Association between radiographic findings in the mandibular condyle and temporomandibular dysfunction in an elderly population*

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Our aims were to study the prevalence of abnormal radiographic findings in mandibular condyles and the possible association between such findings and clinical signs and symptoms of temporomandibular dysfunction (TMD) and dental state. Two cohorts of 70-year-old people, 384 men and 484 women, living in Göteborg, Sweden, participated in the study. The first cohort was examined in 1972 and the other one in 1992. Besides a functional and clinical examination, a questionnaire on TMD and panoramic radiography were included. A deviation from the normal appearance of one or both condyles was found in 26% of the subjects (17% of the condyles). There was no significant difference in this respect between the two cohorts. There were in general only minor and no statistically significant differences between those with normal and deviating condylar findings with regard to various TMD signs and symptoms. The subjects in Eichner group A (with dental support in all zones) showed a slightly lower frequency of abnormal radiographic condylar findings (22%) than those in groups B (reduced dental support) and C (edentulous in one or both jaws; both B and C, 28%). It is concluded that abnormal radiographic condylar findings in these elderly people were not at all or only weakly correlated with signs and symptoms of TMD and dental status. □ *Epidemiology, oral; mandibular mobility; osteoarthrosis; radiography; temporomandibular joint*

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Osteoarthrosis and/or osteoarthritis (OA) are the commonest of the articular disorders affecting human beings, and the relationship of OA to aging is a striking feature (1). According to an early epidemiologic study, the prevalence of radiographic osteophytes in the knee joints was 48% among 385 individuals aged 65 years and more, and 68% of those with osteophytes reported joint pain (2). A Dutch radiographic study showed OA of the knees in 22% of men and 44% of women aged 75 years and more (3). In autopsy studies it has been shown that only a few elderly individuals escape macroscopic changes of OA in the hip and knee joints. More recent studies have shown great variation in the prevalence of OA for different joints. Radiographic findings indicating OA have been reported to be very frequent in the finger joints of elderly subjects: about 90% in elderly women more than 75 years of age, 70% in those aged 65–75 years, but only in less than 5% in those less than 35 years old. Whereas radiography and, still more, histology indicate very high prevalences of OA in many joints of elderly people, clinical investigations usually find much lower frequencies of signs and symptoms related to OA (3, 4).

There are numerous epidemiologic studies of temporomandibular disorders (TMD), but those including specific diagnosis of OA of the temporomandibular joints (TMJ) are rare (5). The prevalences of signs and symptoms of TMD and of TMJ OA differ widely according to various studies, depending on methods of examination and criteria for diagnosis, age, and selection of sample (for reviews, see Refs. 4, 6). The association between clinical signs and symptoms of TMD and radiographic findings in the TMJ has been widely discussed, and conflicting results have been presented (7–13).

The etiology of OA is not well known. However, overloading is usually stated as one major etiologic factor. In this context, the association between dental state, especially loss of molar teeth, and TMJ dysfunction has been the focus of much debate since Costen's suggestion of such a relationship (4, 8, 11, 13–21). There are thus several issues related to TMJ OA which deserve to be further analyzed. It has therefore been the aims of this investigation to study 1) the prevalence of abnormal radiographic findings in the TMJ in two cohorts of elderly individuals; 2) the possible association between such findings and clinical signs and symptoms

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Table 1. Distribution of 70-year-old subjects in the two cohorts, the first investigated in 1972 and the second in 1992, with regard to type of examination

	Cohort 1		Cohort 2		
	Men	Women	Men	Women	Total
Clinical	186	198	207	277	868
Radiographic	180	190	203	267	840
Evaluation of radiographs	103	127	179	234	643

of TMD; and 3) the correlation between dental state and radiographic findings of the TMJ.

Materials and methods

Within the frame of the gerontologic studies of elderly individuals in Göteborg, Sweden (H-70; 22, 23) and the Women study in Göteborg (24, 25), two cohorts of 70-year-old subjects born in 1901/02 and 1922 were examined in 1972 and 1992–93, respectively. The sampling and examination procedures have previously been described in detail for both cohorts (22–25). Both the H-70 and the Women study are multidisciplinary and have included medical, dental, morphologic, biochemical, physiologic, psychologic, nutritional, and socioeconomic data. In the present study the interest has been focused on radiographic findings in the mandibular condyle and signs and symptoms of functional disturbances of the masticatory system.

