5- to 10-year-old children (13). Recent results suggest that the elimination of interferences after orthodontic treatment improves the health of the stomatognathic system (14). Our aim was, therefore, to study longitudinally the significance of occlusal adjustment in preventing TMD-related signs and symptoms and treatment relapse in adolescents with experience of malocclusion therapy.

Subjects and methods

Subjects

A total of 138 healthy adolescents whose orthodontic treatment, including retention, was completed during the year 1991 at the Public Health Center in Turku, were invited to participate in the present study. The preceding orthodontic treatment had been carried out by one orthodontist and with fixed appliances. Forty per cent of the subjects had malocclusions with bilateral and 24% with unilateral class-II molar relationship; the remaining 36% had malocclusions with class-I molar relationship before the start of the orthodontic treatment. Subjects with class-I and class-II molar relationships were evenly distributed between the intervention and control groups. None of the children had previously been interviewed, examined, or treated for TMD-related signs or symptoms. Altogether 123 subjects (88 girls, 35 boys), whose mean (s) age was 14.8 (1.7) years, agreed to participate. The subjects were randomly allocated to intervention ($n = 63$) and control ($n = 60$) groups, and informed consent was obtained. The study was approved by the Ethics Committee of the Public Health Center of Turku, Finland. One subject was excluded because of manifest TMD, and four did not want to continue in the study. We report the follow-up of the 96% who received both examinations.

Table 1. The number of subjects with symptoms in the intervention (n = 63) and in the control (n = 60) group at base line and at the 3-year follow-up examination

Symptoms	Base line		3-year follow-up	
	Intervention, n (%)	Control, n (%)	Intervention, n (%)	Control, n (%)
Specific symptoms				
Jaw pain	3 (5)	6 (10)	2 (3)	3 (5)
Chewing pain	1 (2)	4 (7)	0 (0)	0 (0)
Fatigue of jaws	5 (8)	7 (12)	0 (0)	2 (3)
Luxation or locking of the jaws	4 (7)	5 (8)	4 (7)	2 (3)
Joint sounds (clicking or crepitation)	10 (15)	13 (22)	16 (27)	19 (32)
Nighttime tooth-grinding	4 (7)	10 (17)	9 (15)	9 (15)
Daytime tooth-grinding	2 (3)	3 (5)	0 (0)	3 (5)
Non-specific symptoms				
Recurrent headache	19 (31)	17 (28)	11 (19)	9 (15)
Ear symptoms	8 (13)	11 (18)	5 (9)	2 (3)
Throat pain	0 (0)	0 (0)	0 (0)	1 (2)
Neck pain	2 (3)	4 (7)	5 (9)	7 (12)
Back pain	1 (2)	4 (7)	0 (0)	0 (0)
Vertigo	2 (3)	4 (7)	4 (7)	0 (0)
Globus symptom	4 (7)	6 (10)	1 (2)	2 (3)
Difficulties in swallowing	5 (8)	2 (3)	1 (2)	0 (0)

No significant differences were found between the intervention and control groups (Fisher's exact test).

Interview and clinical examination

The participants were interviewed for the occurrence of symptoms related to TMD on the basis of a list of 18 questions: the occurrence of recurrent headache ($\geq$2 episodes a month), pain in the jaws, throat, neck, and back, ear symptoms, pain in the temporomandibular joints at rest and during chewing. The occurrence of day- and night-time grinding, vertigo, stiffness in jaws, difficulties in swallowing, globus symptoms, joint sounds (clicking or crepitation of the temporomandibular joints), and spontaneous luxation or locking of the jaws were also asked about. The questions were designed to give dichotomized, yes/no answers. The interview was carried out at base line and annually thereafter. In this report the results of the initial and the 3-year follow-up interviews are given. Two of the authors (Y. Le Bell and T. Jämsä), with special expertise in stomatognathic physiology, were carefully calibrated before the study and carried out the interview and the clinical examinations throughout the study. The examiners were unaware of whether occlusal adjustment had been performed. Palpatory tenderness was recorded if pain was noted on either side of the seven masticatory muscles: Mm. temporalis, temporalis insertion, pterygoideus lateralis and medialis, masseter superficialis and profunda, and digastricus posterior. For statistical analysis subjects with no palpatory tenderness in any of the listed muscles were classified as sign-free subjects, whereas those with one or several painful muscles were regarded as subjects with TMD signs. Clicking, crepitation, and tenderness on movement or on maximal opening of the joint were evaluated by bidigital palpation and auscultation. Deviation of the mandible on opening and closing was also recorded. Mandibular mobility was recorded as maximal opening (millimeters) and as maximal movements to the right, to the left, and forward.

