Changes in Clinical Signs of Craniomandibular Disorders From the Age of 15 to 25 Years

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An epidemiologic sample of 84 subjects was followed longitudinally from the age of 15 to 25 years concerning clinical signs of craniomandibular dysfunction. There was an obvious fluctuation of the clinical signs of craniomandibular disorders over the 10-year period. No statistically significant change of any of the separate clinical signs or the clinical dysfunction index was noted, and no subject had severe signs of dysfunction. Muscle pain on palpation was still the most common clinical sign and was noted in nearly half of the subjects after 10 years. Temporomandibular joint clicking was common at the ages of 15 and 25 years, but no subject had developed locking of the temporomandibular joint during the 10-year period. Occlusal interferences in the retruded contact position and on the nonworking side increased during the 10-year period and were now present in 74% and 32% of the participants, respectively. A slight increase of occlusal wear was noted, but more pronounced wear was still a rare finding at the age of 25 years. Twenty-one subjects (25%) were judged by the examiners to be in need of some kind of functional treatment. The treatment advocated was in most cases minor, however, and could, with few exceptions, be incorporated in the subjects' ordinary dental treatment.
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Epidemiologic investigations have shown that both signs and symptoms of craniomandibular disorders are common in all age-groups, and, despite extensive research, the controversies concerning the importance of different presumed etiologic factors persist.

Most research so far has been based on cross-sectional investigations, while longitudinal studies are sparse.[2–5] Longitudinal investigations are important since they can give information about fluctuations and long-term development of signs and symptoms of craniomandibular disorders (CMD). Such investigations might also help to shed further light on the relative importance of different etiologic factors.

The change in subjective symptoms of CMD during a 10-year period in three different age-groups has been described recently.[6] The aims of the present paper were *(1)* to investigate the changes in clinical signs of CMD in a group of subjects from the ages of 15 to 25 years, *(2)* to investigate correlations between clinical signs and subjective symptoms of CMD, and *(3)* to estimate the functional treatment need.

Materials and Methods

Ten years after an epidemiologic investigation of signs and symptoms of CMD in three groups of children, those in the oldest age-group, now aged 25 years, were invited to participate in a clinical examination of signs of CMD. They were also asked to answer a questionnaire about the presence of symptoms from the masticatory system, including headaches, as well as about oral parafunctions and general joint laxity.

Of the 135 subjects, 84 (62%) participated in the clinical follow-up and another 19 (14%) returned the questionnaire but could not participate in the clinical examination. The change in subjective symptoms during the 10-year period has been described elsewhere.[6] Of those who participated in the clinical examination, 46 were men (55%) and 38 were women (45%). Of the dropouts, 19 did not contact the clinic despite two letters of reminder, and the rest had either no known address or had moved far from the clinic.

The standardized clinical examination comprised measurements of range of movement of the mandible, presence of deviation during mouth opening, registration of temporomandibular joint (TMJ) sounds, locking or luxation, pain on movement of the mandible, TMJ or muscle pain on palpation, number of teeth and number of occluding tooth pairs, occlusal interferences in the retruded contact position (RCP) or on the nonworking side in lateral excursions, and, finally, the degree of occlusal wear.

From the five clinical parameters of mandibular mobility, TMJ function, pain on movement of the mandible, TMJ pain on palpation, and muscle pain on palpation, a clinical dysfunction index (D$_i$) according to Helkimo[7] was calculated. The maximal jaw opening, including vertical overbite, lateral excursions, and protrusion, was measured to the nearest millimeter with a ruler. Deviation more than 2 mm on opening was registered. Temporomandibular joint sounds were recorded as grade 1 (palpable clicking when the TMJs were palpated laterally) and grade 2 (audible clicking or crepitations). Temporomandibular joint and muscle tenderness was recorded if the subject described the palpation as painful or if it gave rise to a palpebral reflex. The TMJs were palpated for pain laterally and also posteriorly via the auditory meatus. The muscles palpated were the origin and the insertion of the temporal muscle, the superficial portion of the masseter muscle, the lateral pterygoid muscle, and the posterior belly of the digastric muscle. All muscles were palpated bilaterally.