The first cohort, examined in 1972, comprised 384 subjects, and the second cohort, examined in 1992–93, 484 subjects. Most of these subjects (97%) were examined by means of panoramic radiography (Table 1). The radiographic method enables imaging of the upper and lower jaws, including the maxillary sinuses and the condylar processes, on one single film. Radiographs that did not include interpretable images of both condyles were excluded. On the basis of these criteria 62% of the first and 88% of the second cohort (of those who had been radiographically examined) were included in the radiographic evaluation (Table 1). An analysis of subjects with and without excluded radiographs showed that they did not differ with regard to dental status and signs and symptoms of functional disturbances included in this study.

The examinations included a questionnaire with eight questions on function and dysfunction of the masticatory system. In this study answers to only three of these questions have been included in the analyses. These questions were 1) Does it hurt when you open your mouth wide to take a large bite? 2) Does it hurt in your teeth or jaws when you chew? 3) Are there noises in your jaw joints when you open your mouth wide? For denture wearers there were also questions on the use of the dentures.

In the first cohort a clinical examination was performed, focusing on signs of dysfunction of the masticatory system, by means of palpation of masticatory muscles and TMJs, recording of TMJ sounds, deviations, and pain at mandibular movement, and measuring of the interincisal distance at maximal mouth

Fig. 1. Panoramic radiograph showing flattening of the left condyle.

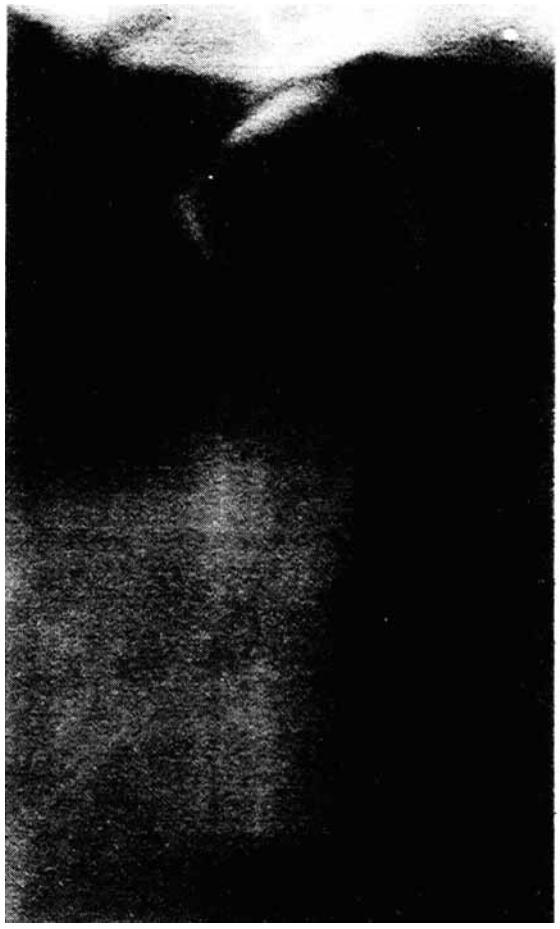

Fig. 2. Enlargement of the left condyle in Fig. 1, showing flattening.

