Mandibular dysfunction in adulthood in relation to morphologic malocclusion at adolescence

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The purpose of this 20-year follow-up study was to assess whether pronounced morphologic traits of malocclusion, persisting from adolescence to about 35 years of age, imply an increased risk of persistent and severe mandibular dysfunction. In 1965–66 malocclusion was recorded in 176 adolescents; in 1981 these persons responded to a questionnaire concerning symptoms of functional disorders, and in 1986–87 malocclusion and signs of dysfunction were registered. Highly significant associations were observed between some of the self-reported symptoms and the signs registered 5–6 years later. Spearman correlation coefficients between the persistent traits of malocclusion, occurring at both examinations, and the signs of mandibular dysfunction were low in general. No association was found between the most severe and persistent functional disorders and any particular malocclusion. It is concluded that orthodontic screening of morphologic malocclusion in childhood would seem of limited value in attempts to predict mandibular dysfunction in adulthood. □ *Clinical study; follow-up study; orthodontics; questionnaire*

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The role of morphologic anomalies of occlusion in the etiology of mandibular dysfunction still seems controversial. Simultaneous occurrence of morphologic malocclusions and functional disorders would be expected sometimes by chance, since several morphologic traits of malocclusion are frequent (1), and so are many self-reported symptoms and clinically diagnosed signs of mandibular dysfunction (2, 3). In cross-sectional studies statistically significant relationships have indeed been found between some of the malocclusion traits and symptoms or signs of dysfunction in children (4, 5) and also in adults (6), but, conversely, absence of significant associations has likewise been reported (7, 8).

From a therapeutic point of view the most important question in this context is whether specific traits of morphologic malocclusion, when observed in childhood, may be expected to predispose to persistent functional disorders in adulthood. Ideally, therefore, causal relations between malocclusion and dysfunction of the masticatory system should be studied longitudinally from childhood to adulthood in an orthodontically untreated population. However, such studies are difficult to accomplish because, today, pronounced malocclusions are often treated before the subjects become adults (8, 9), and, consequently, longitudinal investigations have rarely been carried through into adulthood (10).

In the mid-1960s malocclusion prevalence was recorded in Danish adolescents who had no access to organized orthodontic services and who received little orthodontic care (1). Fifteen years later, in 1981, a subsample of these subjects responded to a questionnaire screening, *inter alia*, for symptoms involving the temporomandibular joints (TMJ) and muscles (11). It was concluded that the morphologic traits of malocclusion, recorded at adolescence, did not seem to predispose for functional disorders of the masticatory system as reported at the age of 30 years. It could not be precluded, however, that late growth changes after the initial examination had altered the occurrence of the malocclusion traits at the time of the questionnaire. Moreover, clinical registration of signs of

mandibular dysfunction in the same individuals would add to the validity of the findings. Another follow-up study was therefore made, in 1986–87, when a selected group of the subjects was re-examined clinically.

It was the purpose of this study to assess whether persistent and severe functional disorders of the masticatory system could be related to pronounced traits of malocclusion persisting from adolescence to about 35 years of age.

Materials and methods

Initially, in 1965–66, the occurrence of malocclusion was recorded in the entire population of teenagers (n = 1252) attending school in a region where no child dental service had been established and orthodontic treatment was uncommon (1). Among these individuals a sample was drawn in two stages—in 1981 and 1986 (Fig. 1).

At the first stage, in 1981, all subjects (n = 977) who could be traced through the Danish Central Person Register (CPR) received a questionnaire containing questions about orthodontic experiences, tooth loss, and symptoms of functional disorders of the masticatory system. Response was obtained from 841 (86%) of the persons then aged 28–34 years. This representative sample and the results from the questionnaires have been described elsewhere (11). Scores of 0, 1, or 2 were assigned to the symptoms in accordance with whether occurrence was not reported, reported occasionally, or daily (Table 1).

