Five-year longitudinal recordings of functional variables of the masticatory system in adolescents with intact and restored dentitions

A comparative anamnestic and clinical study

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Recordings of functional variables of the masticatory system were made in 184 subjects, 18–20 years old, 5 years after the first examination. One hundred and six subjects had restored dentitions at both examinations (group F), 35 subjects with previously intact dentitions had received fillings during the follow-up period (group FI), and 43 subjects had intact dentitions at both examinations (group I). In conformity with the first examination 5 years earlier, the subjects in group F had higher scores for dentin facets on the first lower molar. Together with the finding of more frequent attrition on the distal part of the occlusal surface of the second lower molar, this finding indicates more functional or parafunctional activity in restored dentitions. Unilateral contacts in the retruded contact position (RCP) were equally common in all three groups, but the contacts in RCP were more often located in the molar region in group F. The finding at the first examination that interference causing a lateral slide of the mandible between RCP and the intercuspal position (ICP) was commoner in restored dentitions was not confirmed in the present study. Nor did the correlation analysis show any relationship between occlusal factors and signs and symptoms of mandibular dysfunction. However, the differences found between subjects with intact and restored dentitions indicate that the iatrogenic effect of dental filling therapy merits more consideration and more extensive research. □ *Attrition; chewing habits; clinical study; dental restorations; iatrogenic effects; occlusion; temporomandibular joint symptoms*

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The etiologic importance of dental occlusal factors in mandibular dysfunction is controversial (1). There are studies in which a positive but weak correlation between functional and/or morphologic malocclusion and signs and symptoms of mandibular dysfunction has been established (2–5), but there are studies in which no such correlation has been found (6–8). One occlusal factor that has scarcely been studied is the iatrogenic effect of dental filling therapy. However, in comparative studies of subjects with intact and restored dentitions Kampe et al. (9–10) found a higher frequency and degree of mandibular dysfunction in subjects with fillings. Another comparative study (11) showed differences in some functional recordings, and a personality study (12) showed higher values on the 'muscular tension' and 'somatic anxiety' scales among subjects with restored dentitions. In combination, these findings indicate a possible etiologic importance of dental filling therapy in mandibular dysfunction, and it would be of interest to study the long-term development of mandibular dysfunction, occlusion, and personality characteristics in individuals with intact and restored dentitions.

The aim of this study was to re-examine and compare subjects with intact and restored dentitions after a 5-year period with regard to the following variables: chewing habits, attritional pattern, occlusal interferences of different kinds, and the distance between the retruded contact position (RCP) and the intercuspal position (ICP).

A further aim was to study correlations between different variables. This study is part of a larger comparative study of mandibular dysfunction in subjects 18–20 years old with intact and restored dentitions (13).

Subjects and methods

Subjects

The subjects in this study were the same as in a previous study by Kampe et al. (10). At the anamnestic examination the material consisted of 189 subjects, 18–20 years old, from two districts in Dalarna, Sweden. Forty-four of the subjects had intact dentitions at both examinations (group I), 36 with previously intact dentitions had had fillings in their teeth during the 5-year follow-up period (group FI), and 109 of the subjects had restored dentitions at both examinations (group F). Five subjects had moved from the area and could not participate in the clinical examination but returned the questionnaires (one subject in group I, one subject in group FI, and three subjects in group F). The material is identical to that used in a previous study (13) in which it was described and discussed in detail.

Methods

Data collection followed the same scheme as in the first examination 5 years previously. However, the questionnaire was changed a little; for example, the questions about fillings in the primary dentition and orthodontic treatment were excluded, and the questions about oral parafunctions asked for frequency instead of only yes or no.

The following data were used in this study:

Symptom history. Data concerning chewing side and feelings of unevenness of occlusion were collected from the questionnaire.

Clinical examination. The number and location of premature contacts in RCP were registered. RCP was recorded passively with the observer guiding the mandible up to the first contact with the upper teeth (14). Registration was made with the aid of special wax (Kerr's Occlusal Indicator) when the wax had been penetrated.

The sagittal distance between RCP and ICP was recorded as the difference between the two positions measured in the premolar region with the aid of pencil markings and a ruler. Measurements were made on both sides to the nearest 0.5 mm. If unequal differences on the right and left sides were found, the highest value was recorded.

Attrition was recorded on the central incisors and the first molars in the lower jaw if there were dentin facets. A special recording of facets located on the distal part of the occlusal surface of the second lower molars was made in accordance with Kampe et al. (15). Registration was made with the aid of special wax (Kerr's Occlusal Indicator) and articulation paper (Svedia, Red-Blue Radar).