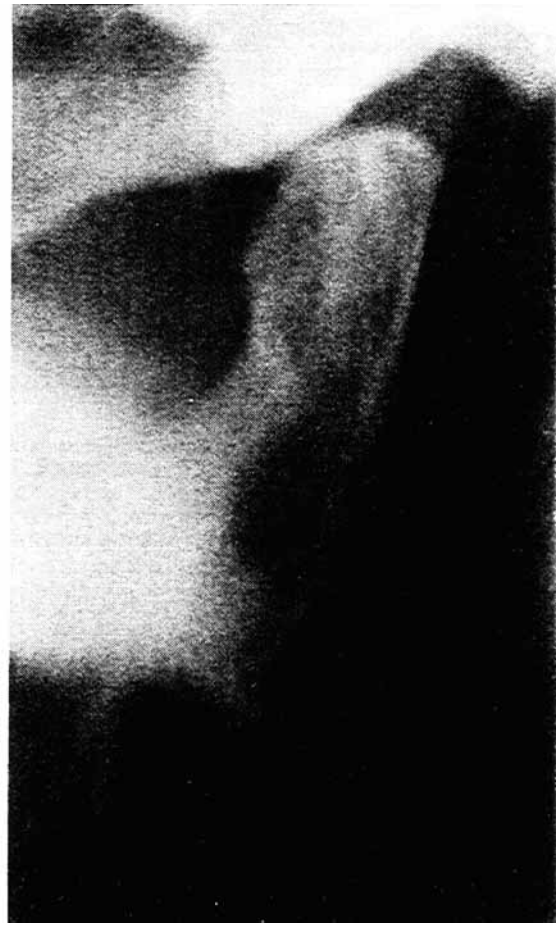

Fig. 3. Condylar change, judged as erosion, from an enlarged area of a panoramic radiograph.

opening with a ruler (in millimeters). The clinical examination was performed as described previously (23, 26). In the second cohort, examined in 1992, clinical functional examination was limited to the measuring of the interincisal distance at maximal mouth opening in the same manner as in 1972. The maximal mouth opening was dichotomized into normal (40 mm or more) or limited (39 mm or less). The dentition was also clinically examined. The dental state was classified into three groups with regard to distribution of tooth support in accordance with Eichner (27): a) with dental support in all zones, b) reduced dental support, and c) edentulous in one or both jaws.

One observer, the first author, scrutinized all radiographs after a calibration period together with a specialist in oral radiology. The condyles were evaluated on the basis of the following scale, largely in accordance with definitions presented previously (28, 29): 1 = normal (without the changes described in points 2 to 5); 2 = flattening; 3 = sclerosis; 4 = osteophyte; 5 = erosion (Figs. 1–3).

To estimate observer variation, 100 randomly selected panoramic radiographs were examined again by the first observer (H. Sato) 2–3 months after the first evaluation. Independently, another observer (M. Ahlqwist) evaluated the same radiographs. The agreement percentage and the index of weighted kappa (κ) were calculated (30).

Statistical comparisons between groups were performed by means of the chi-square test, and the level of significance was set to $P < 0.05$.

Results

Observer variation in evaluation of radiographs

The agreement between the two observers judging whether the condyle was normal was 89%, whereas the repeated evaluations by the main observer coincided in 90%. The corresponding weighted kappa indices were 0.61 and 0.70, respectively. For the various diagnoses the agreement was in general lower, but the inter- and intra-observer variation was of similar magnitude.

Table 2. Percentage distribution of 643 subjects on the basis of radiographic evaluation of the condyles. The frequency (%) of subjects with abnormal findings in one or both condyles is presented in the bottom line

	Cohort 1		Cohort 2		
	Men, $n = 103$	Women, $n = 127$	Men, $n = 179$	Women, $n = 234$	Total, $n = 643$
Normal in both	81	68	75	73	74
Abnormal in right	3	12	10	11	10
Abnormal in left	6	9	8	9	8
Abnormal in both	10	11	7	7	8
One or both abnormal	19	32	25	27	26

Table 3. Percentage distribution of subjects with reported symptoms with regard to radiographic evaluation of the condyles. Statistically significant difference between subjects with radiographically normal and abnormal condyles is denoted (*) ($P < 0.05$)

		Cohort 1		Cohort 2		
Symptoms	Condyle	Men, $n = 103$	Women, $n = 127$	Men, $n = 179$	Women, $n = 234$	Total, $n = 643$
Pain when opening the mouth wide	Normal	2	1	2	2	2
	Abnormal	10	5	7	3	5
P						(*)
Pain in teeth or jaw when chewing	Normal	16	19	3	3	8
	Abnormal	30	12	20	0	7
TMJ sounds	Normal	23	17	10	10	14
	Abnormal	10	15	11	16	14

Table 4. Percentage distribution of subjects with a reduced interincisal distance (<40 mm) with regard to radiographic evaluation of the condyles. Statistically significant differences between subjects with radiographically normal and abnormal condyles are denoted (*) ($P < 0.05$) or (**) ($P < 0.01$)

	Cohort 1		Cohort 2		
Condyles	Men, $n = 103$	Women, $n = 127$	Men, $n = 179$	Women, $n = 234$	Total, $n = 643$
Normal	5	9	6	19	11
Abnormal	0	10	18	31	19
P			(*)		(**)

Radiographic findings

A deviation from the normal appearance of one or both condyles was found in about one-quarter of all subjects (26%). There was no significant difference between the two cohorts, but in the first cohort there were more abnormal findings in the women (32%) than in the men (19%) ($P < 0.05$) (Table 2). An abnormal finding was recorded for 223 of the 1286 examined condyles (17%). The commonest finding was flattening (9%). Erosion, osteophytes and sclerosis were observed less frequently (7%, 7%, and 3%, respectively).

