

Subjective symptoms in temporomandibular joint osteoarthritis

SIGVARD KOPP

Department of Stomatognathic Physiology, University of Gothenburg
Gothenburg, Sweden

Kopp, S. Subjective symptoms in temporomandibular joint osteoarthritis. *Acta Odont. Scand.* 35, 207-215

Questionnaires about subjective symptoms were sent by post to 120 patients referred to the clinic for mandibular dysfunction. A group of 20 patients with crepitation of the temporomandibular joint (TMJ) and a group of 19 patients with palpatory tenderness of the TMJ were compared with a reference group of 29 patients for any difference in local subjective symptoms, frequency of headache and symptoms in other joints. The patients with TMJ crepitation, which were considered to have TMJ osteoarthritis, were older and reported a higher frequency of grating sound from the TMJ than the patients in the reference group. The patients with palpatory tenderness of the TMJ reported a higher frequency of toothgrinding, more severe symptoms of mandibular dysfunction and a higher frequency of symptoms in the hand joints. No correlation was found between subjective symptoms of mandibular dysfunction and those of other joints. The results of the study indicate that patients with TMJ osteoarthritis do not differ from other patients with mandibular dysfunction with respect to subjective symptoms and that subjective symptoms of mandibular dysfunction in general develop independently of those in other joints.

Key-words: Temporomandibular joint syndrome; pathology; human

Sigvard Kopp, University of Gothenburg, Faculty of Odontology, Department of Stomatognathic Physiology, Fack, S-400 33 Gothenburg 33, Sweden

INTRODUCTION

Pain or dysfunction of the masticatory system is a common condition. Recent epidemiologic studies have shown that more than 50% of individuals in the populations examined have or have had such symptoms (Hansson & Öberg, 1971; Agerberg & Carlsson, 1972; Helkimo 1974a; Molin *et al.*, 1976).

Opinions differ concerning the role played by pathologic processes in the articular tissues of the temporomandibular joints (TMJ) in the development of pain and dysfunction of the masticatory system (for reviews, see Ramfjord & Ash, 1971; Kopp, 1972; Carlsson & Öberg, 1974).

The present study is a part of a series

dealing with various aspects of TMJ osteoarthritis (OA). Osteoarthritis (*syn.* arthrosis, degenerative joint disease, osteoarthritis) is used here, in pathologic terms, to designate a lesion localised to the soft and hard tissue layers of the joint surfaces. Such a lesion is due to break-down and wear of the soft tissue layers of the joint surfaces with simultaneous remodelling processes in the underlying bone tissue. The condition is primarily noninflammatory and involves usually single joints of the body (Sokoloff, 1969). A general form of OA (GOA) has, however, been described in association with Heberden's nodes (Kellgren & Moore, 1952) and in hereditary seronegative polyarthritis (Kellgren, Lawrence & Bier, 1963).

Clinically, the term TMJ OA here designates the disturbances of the masticatory function or pain which are caused by osteoarthrotic lesions of the TMJ.

This study concerns subjective symptoms of TMJ OA and the specific aim was to investigate the following questions:

1. Do patients with TMJ OA differ from the rest of the patient population in respect of sex, age, local symptoms, duration of symptoms, headache or symptoms in other joints?
2. Is there a correlation between subjective symptoms of mandibular dysfunction and symptoms experienced in other joints?

MATERIAL AND METHODS

Clinical material

The clinical material originally consisted of 161 consecutive patients referred to the Department of Stomatognathic Physiology at the Faculty of Odontology, Gothenburg. Of these patients, those with pain (including pain in the TMJ and masticatory muscles, facial pain and headache) or dysfunction (including decreased mandibular movement capacity, joint sounds, subluxation and tooth-

grinding/clenching) of the masticatory system as judged from the referral letter were selected. The following were, however, excluded:

- a) patients below 16 years of age, or
- b) patients who had recently sustained a trauma in the facial region, or
- c) patients who had postoperative symptoms in the facial region, or
- d) patients who had verified rheumatoid arthritis (RA) or some other systemic disease involving joints or muscles.

The material examined for subjective symptoms of mandibular dysfunction consisted of 120 patients (Table I), 74% of whom were women. The patients' ages ranged from 16 to 88 (mean 38 years). The female predominance increased with age, for which reason the mean age of the men was lower (33 years) than that of the women (40 years).