When recording the number of occluding tooth pairs in the intercuspal contact position (ICP), only the main antagonist was counted; the maxilla was used as a basis for the counting. The maximum number of pairs in a 32-tooth dentition was therefore 16. Occlusal interferences in RCP were recorded if the subject could feel a clear unilateral contact in RCP. Interferences on the nonworking side were recorded during the first 3 mm of lateral excursion and also in the range from more than 3 mm up to maximal lateral excursion. Occlusal wear was classified according to a 5-point scale, but only the first 4 degrees came to be used (1 = no or slight wear; 2 = wear of enamel only; 3 = wear into the dentin in single spots; 4 = exposure of dentin in an area of more than 2 mm^2). All three authors, who were trained together[8] and who work with CMD patients on a daily basis, took part in the clinical examination. To recalibrate the examiners, the first three patients were examined by all three authors.

Comparisons have been made with the clinical findings and their correlation to subjective symptoms 10 years ago[9] and also with the findings in a 5-year follow-up.[3] All comparisons of the results between the first and third and second and third examination relate only to the subjects included in the second and third investigation, respectively. Consequently, the prevalence figures for the first and second investigation differ in some cases from those presented earlier.

Together, the examiners also made an assessment of each subject's signs and symptoms and decided, after discussion with the participant about the subjective symptoms, whether functional treatment was indicated and, if so, what kind of treatment was to be used. As there are no specific criteria available, the treatment need was assessed on the basis of clinical experience, a concept of a multifactorial etiology of CMD, and a rather conservative approach to treatment. The principles have been presented and discussed in detail in a previous paper.[10]

Statistical Methods

Wilcoxon's matched-pairs signed rank test was used for analysis of differences between the examinations, and Pitman's nonparametric permutation test was used to test for sex differences.[11] Correlations between variables were calculated by means of Spearman's (r_s) and Pearson's (r_p) rank correlation test.[12] The following levels of significance have been used: $P < .001$, $.001 < P < .01$, and $.01 < P < .05$.

Results

Occlusal Factors

The average number of teeth at the age of 25 years was 29 (range 24 to 32), compared to 27 and 28, respectively, at the ages of 15 and 20 years. The number of occluding tooth pairs at the first examination was 12 and this figure remained constant during the 10-year period.

Occlusal interferences in RCP were found in 74% of the 25-year-olds, and this was a statistically significant increase compared to the first examination, in which the corresponding figure was 56% ($P < .01$). The figure for nonworking-side interferences had also increased significantly, from 15% to 32% ($P < .01$). Of these interferences, 4% were registered during the first 3 mm of lateral excursion at the age of 15 years; at the age of 25 years, this figure had increased to 7%.

The degree of occlusal wear increased slightly during the 10-year period. This increase was statistically significant ($P < .001$) in all four regions between the ages of 15 and 20 years, and the increase in occlusal wear seemed to slow down between the ages of 20 and 25 years; it was now statistically significant only in the canine region (Table 1). More pronounced wear, ie, exposure of dentin in an area of more than 2 mm, was still very rare at the age of 25 years. Six individuals (7%) exhibited such wear in the frontal region, eight in the canine region (9%), and one (1%) in the premolar and molar regions.

Table 1 Average Degree of Occlusal Wear in Four Dental Regions

	Age (y)				
Dental region	15	P*	20	P*	25
Incisor	2.05	.001	2.88	NS	2.86
Canine	1.86	.001	2.51	.001	2.76
Premolar	1.21	.001	1.99	NS	2.06
Molar	1.55	.001	1.90	NS	1.92

*P denotes the level of significance of the change between investigations. NS = nonsignificant.