Association between reported, clinical, and radiographic findings

Reported pain at mouth opening was more frequent among those with abnormal than with normal condyles, whereas reported chewing pain and TMJ noise did not differ significantly (Table 3).

When both cohorts were taken together, subjects with abnormal radiographic condylar findings more often had limited maximal opening of the mouth (19%) than those with normal condyles (11%) (Table 4; in the first cohort there was no significant difference).

In the first cohort several of the clinically recorded signs were more frequent in those with abnormal than in those with normal condyles, but there was a statistically significant difference only with regard to TMJ sounds (Table 5).

Subjects in Eichner group A (with dental support in all zones) showed a nonsignificantly lower frequency of abnormal radiographic condylar findings (22%) than those in groups B and C (both 28%). However, in the women in cohort 1 there was a difference ($P < 0.05$) in such findings with regard to dental support (Table 6). Among the totally edentulous subjects in Eichner group C 20 reported that they did not use their dentures regularly. In this subgroup 11 (55%) had abnormal

Table 5. Percentage distribution of subjects in cohort 1 (103 men and 127 women) with clinical signs on the basis of radiographic evaluation of the condyles. Statistically significant differences between subjects with radiographically normal and abnormal condyles are denoted (*) ($P < 0.05$) or (**) ($P < 0.01$)

Sign	Normal	Abnormal	*P*
Lateral movement of mandible: difference between right and left side >3 mm	9	16	
Deviation of the mandible on opening >2 mm	39	48	
TMJ sounds	33	54	(**)
Tenderness to palpation of TMJ laterally	4	3	
Tenderness to palpation of TMJ posteriorly	4	5	
Tenderness to palpation; m. masseter	33	31	
Tenderness to palpation; m. pter.lat./proc. coronoideus	45	54	

Table 6. Percentage distribution of subjects with radiographically abnormal condyles with regard to tooth support on the basis of the Eichner Index. Figures in parentheses denote numbers of subjects in each subgroup. Statistically significant difference between subjects with radiographically normal and abnormal condyles among different Eichner Index groups is denoted (*) ($P < 0.05$)

	Cohort 1		Cohort 2		
Eichner Index	Men, $n = 103$	Women, $n = 127$	Men, $n = 179$	Women, $n = 234$	Total, $n = 634$
A	22 (9)	0 (6)	17 (54)	26 (82)	22 (151)
B	14 (22)	14 (21)	30 (76)	27 (97)	28 (216)
C	21 (72)	38 (100)	24 (49)	31 (55)	28 (276)
P		(*)			

condyles according to the radiographic examination which differed significantly ($P < 0.01$) from the regular complete denture wearers (25%). The distribution of clinical signs of dysfunction did not differ significantly among the Eichner groups, except for one sign: pain on mandibular movement was recorded in 11% in group C as compared with 3% in A and 4% in B ($P < 0.01$).

Discussion

The selection of subjects, the representativeness of the samples, and the methods of examination used in the main investigations, of which this study is a part, have been described and discussed in detail previously (25, 27, 31).

The usefulness of panoramic radiography in epidemiologic studies of dental health has been demonstrated in several studies (for example, 32, 33). The method has also been used in studies of the TMJ (34–36). It has been stated that panoramic radiography is inferior to lateral tomography for diagnosing lesions in the TMJ, especially with regard to the temporal component of the joint. However, changes in the condyle were demonstrated equally frequently, and osteophytes and sclerosis more frequently, in panoramic radiography than in lateral tomography (37). Other authors have also stated that panoramic radiography yields good information compared with other more time and dose-consuming methods such as tomography for diagnosing lesions of the condyle (38). Even though many authors consider tomography the method of choice for examination of TMJ hard-tissue changes, this method underestimates erosive changes in comparison with findings at microscopic examination, according to a recent study of an autopsy material (39). A combination of several radiographic techniques has been suggested to be the most reliable choice for diagnosing changes in the TMJ (37). It was considered impossible, however, to examine all subjects in the epidemiologic cohorts with more than one method, and we therefore chose panoramic radiographs, well aware of the shortcomings of the method, particularly with regard to the temporal component.