At the second stage, in 1986–87, a non-representative group was selected, comprising 306 of the 841 respondents. Most of these subjects were allocated to the study in order that pronounced morphologic traits of malocclusion, as recorded in 1965/66, would be included. Moreover, a comparison group was selected, comprising every third consecutive subject with no malocclusion in 1965/66. Also added were the persons who, in the 1981 questionnaire, had complained of TMJ clicking/grating and difficulty in opening the mouth widely. The latter subjects were selected disregarding the presence or absence of malocclusion at the initial examination. Through the CPR, 245 of the individuals, still residing within or close to the region of their childhood, could be traced. During 1986–87 they were invited by mail to participate in a dental examination at a municipal dental clinic close to their residence. After two reminders 176 (72%) participated, 109 women and 67 men, aged 33–39 years (mean, 35.5 years), 20 of whom had been selected primarily because of the TMJ complaints in 1981. The sample and the criteria of selection have been described in more detail previously (12).

The registrations of malocclusion in 1965/66 and 1986/87 were performed by the same method (13) and by the same examiner. In addition, at both examinations missing teeth were recorded, and the subjects were asked whether they had had orthodontic treatment. Signs of functional disorders of the masticatory system were recorded only at the 1986/87 examination, before the registration of malocclusion. The criteria of registration are given in Table 2 together with the scores assigned.

Subjects with persistent mandibular dysfunction were identified by calculating, for each individual, the product of the sums of scores for the symptoms reported in 1981 (Table 1) and the signs recorded in 1986/87 (Table 2). Thus, absence of either symptoms or signs resulted in a product of zero, whereas frequent and persistent disorders produced high values of the product. The product of the sums of scores was used rather than the sum of the sums of scores, because high values of the latter did not necessarily represent dysfunctions persisting from 1981 to 1986/87.

The examination was 'blind' in the sense that the examiner was unaware of which criterion of selection had caused inclusion of a given individual.

As reported previously (12), the occurrence of the various malocclusion traits was remarkably stable in most individuals between 1965/66 and 1986/87. Associations between the malocclusion traits occurring at both examinations, in 1965/66 and in 1986/87, on the one hand, and the signs of mandibular dysfunction and the product of sums