The articulation pattern of the teeth was recorded as canine guidance, group contact, or other. The presence of occlusal interferences in retruded, protruded, and medio- and latero-truded positions of the mandible (13) was examined by using GHM foil (0.008 mm, Hanel-GHM-Dental GmbH, Nürtingen, Germany). Occlusal centric slides in vertical, horizontal, and lateral directions were also recorded (14). The examination was carried out at base line and annually thereafter.

Treatment

Occlusal adjustment, aiming to eliminate any slides between retruded and intercuspal position, contact on the mediotrusion side, and post-canine contact on the laterotrusion side or during protrusion, was performed for all subjects in the intervention group as described by

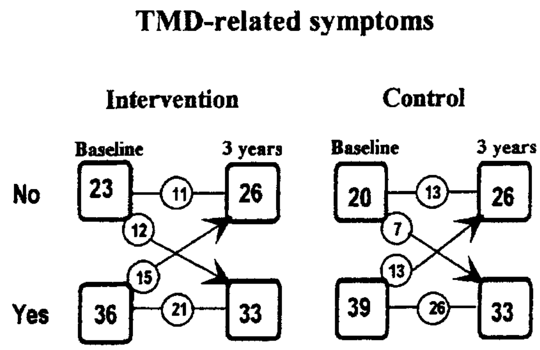

Fig. 1. The number of subjects in the intervention and in the control groups with (Yes) and without (No) any of the symptoms listed in Table 1 at base line and after the 3-year period of follow-up. The numbers on the horizontal lines indicate subjects with no change in symptoms; those on the descending lines indicate new subjects with symptoms, and those on the ascending lines indicate new asymptomatic subjects. *Fisher's exact.

Riise (15). Maintenance adjustments were carried out every 6 months during the follow-up period as needed. Mock adjustments with non-abrasive burs was performed for the control group. All adjustments were carried out by two dentists (M. Karjalainen and Dr Anna Arve), both of whom had expertise in performing occlusal equilibration.

Statistical analysis

Fisher's exact test was used to analyze the difference in the frequency distributions of TMD-related symptoms and signs between the groups and between the two examinations. Analysis of variance (ANOVA) for repeated measures was used to analyze the differences between groups in occlusal centric slides. P values less than 0.05 were considered significant.

Results

Symptoms and signs

Recurrent headaches and ear symptoms had decreased in both groups by the 3-year follow-up examination, but the change was not significant (Table 1). At the same time, the number of symptom-free subjects increased in both groups without any significant differences between groups (Fig. 1). The proportion of subjects with reported temporomandibular joint sounds increased from 17% to 29% over the observation period ($P < 0.02$) (Fig. 2), whereas no such difference was found in the frequency of recorded sounds (Fig. 2). There was a weak correlation between reported and recorded joint sounds at base line ($r = 0.345$), which was much stronger at the end of the 3rd year of follow-up ($r = 0.676$). No differences were found in reported or