Occlusal interference. Interference in RCP was recorded if there was unilateral contact. Interference causing a lateral slide between RCP and ICP was recorded if the lateral slide was 0.5 mm or more. Mediotrusion interference was recorded if contacts on the mediotrusion side of the jaws prevented contact on the laterotrusion side. The registration was checked with the aid of articulation paper. Interference was recorded only on laterotrusion up to cusp to the cusp position of the canines.

Cuspid rise was recorded when laterotrusion ended with contact only between the canines on both sides.

Statistical methods

Differences between the groups were tested with Wilcoxon's two-sample test and the Kruskal–Wallis test (16). The paired Wilcoxon test (16) was used for analysis of differences between the two examinations. Correlations between variables were calculated by means of Spearman's rank correlation test (*rs*) (17).

Results

At the first examination the subjects in group F had a mean of 5.5 restored occlusal surfaces (range, 1–12), and at the second examination, 5 years later, the number had

Table 1. Prevalence of occlusal interferences in group I (43 subjects with intact dentitions), group FI (35 subjects with restored dentitions), and group F (106 subjects with restored dentitions) at the first (I) and at the second (II) examination 5 years later. Percentage of total in each group

	Group I		Group FI		Group F	
Type of interference*	I	II	I	II	I	II
Unilateral contact in RCP	49	63	71	60	62	60
Lateral deviation between RCP and ICP ≥ 0.5 mm	7	19	3	14	36	25
Non-working side interference	12	7	3	9	10	11
Non-working side contact	14	0	18	9	29	3

RCP = retruded contact position; ICP = intercuspal position.

increased to 6.8 (range, 1–17). In group FI the subjects had a mean of 2.1 restored occlusal surfaces (range, 1–7).

One-sided chewing was reported by 49% in group F, 47% in group FI, and 38% in group I. The corresponding figures at the first examination were 31%, 20%, and 30%, respectively. The differences between the groups were not significant, but the increase between the two examinations was statistically significant in group F ($p < 0.001$) and group FI ($p < 0.05$).

Feelings of unevenness of occlusion were reported by 21% of the subjects in group F, 6% in group FI, and 11% in group I. The corresponding figures at the first examination were 10%, 3%, and 18%, respectively. The increase in group F was statistically significant ($p < 0.01$).

Cuspid rise on both sides on lateral movement of the mandible was recorded in 39%, 51%, and 50% of the subjects in group F, group FI, and group I, respectively. The corresponding figures at the first examination were 40%, 59%, and 51%.

The occurrence of different kinds of occlusal interferences is shown in Table 1. Unilateral contact in RCP and mediotrusion side interference were equally common in all three groups. With regard to interference

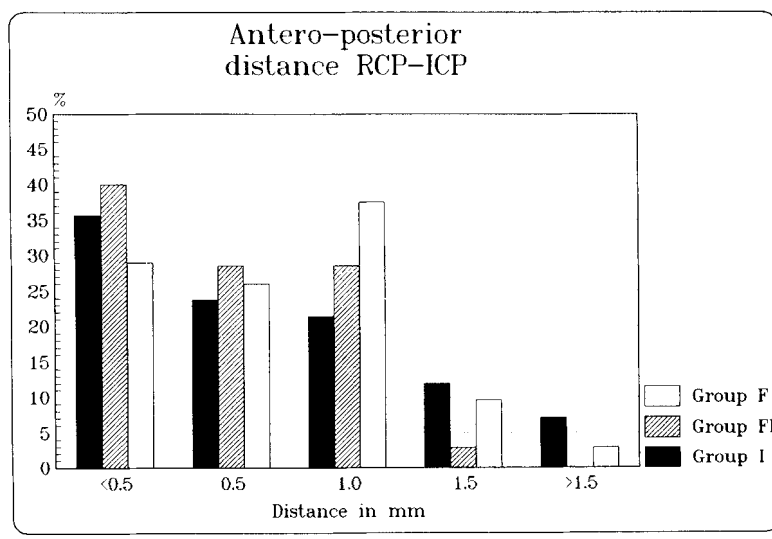

Fig. 1. Anteroposterior distance (mm) between retruded contact position (RCP) and intercuspal position (ICP) among the subjects in group I (42 subjects with intact dentitions), group FI (35 subjects with restored dentitions), and group F (104 subjects with restored dentitions). Percentage distribution in each group. (The differences in number of subjects in Figs. 1, 2, and 3 are due to missing data.)

causing a lateral slide between RCP and ICP there were no statistically significant differences between the groups.