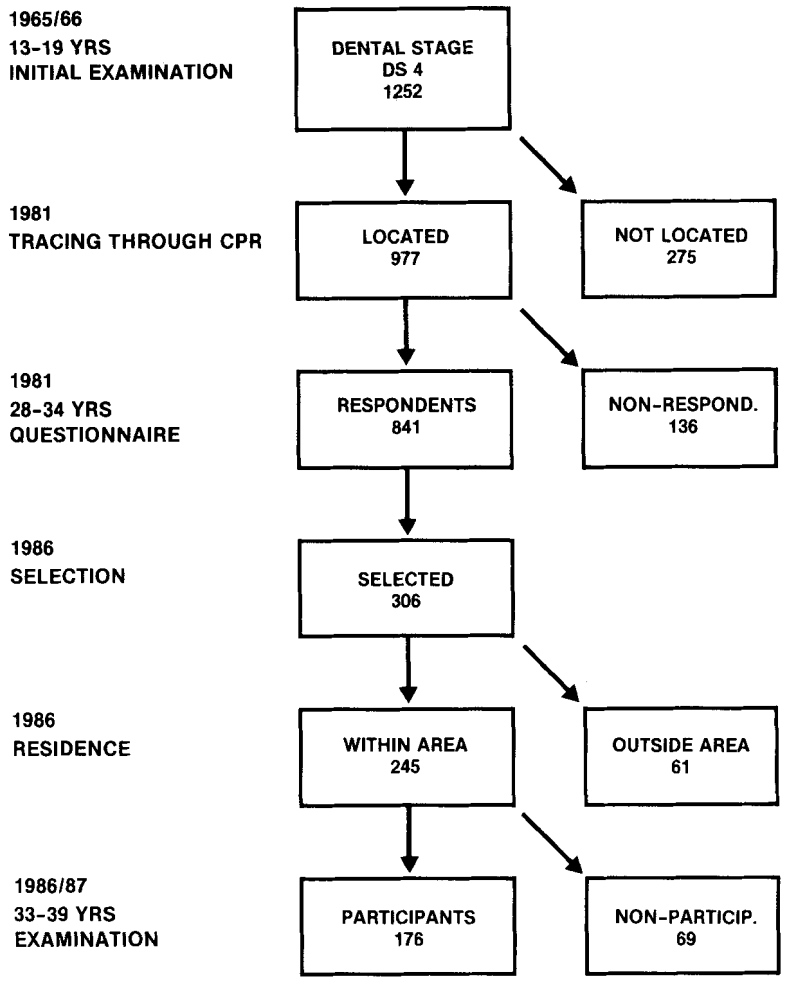

Fig. 1. Flow diagram of selection of subjects.

Table 1. Questions concerning symptoms of mandibular dysfunction in 1981 questionnaire with abbreviations (scores: daily = score 2, occasionally = score 1, never/do not know = score 0)

Clicking/81	'Do you experience clicking or grating in your jaw joint when you move your lower jaw?'
Pain/81	'Do you find it painful to chew or yawn?'
Tenderness/81	'Do you experience tenderness or fatigue in your cheeks?'
Opening/81	'Do you find it difficult to open your mouth widely?'
Locking/81	'Do you suffer from locking of your lower jaw?'

of scores, on the other, were inspected by means of Spearman correlation coefficients. In these calculations the subjects of the comparison group, without malocclusion at both examinations (n = 27), were assigned a score of 0. A given malocclusion trait was assigned

Table 2. Criteria of signs of mandibular dysfunction at 1986/87 examination with abbreviations and scores (score values, 0–2)

Clicking/86 = sign *a* plus sign *b:*
- a) Palpable TMJ clicking or grating at mouth opening and closing: score 1.
- b) Audible TMJ clicking or grating at mouth opening and closing: score 1.

Pain/86 = sign *c* plus sign *d:*
- c) TMJ pain clearly stated on maximum mouth opening: score 1.
- d) TMJ pain on palpation giving rise to palpebral or guarding reflex: score 1.

Tenderness/86 = sign *e* plus sign *f:*
- e) Tenderness of either temporal muscle on palpation giving rise to palpebral or guarding reflex: score 1.
- f) Tenderness of either masseter muscle on palpation giving rise to palpebral or guarding reflex: score 1.

Opening/86 = sign *g* or sign *h:*
- g)* Mouth opening capacity <50 mm in men and <46 mm in women: score 1.
- h)* Mouth opening capacity <47 mm in men and <43 mm in women: score 2.

* Respectively 25th and 10th sex-specific centile calculated from distributions with respect to maximum mouth opening, corrected for overbite.

a score of 1, with the exception of extreme maxillary overjet and deep bite, which were assigned scores of 1 and 2 for grade 1 and grade 2 of the trait, respectively (13). Furthermore, to inspect cases similar to Angle's class II, division 2, subjects with deep bite and *without* extreme maxillary overjet (n = 30) were subdivided into 22 subjects without distal molar occlusion (score 1) and 8 with distal molar occlusion (score 2).

Results

Eighteen (10%) of the subjects had undergone orthodontic treatment, mostly during their twenties; frequencies of the signs of mandibular dysfunction were similar in the treated and untreated individuals. Extractions of teeth excepting third molars were noted in 99 (56%) of the subjects (range, 1–8 extractions). No significant association was found between tooth loss and the occurrence of signs of dysfunction or the product of sums of scores for symptoms and signs.

Maximum mouth opening was significantly higher ($p < 0.001$) in men (mean, 53.7 mm; SD, 5.8 mm; range, 42–65 mm) than in women (mean, 49.8 mm; SD, 5.7 mm; range, 31–62 mm). Consistently higher frequencies of the signs of mandibular dysfunction were observed in the women (Table 3), but the differences were not statistically significant. The mean product of the sums of scores was also higher in women (mean, 2.74; SD, 5.82; range, 0–35) than in men (mean, 1.69; SD, 3.71; range, 0–18), but this difference was not significant either. As can be seen from the variables, the distributions were highly skewed to the right.