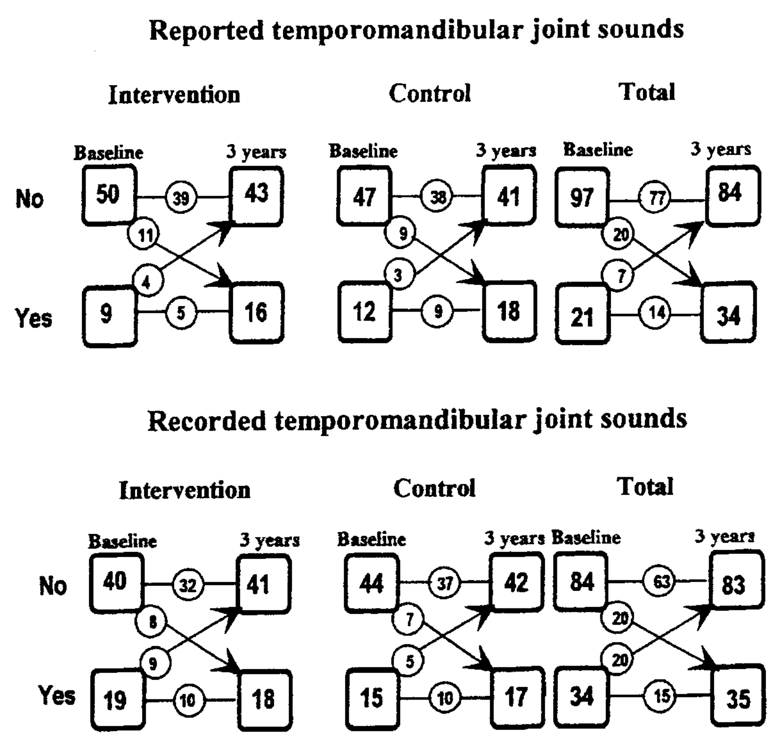

Fig. 2. The number of subjects with (Yes) and without (No) reported (interview) and recorded (auscultation) temporomandibular joint sounds at base line and after the 3-year period of follow-up. For further explanation, see the legend to Fig. 1.

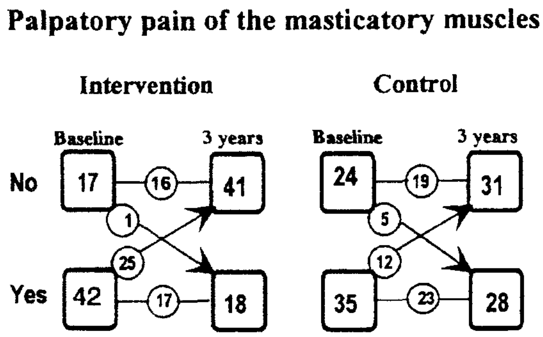

Fig. 3. The number of subjects with (Yes) and without (No) palpatory tenderness of the masticatory muscles in the intervention and in the control groups at base line and after the 3-year period of follow-up. For further explanation, see the legend to Figure 1.

recorded temporomandibular joint sounds between the groups at base line or after the 3-year follow-up (Fig. 2).

The number of subjects with painful muscles decreased significantly in the intervention group during the 3-year follow-up period, whereas no such change was observed in the control group (Fig. 3).

Occlusion and mandibular movement

Occlusal adjustment resulted in reduced horizontal, vertical, and lateral slides between retruded and intercuspal position in the intervention group, whereas no significant changes were recorded for the control group (Table 2). The number of subjects with bilateral group contact decreased significantly in the intervention group as opposed to a slight increase in the control group ($P < 0.04$) (Table 3). Overjet and overbite in the two groups did not differ and remained unchanged during the follow-up period (median (range), 3 (0–8) mm).

No differences were observed between groups in maximal opening at base line or at the 3-year examination (median (range), 52 (38–72) mm). Furthermore, no differences were observed in maximal lateral movement to the right or to the left at base line or at the final examination (median (range), 10 (5–15) mm). Maximal protrusion did not change during the follow-up and was the same in the two groups (median (range), 5 (1–10) mm).

Discussion

We have shown that in a short-term perspective of 3 years, occlusal adjustment improves occlusal stability in terms of reduced amount of slides between retruded and intercuspal position and, at the same time, more equally distributed tooth contacts between the upper and lower dental arches without prematurities. Moreover, the number of subjects with palpatory pain in the masticatory muscles decreased in the intervention group. Since prevention is the best approach to treat all chronic diseases including TMD, occlusal adjustment, successfully used to treat manifest TMD earlier (16, 17), was here tested for preventive purposes. We cannot agree with earlier studies claiming that early treatment of occlusal conditions to prevent the development of TMD would not be justified scientifically (18). On the contrary, we have shown here that stable occlusion—that is, an occlusion without interferences and slides between intercuspal and retruded position—may significantly reduce the many risks of TMD. Indeed, the positive results of the treatment method are believed to be due to elimination of occlusal risk factors of TMD (15). Needless to say, further follow-up of these subjects will be required to answer the question whether TMD in adulthood can be prevented by careful adjustment of occlusion.