Patients with clinically verified mandibular dysfunction were allocated to groups according to the following experimental criteria.

E₁-group (experimental group 1) consisting of 20 patients with TMJ crepitation audible with stethoscope.

E₂-group (experimental group 2) consisting of 19 patients with local tenderness to palpation of the TMJ, laterally or posteriorly but without crepitation (Table II).

R-group (reference group) consisting of 29 patients without the above criteria.

Questionnaire

Questionnaires concerning the patients' subjective symptoms were sent by post to the 120 patients about 1 week before their first visit to the clinic. The questionnaire contained information, instructions and 35 questions of multiple choice type. The questions concerned symptoms of mandibular dysfunction, their severity and duration, headache and symptoms in other joints. The questions about current symptoms referred to the last month. The questionnaire is available from the author on request.

The degree of subjective dysfunction was estimated by the anamnestic dysfunction index (A₁; Helkimo, 1974b). The severity of

Table I. Age and sex distribution of the patients investigated for symptoms of mandibular dysfunction

Sex	Patient groups	Age groups Years						Total
		16-20	21-30	31-40	41-50	51-60	61-88	
Women	All patients	9	24	14	14	12	11	84
	E ₁ -group		1	3	3	3	7	17
	E ₂ -group	2	5	1	3	3	1	15
	R-group	4	7	4	2	1	1	19
Men	All patients	5	13	9	5	4		36
	E ₁ -group			1	1	1		3
	E ₂ -group		1	1	1	1		4
	R-group	2	4	2	1	1		10
Both sexes	All patients	14	37	23	19	16	11	120
	E ₁ -group		1	4	4	4	7	20
	E ₂ -group	2	6	2	4	4	1	19
	R-group	6	11	6	3	2	1	29

Table II. Distribution of the patients in the E-groups according to criteria of selection. Mean ages (years) for the different sub-groups are given within brackets

Crepitation of the TMJ	Palpatory tenderness of the TMJ				Total
	absent	laterally	posteriorly	laterally and posteriorly	
absent	0 —	9 (38)	4 (40)	6 (36)	19 (38)
present	8 (48)	6 (52)	0 —	6 (64)	20 (55)
Total	8 (48)	15 (44)	4 (40)	12 (50)	39 (47)

symptoms in other joints were estimated by the questions concerning joint swelling, duration, medical consultation and hospital care.

Clinical examination methods

The examination of TMJ crepitation and TMJ palpatory tenderness was performed by the author according to the principles described by Carlsson & Helkimo (1972) and Kopp

(1977). TMJ crepitation was assessed by stethoscope. TMJ palpatory tenderness was recorded when a difference in tenderness between right and left sides was reported by the patient on inquiry or when the palpatory pressure evoked pain or palpebral reflexes. The reproducibility in one week of crepitation and tenderness to palpation of the TMJ was tested by repeated examination of 79 patients.

Serologic RA tests (AAF, AFT) were done in 13 suspected cases with recurrent episodes of pain or swelling of several peripheral joints.

Statistical methods

Scott's π (π) was calculated as a measure of the reproducibility of the experimental criteria (Scott, 1955).

$$\pi = \frac{\% \text{ observed agreement} - \% \text{ agreement expected by chance}}{100 - \% \text{ agreement expected by chance}}$$

Significance tests for differences between sexes, age-groups and patient-groups were performed by Fisher's permutation test and tests for correlations were performed by Pitman's permutation test. Both methods are non-parametric and applicable to discrete as well as continuous distributions and give correction for ties (Odén & Wedel, 1975).

Sex and age were included as confounding (background) variables in the tests when correlated to subjective symptoms with a probability of $p < 0.4$. The material was then divided into groups according to sex or age. Three age-groups were used: 16–24, 25–49, 50–88 years.

The levels of statistical significance of Fisher's permutation test (F) are denoted by ** $p < 0.01$, * $0.01 \leq p < 0.05$ and n.s. (not significant) $p \geq 0.05$.

Pearson's product-moment correlation coefficient (r) was also calculated to provide an approximate estimation of the strength of the correlations containing continuous variables, but no significance tests were based on this coefficient.

The upper limit of the expected number of falsely significant tests has been calculated according to the conventions given by Eklund & Seeger (1965).