Table 2 Prevalence (%) of Clinical Signs of CMD

	Age (y)		
Variable	15	20	25
Reduced movement capacity	2	10	5
Deviation on opening	10	24	18
Locking of the mandible	1	1	0
Pain on movement	1	3	4
TMJ clicking			
Grade 1	18	22	10
Grade 2	10	10	7
TMJ crepitation	1	2	1
TMJ tenderness	10	3	10
Muscle tenderness			
1-2 muscle sites	31	25	27
>2 muscle sites	10	14	19

Clinical Signs of Dysfunction

The prevalences of different clinical signs of dysfunction at the ages of 15, 20, and 25 years are summarized in Table 2. No statistically significant change of any of the variables was noted between 15 and 25 or 20 and 25 years of age.

Mandibular Mobility. There was no change in mandibular movement capacity during the 10-year follow-up. At the age of 25 years the mean maximal mouth opening capacity was 56.5 mm (range 43 to 76 mm), mean lateral movements measured 9.9 mm (range 5 to 16 mm), and mean protrusive movement measured 9.1 mm (range 4 to 12 mm). Five subjects (6%) had a reduced movement capacity according to the Helkimo index, in all cases due to a reduction of one of the horizontal movements.

Function of the TMJs. Fifteen subjects (18%) had a deviation of the mandible of more than 2 mm during maximal mouth opening. Eight subjects (10%) had grade 1 TMJ sounds, another six (7%) had grade 2 TMJ sounds, and only one had crepitations. No cases of locking were recorded.

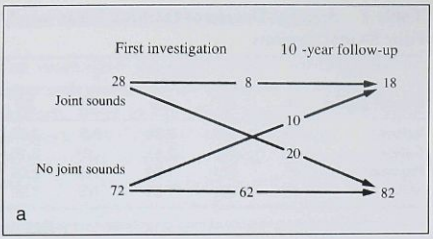
There was no statistically significant change in clinically recorded TMJ sounds from the ages of 15 to 25 years. During the same period, however, the subjective reports of TMJ sounds increased significantly ($P < .01$). The change of both clinically recorded and subjectively reported joint sounds during the 10-year period is shown in Fig 1.

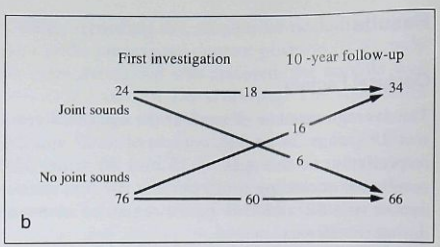
Pain on Movement of the Mandible. In only three subjects (4%) was pain on movement recorded.

TMJ Pain on Palpation. Eight subjects (10%) reported tenderness upon lateral palpation of the TMJs. None reported tenderness when the joints were palpated via the auditory meatus.

Muscle Pain on Palpation. The most common clinical sign of CMD was muscle pain on palpation. Twenty-seven percent of the subjects reported pain on palpation of 1 to 2 muscle sites, and another 19% were tender in 3 or more muscle sites.

Clinical Dysfunction Index. Not one single subject was recorded as having severe clinical signs of CMD according to the clinical dysfunction





Figs 1a and 1b Change in clinically recorded *(a)* and subjectively reported *(b)* joint sounds during a 10-year period.

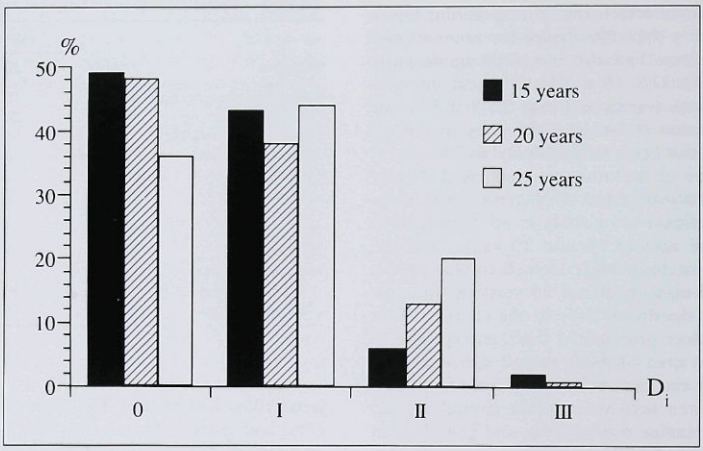


Fig 2 Percentage distribution of 84 subjects according to the clinical dysfunction index (D_i) at the ages of 15, 20, and 25 years.