The number of symptomatic subjects was clearly higher both at base line and after 3 years than reported earlier for non-patients in a similar age range (19, 20). This may indicate that subjects undergoing treatment or with recently treated malocclusions generally have a higher frequency of TMD-related symptoms than subjects with no history of malocclusion or malocclusion therapy, as has been shown in earlier studies (14, 21). On the other hand, TMD-related symptoms have been shown to increase with age also in subjects with no recorded malocclusions but are then described to be mostly occasional and mild (22). The large variation in the prevalence of TMD-related symptoms in non-patients has also been recognized earlier (1, 7) and is thought to be due to growth-related adaptation of the masticatory apparatus. Contrary to the prevalence of symptoms, that of reported joint sounds increased during the follow-up period. However, the frequency of recorded joint sounds remained the same. The weak correlation between reported and recorded joint sounds at base line is probably due to the study effect: our subjects learned to recognize and report their existing

Table 2. Occlusal centric slides (mean and standard deviation (s), in mm) in the intervention (n = 63) and in the control (n = 60) group at base line and at the 3-year follow-up examination

	Intervention		Control		
Direction of slide	Mean	s	Mean	s	P*
Horizontal					
Base line	1.1	0.1	1.1	0.1	NS
3-year follow-up	0.7	0.1	1.0	0.1	0.001
Vertical					
Base line	0.9	0.1	1.0	0.1	NS
3-year follow-up	0.5	0.1	0.9	0.1	0.001
Lateral					
Base line	0.5	0.1	0.4	0.1	NS
3-year follow-up	0.3	0.1	0.5	0.1	0.003

* ANOVA for repeated measurements.

Table 3. Articulation pattern at base line and at the 3-year follow-up examination in the intervention and in the control group

	Intervention, *n*	Control, *n*	*P**
Canine guidance bilateral			
Base line	16	15	
3-year follow-up	32	22	NS
Group contact bilateral			
Base line	21	20	
3-year follow-up	9	23	0.04
Other pattern			
Base line	22	24	
3-year follow-up	21	15	NS

* Fisher's exact test.

joint sounds more accurately over time. Our findings are partly in line with earlier results showing an increase in reported joint sounds in 15- to 18-year-old adolescents (23) but do not support the occurrence of a similar increase in recorded joint sounds. The prevalence of recorded joint sounds at base line and at the end of the 3rd year were both higher than reported earlier for healthy adolescents (23, 24). The use of a stethoscope in joint sound assessment may explain the difference with regard to the findings obtained by palpation and the naked ear (24). The reason for the high prevalence rates compared with those obtained earlier by auscultation (23) is probably the difference in the examination set-up. In our study the clinical examination and the preceding interview were both carried out by the same dentist, unlike in the study referred to above (23). Therefore, awareness of the results of the interview might have increased the detection rate of joint sounds in our study.

The present results do not yet answer the question of whether orthodontic treatment relapse can be prevented by careful occlusal adjustment. The fact that we found no indication of treatment relapse, which, however, is known to start shortly after retention (11), suggests that our methods were too crude to detect subtle changes in the orthodontically treated occlusion. However, on the basis of the interference-free occlusion and the reduced frequency of masticatory muscle tenderness on palpation, more stable results and a lower frequency of treatment relapse can be predicted for our intervention group as compared with the control group. More accurate measurements on cast models and a longer follow-up are in progress.

In conclusion, occlusal adjustment after orthodontic treatment improves occlusal stability and reduces the number of cases of palpatory tenderness in the masticatory muscles.

Acknowledgements.—The financial support of the Finnish Dental Society to the first author is gratefully acknowledged. The authors also wish to thank Dr Kalle Virta for referring orthodontic patients to us and Dr Anna Arve, whose contribution in performing occlusal adjustment has been valuable and untiring. The authors are also grateful for the skilled assistance of Ms Rauni Mäkinen and Ms Outi Sallinen.