RESULTS

Experimental criteria

The agreement between the repeated recordings for crepitation was 90%. The reproducibility according to Scott's π was

calculated to be 0.68. The index value of TMJ crepitation increased significantly with age (F: $p < 0.01$, $\pi = 0.51$; Fig. 1).

The agreement between the two recordings of tenderness to palpation of the TMJ was 80%. The reproducibility according to Scott's π was calculated to be 0.35. Tenderness to palpation of the TMJ increased significantly in index value with age (F: $p < 0.05$, $\pi = 0.27$; Fig. 2).

No difference in age could be found between the patients with lateral and posterior tenderness to palpation of the TMJ (Table II).

Age and sex distribution

In groups E₁ and E₂ the mean age was higher (55 and 38 years, respectively) and women were more preponderant (85 and 79%, respectively) than in group R (30 years and 66%, respectively; Table I). The E₁-group differed significantly from the R-group in age (F: $p < 0.01$), but not with respect to sex distribution. No statistically significant difference could be found between groups E₂ and R with respect to sex and age.

Subjective symptoms

The frequency distributions of the subjective symptoms studied for the different groups are given in Table III and in Figs. 3, 4, 5 and 6.

From 70% (E₁-group) to 95% (E₂-group) of the patients had severe subjective symptoms according to the anamnestic dysfunction index (Fig. 3). From 31% (R-group) to 68% (E₂-group) of the patients experienced severe discomfort according to their own evaluation (Fig. 4). The E₂- and R-groups differed significantly in this last respect (F: $p < 0.01$).

The patients in the E₁-group reported a grating sound from the TMJ significantly more often than the patients in the R-group (F: $p < 0.01$) but no difference between the groups was observed for clicking sound.

Stiffness or pain in the hands and fingers and difficulty in moving the fingers were

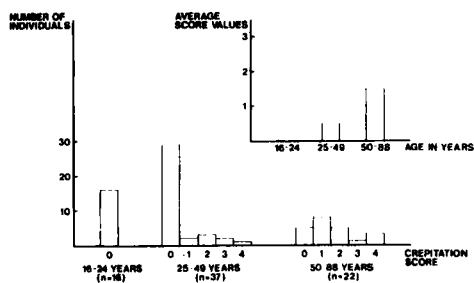


Fig. 1. Distribution of the score of TMJ crepitation according to age for 75 patients. Average score values are inserted. The following scale was used: 0 = no crepitation, 1 = crepitation audible only by stethoscope in one joint, 2 = crepitation audible without stethoscope in one joint or with stethoscope in two joints, 3 = 1 + 2 and 4 = 2 + 2.

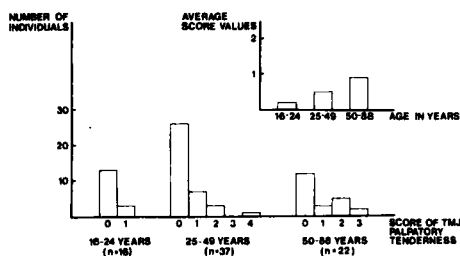


Fig. 2. Distribution of the score of TMJ palpatory tenderness according to age for 75 patients. Average score values are inserted. The following scale was used: 0 = no palpatory tenderness, 1 = palpatory tenderness either laterally or posteriorly of one joint, 2 = palpatory tenderness laterally and posteriorly of one joint or either laterally or posteriorly in two joints, 3 = 1 + 2 and 4 = 2 + 2.

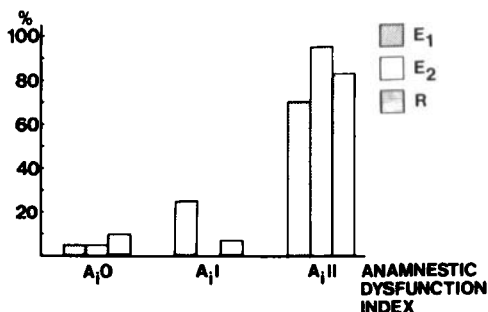


Fig. 3. Percentage distribution of the E₁-group, E₂-group and R-group according to the anamnestic dysfunction index of Helkimo (1974b). A_i0 = subjectively symptom-free, A_i1 = mild symptoms, A_i11 = severe symptoms.