index (Di) at the age of 25. The distribution of the participants, according to the index, at the ages of 15, 20, and 25 is shown in Fig 2. There was no statistically significant change during the 10-year period for any of the five parameters making up the index or for the index as a whole.

Sex Differences

Only a few statistically significant differences were found between men and women at the age of 25 years. Men had more teeth than women (29.4 compared to 28.3), and men also exhibited more occlusal wear in all four dental regions; however, the difference was statistically significant only in the canine ($P < .01$) and premolar regions ($P < .05$).

Of the variables included in the clinical dysfunction index, men had a larger maximal mouth opening compared to women (58.2 and 54.4 mm, respectively; $P < .01$), and jaw muscles tender upon palpation ($P < .05$) and TMJ sounds ($P < .05$) were a more common finding in women than in men.

Correlations Between Variables

A combined occlusal wear index, which takes into account the wear in all four dental regions, was significantly correlated to subjective reports of nocturnal tooth clenching and/or grinding ($P < .01$, $r_s = 0.39$). Two variables were correlated to the degree of occlusal wear: TMJ pain on palpation ($P < .05$, $r_s = 0.23$) and subjective reports of difficulties in mouth opening ($P < .05$, $r_s = 0.26$).

None of the many subjective and clinical variables recorded showed any significant correlation to clinically recorded occlusal interferences in

Table 3 Correlation Between Clinically Recorded and Subjectively Reported Joint Sounds ($P < .001$, $r_p = 0.53$)

	Subjective reports			
Clinically recorded	Frequent	Occasional	No joint sound	Total
Grade 2	4	3	0	7
Grade 1	3	2	3	8
No joint sound	2	15	52	69
Total	9	20	55	84

RCP. Nonworking-side interferences during the first 3 mm of lateral excursion were significantly correlated to a combined variable of positive reports of one or more of the subjective symptoms TMJ sounds, jaw fatigue, and difficulties in mouth opening ($P < .05$, $r_s = 0.23$), and nonworking-side interferences from more than 3 mm to maximal lateral excursion were correlated to subjective reports of intermittent locking of the TMJs, which was reported by six individuals ($P < .01$, $r_s = 0.30$).

A fairly strong correlation was found between clinically recorded TMJ sounds according to the two grades used and subjective reports of frequent or occasional joint sounds ($P < .001$, $r_p = 0.53$, Table 3) and the agreement between clinically recorded and subjectively reported TMJ sounds ("yes or no") was 76%.

Reduced mandibular movement capacity was correlated to TMJ pain on palpation ($P < .05$, $r_s = 0.26$) and muscle pain on palpation ($P < .05$, $r_s = 0.22$). Muscle pain and TMJ pain on palpation were significantly correlated to one another ($P < .001$, $r_s = 0.39$), and both these variables were correlated to subjective reports of difficulties in mouth opening ($P < .01$, $r_s = 0.28$ and $P < .01$, $r_s = 0.33$, respectively). The subjective variable intermittent locking of the jaw was significantly correlated to both pain on movement of the mandible and subjective assessment of general joint laxity ($P < .01$, $r_s = 0.32$ and $P < .05$, $r_s = 0.20$, respectively). Finally, the clinical dysfunction index as a whole showed correlations to reports of jaw fatigue and difficulties in mouth opening ($P < .05$, $r_s = 0.23$ and $P < .01$, $r_s = 0.35$, respectively).