The distribution of the subjects with regard to the sagittal distance between RCP and ICP is shown in Fig. 1. There were no statistically significant differences between the groups.

The subjects of group I, group FI, and group F had a mean of 1.7, 2.2, and 1.8 premature contacts in the RCP, respectively. The distribution of the subjects with regard to the location of premature contacts in the RCP to different parts of the dentitions is shown in Fig. 2. At the second examination the contacts in RCP were significantly more often ($p < 0.05$) located in the molar or premolar/molar regions than in the premolar region in group F ($p < 0.05$) than in the other groups. There was also a statistically significant change of the location of the contacts in the retruded contact position in group F ($p < 0.05$) between the two examinations from the premolar region to the premolar/molar or molar regions.

The occurrence of dentin facets in the lower central incisors and first lower molars in the different groups is shown in Fig. 3. With regard to dentin facets in the first lower molars, the differences between group F and the other groups were statistically significant ($p < 0.001$), and the increase of dentin facets between the two examinations in group F was statistically significant ($p < 0.001$).

Attrition of the distal part of the occlusal surface of the second lower molars in accordance with Kampe et al. (15) was recorded in 36% of the subjects in group F, 6% in group FI, and 2% in group I. The differences between group F and the other groups were statistically significant ($p < 0.001$). At the first examination no such attrition was found in any of the groups.

Statistically significant correlations between the anamnestic dysfunction index (Ai), the clinical dysfunction index (Di) (13), and all the other variables reported in this and the previous paper (13) are shown in Table 2. There was a statistically significant and positive correlation between Ai and muscle tenderness in all three groups, between Ai and accidental biting of the tongue or cheeks in group F, between Di and reported TMJ sounds in group F, and between Ai and Di in group FI and group F.

Discussion

The mean number of fillings increased in group F between the two examinations. However, many of the subjects had the same

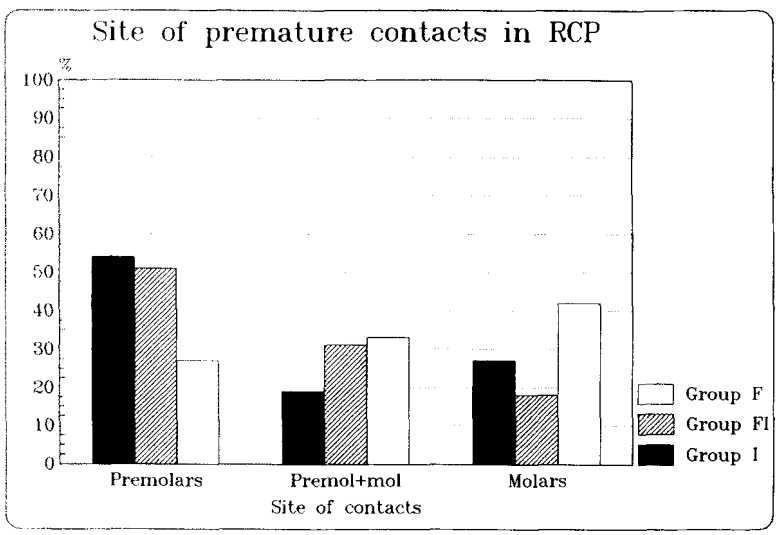

Fig. 2. Site of premature contacts in the retruded contact position (RCP) at the second examination among 43 subjects with intact dentitions (group I), 35 subjects with restored dentitions (group FI), and 102 subjects with restored dentitions (group F). Percentage distribution in each group.