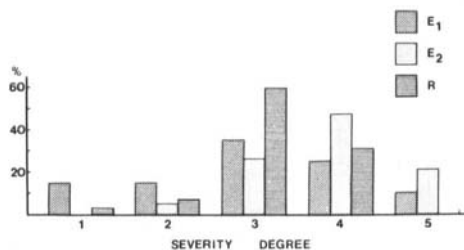


Fig. 4. Percentage distribution of the E₁-group, E₂-group and R-group according to their own estimation of the severity of symptoms. The following scale was used in the questionnaire: 1 = none or minimal discomfort, 2 = slight discomfort, 3 = moderate discomfort, 4 = severe discomfort, 5 = very severe discomfort.

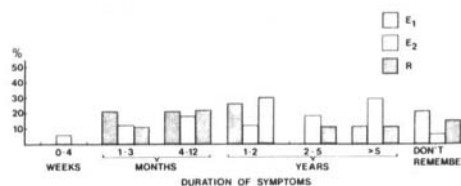


Fig. 5. Percentage distribution of the E₁-group, E₂-group and R-group according to the duration of symptoms.

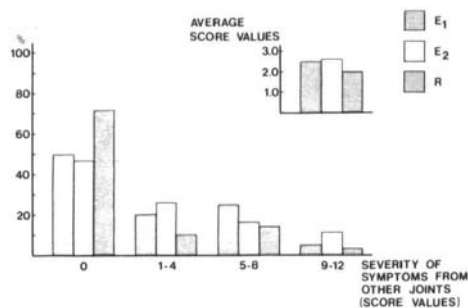


Fig. 6. Percentage distribution of the E₁-group, E₂-group and R-group according to the severity of symptoms in other joints. Average score values are inserted. The severity were scored by the following variables: joint swelling (2 units); duration less 1 year (1 unit), 1 year or more, but less than 5 years (2 units), 5 years or more (3 units); medical consultation (2 units); and hospital care (5 units).

Table III. Percentage distribution of symptoms for the patients in the E- and R-groups. The confounding factors sex and age are noted when correlated to symptoms with a probability of $p < 0.4$

Symptoms	Frequency in the E ₁ -group n = 20	Frequency in the E ₂ -group n = 19	Frequency in the R-group n = 29	Test of difference between E ₁ - and R-group	Test of difference between E ₂ - and R-group	Confounding factors (age, sex)
Symptoms in the masticatory system						
Anamnestic dysfunction index						
Clicking sound from TMJ	Fig. 3	Fig. 3	Fig. 3	n.s.	n.s.	—
Grating sound from TMJ	30	63	62	n.s.	—	—
Feeling of stiffness in TMJ	55	5	7	**	—	—
Difficulties in opening the mouth	35	53	44	n.s.	n.s.	sex
Locking of the jaw	60	58	50	n.s.	—	sex
Pain in TMJ/masticatory muscles	30	32	48	n.s.	—	sex, * age
Severity of symptoms	75	84	68	n.s.	n.s.	sex, age
Duration of symptoms	Fig. 4	Fig. 4	Fig. 4	n.s.	**	sex
Similar symptoms before	Fig. 5	Fig. 5	Fig. 5	n.s.	n.s.	sex, age
Tooth-grinding (asleep)	30	26	19	n.s.	n.s.	age
Tooth-clenching (awake)	0	47	17	n.s.	*	sex, age**
	70	58	59	n.s.	—	sex, age
Headache (once a week or more)	40	42	31	—	n.s.	sex*
Symptoms in other joints						
Stiffness or pain	55	53	36	—	n.s.	age**
Severity of symptoms in other joints	Fig. 6	Fig. 6	Fig. 6	n.s.	n.s.	age**
Joint swelling	25	26	14	—	n.s.	age**
Duration > 5 years	25	21	10	n.s.	n.s.	age*
Medical consultation	35	21	21	n.s.	—	age**
Hospital care	10	5	3	n.s.	n.s.	age*
Stiffness or pain in hands/fingers	35	42	3	n.s.	**	sex, age
Difficulty in moving the fingers	25	42	10	n.s.	*	sex, * age**

reported significantly more often by patients in the E₂-group than in the R-group ($F: p < 0.01$ and $p < 0.05$, respectively).