Estimation of Treatment Need

Twenty-one subjects (25%), eight women and thirteen men, were judged to be in need of some kind of functional treatment. The treatment advocated was, however, in most cases minor. Ten participants were judged to benefit from occlusal adjustment, two from therapeutic jaw exercises, and nine were judged to need occlusal splint therapy. Eleven of those with a functional treatment need (52%) had D_i II, seven had D_i I, and three had D_i 0.

Discussion

In longitudinal clinical research, loss of participants is almost impossible to avoid, and this is a problem when the results are analyzed. In the present investigation, the drop-out rate to the clinical examination was high, 38%, but 19 (14%) of these persons answered the questionnaire. The drop-out rate should be viewed considering the fairly long period covered by the study. Also, the main reason for nonparticipation (13 individuals) was no known address or residence far from the clinic, and it is not likely that this kind of drop-out should bias the results. If these 13 individuals are excluded, the actual drop-out rate is 19 of 122 (16%).

However, there is a considerable loss of participants, and because of that, the results must be interpreted with some caution.

During the 10-year period, a statistically significant but numerically small increase in number of teeth was recorded, and this could be explained by the eruption of third molars. The stability of the occlusion, expressed as the number of occluding tooth-pairs, seems to establish early. It was already very good at the age of 15 years with no further change to the age of 25 years.

The etiologic importance of occlusal interferences in the development of CMD is a topic of great controversy.[13–15] At the age of 25 years, both occlusal interferences in RCP and on the nonworking side were significantly more common than at the age of 15 years, and the vast majority now had one or more such interferences. That occlusal interferences are a common finding in nonpatients has been shown in many previous studies.[16–18] In the present investigation, no correlation was found between signs or symptoms of CMD and interferences in RCP, and only a few, and weak, correlations to nonworking-side interferences were found. This is in agreement with the findings in most previous research in this field. This finding could, however, not be interpreted as proof that occlusal factors are of no importance in the development of CMD. It is now widely acknowledged that the etiology of CMD is multifactorial. In an epidemiologic, heterogeneous sample, other factors can mask a cause-effect relationship,[19] and it is thought that it is possible, as stated by Kirveskari et al,[18]

that "the lack of association between occlusal interferences and signs of CMD is due to the omnipresence of interferences." That iatrogenic interferences can cause both signs and symptoms of CMD[20-22] and that occlusal adjustment can improve such symptoms[23] have been shown previously. There seems, however, to be a great individual variation in both response and adaptation to experimental occlusal interferences.[24]

The degree of occlusal wear increased slowly between the ages of 15 and 20 years and even more slowly between 20 and 25 years. Men exhibited more wear than women, and more pronounced wear was very rare. That occlusal wear is a slow process and more common in men than in women corroborates earlier findings.[25,26] It is also obvious that the mechanisms behind occlusal wear are very complex and involve different combinations of attrition, erosion, and abrasion. Bruxism has been discussed in this context, and in the present investigation a statistically significant correlation was found between this factor and the degree of occlusal wear, which supports the opinion that bruxism is an important factor in occlusal wear. The finding that bruxism has only a small explanatory value for occlusal wear[25] is probably because bruxism is, in most cases, an unconscious habit and subjective reports of oral parafunctions are very uncertain. The difference in the amount of occlusal wear between 15 to 20 and 20 to 25 years of age indicates that occlusal wear is not a linear process throughout life but may occur in bursts that coincide with the presence of certain causative factors.[26,27]

None of the five variables included in the clinical dysfunction index had changed during the 10-year period, including maximal mouth opening. It has previously been shown that this variable increases with advancing age up to the age of 15 years[2,28] but after that, no further increase occurs.[28] The finding of a greater jaw-opening capacity in men than in women also corroborates earlier findings.[28]

Positive recordings of the variables pain on movement of the mandible and TMJ pain on palpation were very rare, while one or more muscle sites tender to palpation were very common. Jaw muscles tender to palpation were also more common in women compared to men, and this is in agreement with the results reported by Salonen et al.[29]

Temporomandibular joint sounds were a fairly common clinical sign, but spontaneous fluctuations were common during the 10-year period covered by the investigation. In contrast to subjective reports of such sounds, no statistically significant increase was noted. One possible explanation for the increase of subjective reports, without a corresponding increase of clinically recorded sounds, might be that previous examinations have made the participants more alert in noticing even minor and occasional TMJ sounds.