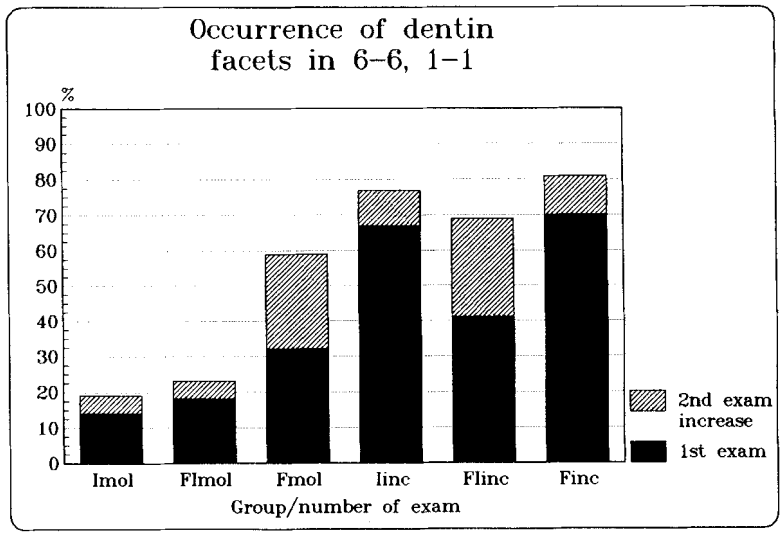

Fig. 3. Occurrence of dentin facets in lower central incisors and lower first molars in 43 subjects with intact teeth (group I), 35 subjects with restored dentitions (group FI), and 106 subjects with restored dentitions (group F) at the first and at the second examination 5 years later. Percentage of total in each group.

Table 2. Significant correlation coefficients, at the second examination, among the anamnestic dysfunction index (Ai), the clinical dysfunction index (Di) and the other variables described in this study in group I (44 subjects with intact dentitions), group FI (36 subjects with restored dentitions), and group F (109 subjects with restored dentitions)

Variable	Ai			Di		
	I	FI	F	I	FI	F
Pain in the face or in the jaws					0.47**	0.20*
Reported TMJ sounds						0.31***
Aching neck, back, throat, and shoulders			0.26**			0.24**
Headache	0.39**		0.23**			0.22*
Feeling of locking or luxation of the mandible						0.28**
Difficulties in mouth opening						0.24**
Tooth grinding	0.36*					
Tooth clenching		0.30*			0.52**	
Accidental biting of the tongue or cheeks			0.39***			
Feeling of unevenness of occlusion			0.19*			0.25**
Pressing of the tongue					0.41**	
Cheek biting	0.33*					
Special chewing side		0.24**				0.21*
Ai					0.57***	0.26**
Muscle tenderness	0.29*	0.43**	0.31***			
Pain during extreme movements	0.31*	0.41**	0.27**			
Lateral deviation between RCP and ICP > 0.5 mm			0.29**			
Mediotrusion side contact		0.41**				
Cuspid protection				−0.36*		
Dentin facets, 6–6				0.32*		
Location of the RCP contacts						−0.22*

TMJ = temporomandibular joint; RCP = retruded contact position; ICP = intercuspal position.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

number of fillings at both examinations, whereas others had up to 10 more filled occlusal surfaces. In this connection group FI is of special interest as the subjects had no fillings at the first examination. In the study of signs and symptoms of mandibular dysfunction (13) the subjects with restored dentitions had a significantly increased and higher degree of both anamnestic and clinical dysfunction than the subjects with intact teeth (group I) at the second examination. These findings indicate a possible etiologic significance of dental filling therapy in mandibular dysfunction, in accordance with Kampe et al. (9, 10). However, there were subjects with many fillings and mild or no dysfunction and subjects with few fillings and severe dysfunction. Thus, a possible relationship between fillings and mandibular dysfunction is probably complicated, and, in line with the general opinion in stomatognathic physiology today, the findings in this study support a multifactorial etiology in mandibular dysfunction (18–20).

In conformity with previous studies (9–11), unilateral contacts in RCP were equally common in all three groups. This is of interest, and, together with the finding of more signs and symptoms of mandibular dysfunction in subjects with restored dentitions (13), this finding indicates that the etiologic significance of this occlusal factor in mandibular dysfunction is questionable. This is in line with other studies (7, 8, 21).

With regard to interference causing a lateral slide between RCP and ICP, the significantly higher prevalence among the subjects with restored dentitions in the previous study (11) was not confirmed, but there was still a non-significant difference between the groups. However, more studies are necessary to ascertain whether there is a difference between subjects with intact and restored dentitions. Above all, more comparative follow-up studies are urgently needed.