Persistent mandibular dysfunction was found in 63 subjects who had reported at least one symptom in 1981 and presented at least one sign in 1986/87 (Table 4). The Spearman correlation coefficient between the sums of scores for symptoms and signs was 0.37 ($p < 0.001$). Significant correlations were observed between TMJ clicking/grating and pain at the clinical examination and the symptoms reported 5–6 years earlier (Table 5). Clinically reduced

Table 3. Frequencies (%) of signs of mandibular dysfunction registered in 1986/87 by sex

Signs (Score 1 or 2) (cf. Table 2)	Men (n = 67)	Women (n = 109)	Total (n = 176)
Clicking/86	31.4	45.0	39.8
Pain/86	1.5	8.3	5.7
Tenderness/86	1.5	5.5	4.0
Opening/86*	23.9	22.9	23.3

* By definition about 25% (see Table 2).

Table 4. Cross-tabulation of subjects by individual sums of scores of symptoms in 1981 and signs in 1986/87

	Symptoms			
Signs	0	1	2+	Total
0	49	19	14	82
1	17	10	10	37
2+	14	13	30	57
Total	80	42	54	176

mouth opening capacity was associated only with reported difficulty to open widely, and tenderness of the temporal and masseter muscles showed no association with the symptoms.

Spearman correlation coefficients between the persistent traits of malocclusion, occurring at both examinations, and the signs of mandibular dysfunction were low in general. The pattern was largely similar in the two sexes, and only the correlation coefficients for the sexes combined are shown in Table 6. The only correlations significant at the 5% level were found between distal molar occlusion and Angle's class II, division 2, on the one hand, and TMJ pain and tenderness, on the other. No significant correlation was observed between the malocclusion traits and the product of sums of scores.

The clinical findings and the reactions of the subjects gave rise to discussions with 14 persons, 11 women and 3 men, 11 of whom were subsequently noted to have complained of three or more symptoms in the 1981 questionnaire. As might be expected, the product of sums of scores was high (mean, 14.29; SD, 10.06; range, 0–35). Nine of the subjects had severe functional disorders; they were offered referral for free diagnosis and treatment at the Royal Dental College, Copenhagen, and the offer was accepted by seven but refused by two. Among the other five subjects, two had received treatment with occlusal splints previously, and the other three had no subjective discomfort at the time. The 14 subjects presented with various malocclusion traits, none of which, however, occurred more frequently than would be expected by chance. For example, at both examinations distal molar occlusion without deep bite was registered in two cases, deep bite without distal occlusion in one, deep bite and distal occlusion in one, and one subject had no malocclusion.

Discussion

The sample was not representative of the population examined initially in 1965–66 nor of the respondents to the questionnaire in 1981. On the contrary, most subjects were selected in order that pronounced morphologic malocclusion traits would be well represented (12). Moreover, 20 subjects who had complained of both TMJ clicking/grating and opening difficulty were included. Therefore, comparison of the present fre-

Table 5. Spearman correlation coefficients between symptoms (81) and signs (86) of mandibular dysfunction

	1	2	3	4	5	6	7	8
1. Clicking/81								
2. Pain/81	0.37***							
3. Tenderness/81	0.32***	0.44***						
4. Opening/81	0.47***	0.43***	0.35**					
5. Locking/81	0.36***	0.28***	0.11	0.52***				
6. Clicking/86	0.40***	0.11	0.07	0.33***	0.29***			
7. Pain/86	0.17*	0.24**	0.26***	0.26***	0.26***	0.23**		
8. Tenderness/86	0.07	0.15	0.11	0.05	0.09	0.15	0.58***	
9. Opening/86	0.02	0.11	0.09	0.19*	0.07	0.00	0.12	0.05