Clicking sounds in the TMJs can have several different causes, eg, deviation in form, incoordination, or disc displacement, and no attempts were made in the present investigation to differentiate between different diagnoses. However, at the clinical examination no cases of locking of the TMJs were found, and there is nothing in the present results that supports the opinion, sometimes put forward in the dental literature, that progression from clicking to locking is likely to occur.

Subjective reports of occasional events of intermittent locking of the jaws were also rare in the present sample (7%).[6] Still, it is interesting that a correlation was found between this variable and subjective assessment of general joint laxity. This supports earlier findings that systemic joint laxity is significantly more prevalent in patients with TMJ derangements.[30,31]

Many of the clinical variables of CMD were significantly correlated to one another. This implies that patients with CMD are not only multisymptomatic but are also likely to exhibit more than one clinical sign of CMD. This is also a logical finding considering the interaction between the different functional parts of the masticatory system.

No statistically significant change of the clinical dysfunction index was noted during the 10-year period, despite a numerical increase of subjects with D, II and in contrast to an increase of subjective symptoms during the same period.[6] Once again, the explanation for the increase of the subjective symptoms might be an increased awareness due to the examinations 5 and 10 years previously.

It is always difficult to estimate treatment need, and from the results presented above, it is obvious that clinical signs per se do not equal treatment need. This must instead be based on clinical experience, taking into account the presence of both clinical signs and subjective symptoms in each individual. That the presence of clinical signs has had an influence on the decision is, however, illustrated by the fact that more than half of those judged to be in need of functional treatment had D, II, and these patients represent 11 of the 17 individuals in the whole sample who had this degree of clinically recorded dysfunction. On the other hand, three of those judged to be in need of treatment had no clinical signs of CMD according to the index used. All three were men and they were recommended splint treatment, two because of pro-

nounced occlusal wear and one because he had received complaints of severe grinding noises at night. A pure, dynamic parafunction such as grinding does not create other signs in muscles or joints in most cases, but the loss of tooth substance and/or grinding noises might merit prophylactic treatment.

If these three men are excluded, the estimated treatment need was the same in men as in women (21.7% and 21.1%, respectively). This corroborates the findings in most epidemiologic investigations, where no pronounced sex-difference concerning CMD has been found.[32,33]

The estimated treatment need, 25%, might seem high, but it is in agreement with previous reports.[10,32–35] It should, however, be strongly noted that in most cases the treatment advocated was simple and not time-consuming and could, with few exceptions, be incorporated in the subjects' ordinary dental treatment. Further, in some cases the occlusal adjustment was advocated mostly to improve the comfort in the occlusion and not primarily to alleviate signs and/or symptoms of CMD.

The demand for treatment in a larger sample[6] from which the present material is a subgroup, was only 2.4%. This was also found in 20-year-old subjects.[10] In both these investigations,[6,10] all of those who demanded treatment were women. This is in line with the skewed sex-distribution found in numerous clinical populations of CMD patients. The sex discrepancy between epidemiologic and clinical examinations is likely to be mainly explained by a higher propensity to seek treatment among women than men.

The explanation of the discrepancy between demand and estimated need of treatment of CMD is probably that most subjects are not aware of the possible correlation between subjective symptoms such as headaches and jaw fatigue and functional disturbances in the masticatory system. At the same time, this is a strong indication that a dental examination should also include an examination of the functional status, especially since it is well documented in many investigations that functional treatment has a favorable effect on symptoms of CMD, which is further confirmed by a decrease in sick-leave after such treatment.[36,37] Identification and treatment of CMD are thus to the benefit of both the individual and society.