Non-working side interference or contacts were equally common in all three groups. If there is a true difference between the groups, as indicated in a previous study of subjects 18, 19, and 20 years old (9), the negative findings in this and the previous study (10) may be due to methodologic differences. In these studies interference was recorded on laterotrusion to close contact on the cuspids or, in case of unerupted cuspids, on laterotrusion <3 mm, whereas in the first study interference was recorded during the course of full lateral movement. However, it is also possible that a more muscularly active registration method would give different figures for this kind of contact. This suggestion is based on the finding of more attrition on the distal part of the occlusal surface of the second lower molar in group F, both in this and in a previous study (15). Studies of the attritional pattern of the dentitions of Australian aborigines (22) show typical facets on the mediotrusion side. In that paper Murphy writes, 'This meeting on the nonfood side of the distal areas of the reciprocal dental arches before the ending of the masticatory stroke in centric occlusion is of some biological importance. It may be necessary for some kind of 'balance' to avoid, perhaps, damage to the temporomandibular joints and other structures involved' (22). Hypothetically, the reason for this attrition among the aborigines may be the vigorous chewing performed and, in restored dentitions, the artificial materials incorporated in the teeth. 'The possible adaptive mechanism could be that the TMJs take over the protection of the dentition from overloading through increased activity in the superior head of the lateral pterygoid muscle and the hyoids' (23). The finding in this and in a previous study (11) that the RCP contacts are more often located in the molar or the premolar/molar regions in group F than in group I and the finding of a significant change of the location of the contacts in the retruded contact position in group F from the premolar to the premolar/molar or molar regions support this hypothesis and indicate an altered muscular tension in subjects with restored dentitions. A new, muscularly active registration method for mediotrusion side contacts is under development and will be tested in the near future.

In line with the finding of more frequent attrition on the second lower molar in previous studies (9, 11, 15), the finding of more dentin facets on the first lower molar in group F indicates more parafunctional activity in

restored dentitions. In this connection the finding of more frequent clenching in group F+FI (13) and increased feelings of unevenness of occlusion in group F indicate a possible etiologic significance of dental restorations in tooth clenching.

A positive correlation was found between the anamnestic and clinical dysfunction indices. This is in accordance wtih other investigations (21, 24, 25) and strengthens the validity of the results (26). With regard to occlusal interference, the only statistically significant correlation with the dysfunction indices was found between interference causing a lateral slide between RCP and ICP and the anamnestic dysfunction index in group F and between mediotrusion side contact and the anamnestic dysfunction index in group FI. This weak correlation between occlusal interference and the dysfunction indices is in accordance with other studies (2, 7, 21) and indicates that the kinds of occlusal interference studied in this investigation have little etiologic significance in mandibular dysfunction. However, it is possible that other kinds of occlusal interference, recorded with other registration methods, would show a stronger correlation with signs and symptoms of mandibular dysfunction—for example, a division into interferences on artificial materials (fillings, crowns, and so forth) and on natural tooth substance (enamel and dentin) and registration with muscularly more active methods (27). This suggestion is based on the finding in a previous study (11) that all premature contacts in RCP were situated on natural tooth substances—that is, enamel or dentin—and the finding in another study (28) that the subjects experienced a clear difference of the feeling of the occlusion when the fossa bottom filling facets were ground away. General comments were the bite felt more even, more stable, and the lower jaw came closer to the upper.

In conformity with previous studies of individuals with intact and restored dentitions (13, 23), this study indicates that there are differences between subjects with and without dental fillings. In this study clear differences were found for dentin facets on the first lower molars, attrition on the distal part of the occlusal surface of the second lower molar, and location of the RCP contacts. In combination with the findings of a higher frequency and degree of mandibular dysfunction (13, 23) and higher values on the 'somatic anxiety' and 'muscular tension' scales (12, 29) among the subjects with restored dentitions, these findings strengthen the suspicion that dental filling therapy is a possible etiologic factor in mandibular dysfunction. However, more studies are necessary to establish the mechanisms involved, and for further interpretation of the results studies from other research centers would be of interest.