References

1. Nilner M. Epidemiology of functional disturbances and diseases in the stomatognathic system. A cross-sectional study of 7–18 year olds from an urban district [dissertation]. Malmö, Sweden: Univ. of Malmö; 1983.
2. Egermark-Eriksson I, Carlsson GE, Magnusson T, Thilander B. A longitudinal study on malocclusion in relation to signs and symptoms of craniomandibular disorders in children and adolescents. Eur J Orthod 1990;12:399–407.
3. Kirveskari P, Alanen P. Scientific evidence of occlusion and craniomandibular disorders. J Orofacial Pain 1993;7:235–40.
4. Dahl BL, Krogstad BS, Ogaard B, Eckersberg T. Signs and symptoms of craniomandibular disorders in two groups of 19-year-old individuals, one treated orthodontically and the other not. Acta Odontol Scand 1988;46:89–93.
5. Egermark I, Thilander B. Craniomandibular disorders with special reference to orthodontic treatment: an evaluation from childhood to adulthood. Am J Orthod Dentofac Orthop 1992; 101:28–34.
6. Dibbets JMH, van der Weele T. Orthodontic treatment in relation to symptoms attributed to dysfunction of the temporomandibular joint. A 10-year report of the University of Groningen study. Am J Orthod Dentofac Orthop 1987;91: 193–9.
7. Dibbets JMH, van der Weele T. Extraction, orthodontic treatment, and craniomandibular dysfunction. Am J Orthod Dentofac Orthop 1991;99:210–9.
8. Dibbets JMH, van der Weele T. Long-term effects of orthodontic treatment, including extraction, on signs and symptoms attributed to CMD. Eur J Orthod 1992;14:16–20.
9. Sadowsky C, Sakols EI. Long-term assessment of orthodontic relapse. Am J Orthod 1982;82:456–63.
10. Larsson E, Schmidt GY. The effect of the supra-alveolar soft tissues on the relapse of orthodontic treatment. Swed Dent J 1981;5:123–7.
11. Reitan K. Principles of retention and avoidance of posttreatment relapse. Am J Orthod 1969;55:776–90.
12. Clark GT, Adler RC. A critical evaluation of occlusal therapy: occlusal adjustment procedures. J Am Dent Assoc 1985;110: 743–50.
13. Kirveskari P, Alanen P, Jämsä T. Association between craniomandibular disorders and occlusal interferences in children. J Prosthet Dent 1992;67:692–6.
14. Jämsä T. Craniomandibular disorders associated with orthodontic treatment in children and adolescents [dissertation]. Turku, Finland: Univ. of Turku; 1991.
15. Riise C. Clinical and electromyographic studies on occlusion [dissertation]. Stockholm, Sweden: Karolinska Inst.; 1983.
16. Forssell H. Mandibular dysfunction and headache [dissertation]. Turku, Finland: Univ. of Turku; 1985.
17. Karppinen K. Occlusal adjustment. A method of treating head-, neck- and shoulder-pain [dissertation in Finnish, English summary]. Turku, Finland: Univ. of Turku; 1995.
18. Vanderas AP. Relationship between malocclusion and craniomandibular dysfunction in children and adolescents: a review. Pediatr Dent 1993;15:317–22.
19. Pahkala R. Orofacial dysfunctions and development of occlusion. A longitudinal study of articulatory speech disorders, craniomandibular disorders and orofacial motor skills in children from 7 to 10 years of age [dissertation]. Kuopio, Finland: Univ. of Kuopio; 1993.
20. Waltimo A, Könönen M. Maximal bite force and its association with signs and symptoms of craniomandibular disorders in young Finnish non-patients. Acta Odontol Scand 1995;53:254–8.

21. Egermark I, Rönnerman A. Temporomandibular disorders in the active phase of orthodontic treatment. J Oral Rehab 1995; 22:613–8.
22. Magnusson T, Carlsson GE, Egermark I. Changes in subjective symptoms of craniomandibular disorders in children and adolescents during a 10-year period. J Orofacial Pain 1993;7: 76–82.
23. Könönen M, Waltimo A, Nyström M. Does clicking in adolescence lead to painful temporomandibular joint clicking? Lancet 1996;347:1080–1.
24. Wänman A, Agerberg G. Mandibular dysfunction in adolescents II. Prevalence of signs. Acta Odontol Scand 1986;44:55–62.

Received for publication 14 February 1997
Accepted 15 May 1997