Conclusion

This longitudinal investigation shows that clinical signs of CMD are common in the population and that the prevalence figures for different clinical signs are fairly constant from the age of 15 to 25 years, but spontaneous fluctuations are common. The estimated treatment need for CMD was 25%, but the treatment advocated was in most cases simple and not time-consuming.

Acknowledgments

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Resumen

Cambios en los signos clínicos de los desórdenes craneomandibulares desde los 15 a los 25 años de edad

Se realizó un estudio sobre los signos clínicos de disfunción craneomandibular en una muestra epidemiológica compuesta de 84 personas que fueron seguidas longitudinalmente desde los 15 a los 25 años de edad. Se presentó una fluctuación obvia de tales signos a través del periodo de 10 años. No se observaron cambios estadísticamente significativos en ninguno de los signos clínicos por separado, o en el índice de disfunción clínica, y ningún sujeto presentó signos severos de disfunción. El signo clínico mas común fue todavía el dolor muscular a la palpación, y fue notado en casi la mitad de los sujetos después de 10 años. Los sonidos de clic en la articulación temporomandibular (ATM) fueron comunes a la edad de 15 y 25 años, pero ninguna persona había experimentado el cierre trabado de la ATM durante el periodo de 10 años. Las interferencias oclusales en la posición de contacto retruída y en el lado de balanza aumentaron durante el periodo de 10 años y ahora estaban presentes en el 74% y 32% de los participantes, respectivamente. Se notó un leve aumento en el desgaste oclusal, pero los casos pronunciados no fueron comunes a los 25 años de edad. Los examinadores juzgaron que 21 sujetos (25%) necesitaban algún tipo de tratamiento funcional. El tratamiento aconsejado en la mayoría de los casos fue menor, sin embargo, a excepción de algunas veces se pudo incorporar en el tratamiento dental usual de la persona.

Zusammenfassung

Veränderungen der klinischen Befunde bei Myoarthropathien im Alter von 15 bis 25 Jahren

Eine Gruppe von 84 Probanden wurde vom Alter von 15 bis 25 Jahren longitudinal bezüglich ihrer klinischen Myoarthropathiebefunde verfolgt. Es liessen sich offensichtliche Fluktuationen dieser Befunde über die Dauer von 10 Jahren feststellen. Bei keinem der einzelnen klinischen Zeichen konnte eine statistisch signifikante Veränderung gefunden werden, ebensowenig wie beim klinischen Dysfunktionsindex; keiner der Probanden litt unter ernsten Myoarthropathiesymptomen. Auch nach 10 Jahren blieb die Palpationsdolenz der Muskulatur das meistverbreitete Symptom, es wurde bei fast der Hälfte der Probanden festgestellt. Das Kiefergelenkknacken war im Alter von 15 und 25 Jahren häufig, aber keiner der Probanden hatte in der 10-Jahres-Periode eine permanente Diskusverlagerung entwickelt. Die okklusalen Interferenzen in retrudierter Kontaktposition bzw. auf der Balanceseite verzeichneten in der 10-Jahres-Periode eine Zunahme und waren nun in 74% bzw. 32% der Probanden anzutreffen. Eine geringe Zunahme konnte bei den okklusalen Schliffacetten festgestellt werden, aber ein fortgeschrittenes Stadium von Abrasion blieb auch im Alter von 25 Jahren ein seltener Befund. 21 Probanden (25%) wurden von den Untersuchenden als therapiebedürftig eingeschätzt. Die vorgeschlagenen Therapiemassnahmen waren in den meisten Fällen von kleinem Ausmass und konnten, mit wenigen Ausnahmen, in die normale zahnärztliche Behandlung eines jeden Patienten einbezogen werden.