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References

1. Storey AT. Controversies related to temporomandibular joint function and dysfunction. In: Zarb GA, Carlsson GE, eds. Temporomandibular joint. Function and dysfunction. Copenhagen: Munksgaard, 1979:433–57.
2. Wänman A. Craniomandibular disorders in adolescents. A longitudinal study in an urban Swedish-population [Thesis]. Swed Dent J 1987(supp 144).
3. Egermark-Eriksson I. Mandibular dysfunction in children and in individuals with dual bite [Thesis]. Swed Dent J 1982(suppl 10).
4. Nilner M. Epidemiology of functional disturbances and diseases in the stomatognathic system [Thesis]. Swed Dent J 1983(suppl 17).
5. Mohlin B, Kopp S. A clinical study on the relationship between malocclusions, occlusal interferences and mandibular pain and dysfunction. Swed Dent J 1978:105–12.
6. De Boever JA, Adriaens PA. Occlusal relationship in patients with pain-dysfunction symptoms in the temporomandibular joints. J Oral Rehabil 1983; 10:1–7.
7. Droukas B, Lindee C, Carlsson GE. Relationship between occlusal factors and signs and symptoms of mandibular dysfunction. Acta Odontol Scand 1984;42:277–83.
8. Droukas D, Lindee C, Carlsson GE. Occlusion and mandibular dysfunction: a clinical study of patients referred for functional disturbances of the masticatory system. J Prosthet Dent 1985;53:402–6.
9. Kampe T, Hannerz H, Ström P. Dental filling therapy as a possible etiological factor regarding mandibular dysfunction. A comparative anamnestic and clinical study. Acta Odontol Scand 1984;42:225–33.
10. Kampe T, Hannerz H, Ström P. Mandibular dysfunction related to dental filling therapy. A comparative anamnestic and clinical study. Acta Odontol Scand 1986;44:113–21.

11. Kampe T, Hannerz H. Differences in occlusion and some functional variables in adolescents with intact and restored dentitions. Acta Odontol Scand 1987;45:31–40.
12. Kampe T, Edman G, Molin C. Personality traits of adolescents with intact and restored dentitions. Acta Odontol Scand 1986;44:23–30.
13. Kampe T, Hannerz H, Ström P. Five-year follow-up study of mandibular dysfunction in adolescents with intact and restored dentitions. A comparative anamnestic and clinical study. J Craniomandib Disord 1990. In press.
14. Helkimo M, Ingervall B, Carlsson G. Variation of the retruded and muscular position of the mandible under different recording conditions. Acta Odontol Scand 1971;29:423–37.
15. Kampe T, Hannerz H, Ström P. Facet pattern in intact and restored dentitions of young adults. A comparative study. Acta Odontol Scand 1984;42: 225–33.
16. Bradley JV. Distribution-free statistical tests. New Jersey: Prentice Hall, 1968.
17. Siegel S. Non-parametric statistics for behavioural sciences. New York: McGraw-Hill, 1956.
18. Zarb GA, Mohl N. Occlusion and temporomandibular disorders: a prologue. In: Mohl N, Zarb GA, Carlsson GE, Rugh J, eds. A textbook of occlusion. Chicago: Quintessence Publishing Co., 1988:377–83.
19. Zarb GA, Speck JE. The treatment of mandibular dysfunction. In: Zarb GA, Carlsson GE, eds. Temporomandibular joint. Function and dysfunction. Copenhagen: Munksgaard, 1979: 373–96.
20. Rugh JD, Sohlberg WK. Psychological implications in temporomandibular pain and dysfunction. In: Zarb GA, Carlsson GE, eds. Temporomandibular joint. Function and dysfunction. Copenhagen: Munksgaard, 1979:238–68.
21. Egermark-Eriksson I, Carlsson GE, Magnusson T. A long-term epidemiologic study of the relationship between occlusal factors and mandibular dysfunction in children and adolescents. J Dent Res 1987;66:67–71.
22. Murphy TR. The relationship between attritional facets and the occlusal plane in aboriginal Australians. Arch Oral Biol 1964;9:269–280.
23. Kampe T. Function and dysfunction of the masticatory system in individuals with intact and restored dentitions. A clinical, psychological and physiological study [Thesis]. Swed Dent J 1987 (suppl 42).
24. Helkimo M. Studies on function and dysfunction of the masticatory system [Dissertation]. Gothenburg: University of Gothenburg, 1974.
25. Magnusson T, Egermark-Eriksson I, Carlsson GE. Four-year longitudinal study of mandibular dysfunction in children. Community Dent Oral Epidemiol 1985;13:117–20.
26. Rieder CE. Comparison of the efficacy of a questionaire, oral history, and a clinical examination in detecting signs and symptoms of occlusal and temporomandibular joint dysfunction. J Prosthet Dent 1977;38:433–9.
27. Kampe T. Ny registreringsmetod inom bettfysiologin. Tandlakartidningen 1981;73:942–8.
28. Kampe T, Hannerz H, Ström P. Fyllningskorrigering som behandlingsmetod för individer med mandibulär dysfunktion. Tandlakartidningen 1983;75:1247–55.
29. Kampe T, Edman G, Hannerz H. Five-year follow-up study of adolescents with intact and restored dentitions: Personality traits. J Oral Rehabil 1991. In press.

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