We have only scrutinized the condyles and only used radiographs in which both condyles could be clearly seen. The excluded radiographs comprised about 23% of the material, but an analysis showed that the subjects without acceptable radiographs did not differ from the remaining subjects with regard to clinical background factors studied. Both intra- and inter-observer variation was small with regard to the judgement whether the condylar findings were normal or abnormal. This dichotomy was used in the analyses, whereas the less consistent detail diagnoses were not further analyzed with regard to association with clinical signs and symptoms.

The relationship between OA changes in the condyle and the temporal component is not unequivocally described in the literature (6, 14, 39–44). If there are more severe changes in one of the components, however, the other one usually also appears to be afflicted. A recent study (40) reported erosive changes more often in the temporal component than in the condyle, but when there was such a change in the condyle, then as a rule there was also one in the temporal component. It is therefore highly probable that when condylar findings were recorded in this study, they indicated osseous changes also in other parts of the TMJ. Presumably, however, the panoramic condylar findings underestimated changes that would have been detectable with direct macroscopic and microscopic techniques.

It is well established that when discussing the prevalence of OA of the TMJ, many factors must be considered, such as the methods used for examination, criteria for diagnosis, and age and gender composition of the samples examined (for a review, see Ref. 4). In this study one or both condyles in about one-quarter of the subjects were evaluated as deviating from a normal radiographic appearance. Most of the findings were such that usually are considered indicative of OA. This prevalence is close to the figure (22%) reported for macroscopic OA lesions in an autopsy material consisting of TMJs from 102 individuals between 20 and 93 years of age (14) but lower than that found in another sample (38%) with an older mean age (41). Frequencies of osseous changes in clinical and autopsy studies of the TMJ have differed much—from about 20% to 90%—according to various reports, probably depending more on definitions and methods used than on real sample differences (6, 14, 39–47). In several of these studies osseous changes were often found in asymptomatic subjects.

The increased frequency of TMJ sounds in subjects with condylar findings is in accordance with some previous reports (4, 8). Otherwise, however, were there no strong associations in this study between any clinical sign or symptom and the radiographic findings, and the weak correlations found were not consistent in the two cohorts and among the genders. Nor was there any strong association between clinical signs or symptoms and specific radiographic findings, such as erosion, flattening, or osteophytes. This poor correlation corroborates the results of several previous studies, using various radiographic methods (6, 11, 12, 20, 47). This is also in accordance with the current description of the development of the symptoms of OA (4, 11) and the fact that radiographs do not depict the ongoing process but rather the rough result of previous processes (40).

In a recent study a high rate of unexpected osseous changes was found in patients with a clinical diagnosis of derangement or OA, which was taken as a support for the need for tomograms (47). This conclusion can be questioned with regard to the well-established good prognosis of OA of the TMJ, the poor correlation between radiographic and clinical findings, and the fact that conventional radiography is not sensitive enough to reveal ongoing processes in the TMJ. While we await more sensitive diagnostic tools, the simple panoramic radiographic method is probably sufficient to disclose gross changes and abnormalities.

One hypothesis when beginning the study was that there might be fewer condylar findings in those with better dental status. It could therefore be expected that we would obtain fewer abnormal findings in the new cohort (1992–93) than in the first one (1972), since dental status has improved with time. This could not be verified in this material. Two recent autopsy studies reported slightly deviating results with regard to the influence of dental state on TMJ abnormalities. The first one (48), based on 34 condyles, found that condyles with changes 'tended to be from the side of the mandible with minimal areas of occlusal contact'. The other more extensive investigation (49), based on 248 TMJs from 224 fresh cadavers, reported no significant difference in morphologic alterations in the TMJs from persons with natural dentition compared with those from edentulous individuals. They concluded that 'the relationship between arthrotic changes, internal derangement, and pain/dysfunction is complicated and far from linear'.

In conclusion, this study indicates that there are in general no or only weak correlations between radiographically diagnosed condylar findings and clinical signs and symptoms of masticatory dysfunction and dental status in elderly people.

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