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 6. Spearman correlation coefficients between malocclusion traits and signs of mandibular dysfunction and product of sums of scores for symptoms and signs

n = Comparison group (27) + malocclusion trait	Clicking/86	Pain/86	Tenderness/86	Opening/86	Product
Any malocclusion (139)	0.06	0.11	0.09	0.04	0.07
Distal molar occlusion (25)	0.04	0.30*	0.26	0.00	0.19
Extreme maxillary overjet (20)	0.02	†	0.12	−0.07	0.00
Mand. overjet/ant. cross-bite (8)	0.29	†	†	−0.06	0.22
Deep bite (39)	−0.02	0.17	0.17	0.03	0.09
Angle class II, division 2 (30)	0.08	0.31*	0.31*	0.05	0.19
Frontal open bite (5)	0.20	†	†	−0.18	0.06
Posterior cross-bite (36)	0.15	†	†	0.09	0.14
Scissors bite (10)	0.02	†	†	0.11	0.08
Crowding (71)	0.04	0.09	0.13	0.13	0.09

* $p < 0.05$.
† Sign not observed.

quencies per se of the signs with prevalences reported in earlier epidemiologic studies is of little interest.

At variance with the present findings (Table 4), cross-sectional investigations usually have shown higher frequencies of clinical signs than self-reported symptoms (8, 14). It should be noted, however, that we recorded relatively few signs, using rather crude criteria, because it was of prime interest to identify the subjects with persistent and severe functional disorders causing discomfort. By this token comparatively high reliability of the registrations of signs would be expected (15–17) and also a somewhat higher correlation coefficient (0.37) between occurrence of any symptoms and signs than observed earlier (16, 18). The strong association between self-reported joint sounds and difficulties with mouth opening (Table 5) could be expected owing to the selection of subjects with TMJ complaints in 1981. However, whereas clinically determined joint sounds were associated with these symptoms, clinically restricted opening capacity did not correlate to joint sounds, either in 1981 or in 1986/87. It is possible that, during this period, internal derangement characterized by clicking had induced osteoarthrosis (19, 20), passing through the active state to healing with grating (crepitation) and normal mobility (20).

The material provided a unique opportunity for testing the hypothesis that morphologic malocclusion may increase the risk of mandibular dysfunction. The study design was not strictly longitudinal, since functional disorders were not recorded at adolescence. The morphologic traits of malocclusion, however, were recorded both at adolescence and in adult life. In view of the age range of the sample (33–39 years), no increase in frequency of the signs would be expected (21, 22). Moreover, the most persistent functional disorders were probably identified by means of the product of sums of scores for the symptoms and signs, separated in time by 5–6 years. If certain morphologic traits did, in fact, predispose to mandibular dysfunction, this causal relation would be expected to emerge when subjects afflicted with these traits for more than 20 years were compared with subjects whose dentitions were free of malocclusion over that period of time.

Essentially, no relationship was found between the various morphologic traits of malocclusion and mandibular dysfunction, which is in keeping with several cross-sectional findings (7, 8, 23). However, weak but significant correlations were observed between pain on palpation of the TMJ and temporal and masseter muscles and distal molar occlusion and, especially, Angle's class II, division 2. This is in accordance with some earlier findings (4, 5, 10, 24) but

at variance with others (6, 25). The clinical examination gave rise to comprehensive inquiries in 14 subjects, 9 of whom had considerable discomfort. However, they were not characterized by specific malocclusions; among the 14 subjects, 3 had distal molar occlusion and 2 had a deep bite, which is close to the numbers expected by chance.

It should be noted that reference for diagnosis of morphologic malocclusion is the intercuspal position. Being a reflex position controlled by relative maximal occlusal stability, it does not necessarily coincide with the structural position, compliant with physiologic loading of muscles and joints (26).

In conclusion, the hypothesis that morphologic malocclusion predisposes to mandibular dysfunction was refuted. Future research in this area should probably focus on functional, rather than morphologic, malocclusion (27). The results of this clinical follow-up study support the conclusion in the 1981 questionnaire study (11) that orthodontic screening of morphologic malocclusion in childhood would seem of limited value in attempts to predict risks of functional disorders in adulthood.

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