The frequency of symptoms in other joints in the form of stiffness or pain, swelling and difficulty in moving the fingers increased significantly with age ($F: p < 0.01$, $0.26 \leq r \leq 0.36$) as did the duration ($F: p < 0.05$, $r = 0.47$) and the severity ($F: p < 0.01$, $r = 0.39$) of these symptoms.

No statistically significant correlation could be found between the symptoms of

mandibular dysfunction included in the anamnestic dysfunction index and stiffness or pain in other joints. The severity of the symptoms in other joints did not show any statistically significant correlation with the anamnestic dysfunction index. This also holds for the anamnestic dysfunction index and stiffness or pain in hands and fingers.

In reply to the question regarding symptoms (stiffness and pain) from other joints, 3 patients answered that they had such symptoms in all joints; 21, in the neck and

shoulders; 17, in the fingers, hands or arms; 8, in the back; and 18 in the hips, knees and feet.

Of altogether 83 significance tests performed in the present study, 16 proved significant at the 5% level and 9 at the 1% level. The upper limit of the expected number of false significances was calculated to be at most 4 and 1, respectively, at the two levels.

DISCUSSION

The age and sex distribution of the material resembled that in similar investigations on record (*Agerberg et al.*, 1970; *Carlsson & Svärðström*, 1971; *Rosell & Öberg*, 1975; *Carlsson, Magnusson & Wedel*, 1976) with a mean age of 38 years and a male/female ratio of 1:3. Also the distribution and duration of the symptoms were similar to that in earlier studies. It therefore appears warranted to assume that the patients in the present material constitute a representative sample of patients in Sweden seeking treatment for mandibular dysfunction.

Clinical criteria have been used experimentally in order to select patients with OA of the TMJ. Two clinical signs commonly associated with OA of the TMJ were chosen as criteria.

TMJ crepitation is generally considered as an indication of structural damage to the articular surfaces of the joint (*Laine*, 1968; *Carlsson & Helkimo*, 1972; *Krogh-Poulsen*, 1974; *Toller*, 1974). Crepitation is a sound of polyphasic type which can be distinguished from the mono- or diphasic clicking sound at auscultation or palpation (*Findly & Kilpatric*, 1960). The relatively good reproducibility of TMJ crepitation reflected in Scott's pi includes both the constancy of the sign and of the observer at a 1 week interval. There is good reason, however, to assume that crepitation occurs also in other diseases of the TMJ, especially in RA. Serologic tests for rheumatoid factors were therefore performed

in suspected patients and patients with positive tests were excluded as were all patients with known systemic diseases of muscles and joints. Since crepitation probably do not appear until relatively late in the development of OA, it was not considered sufficient as the only criterion.

Tenderness to palpation laterally or posteriorly of the TMJ can originate from muscle attachment near the joint, from the capsule or from the bony tissue of the joint. This sign may appear in the course of a disease of the joint as OA but also following muscular hyperfunction. Local tenderness of the TMJ is presumably a criterion of low specificity and the low value of Scott's pi also indicated a low reproducibility in 1 week. The low index value is probably due to both observer variability (*Carlsson, Helkimo & Agerberg*, 1974) and low constancy of the sign (*Kopp*, 1977).

The patients with TMJ crepitation had a significantly higher age than the other patients. This lends a certain support to the validity of crepitation as a criterion of TMJ OA, since the risk of being afflicted with OA increases with age in most joints, including the TMJ (*Blackwood*, 1963; *Moffett*, 1964; *Bollet*, 1969; *Sokoloff*, 1969; *Öberg, Carlsson & Fajers*, 1971). The patients with TMJ crepitation (E₁-group) could therefore be considered to have TMJ OA according to clinical definitions. The results of a radiographical investigation are under preparation, which may elucidate whether this criterion can identify patients with TMJ OA according to radiographical definitions.

The possibility that the symptoms of mandibular dysfunction of the patients in the E₁-group have no association at all with structural changes in the joint, cannot be excluded. However, the significantly later appearance of the symptoms among patients with crepitation of the TMJ (55 years of age) as compared to the reference patients (30 years of age) makes this unlikely.

The reproducibility of the answers to the questionnaire proved acceptable (*Kopp*, 1976), but it was not possible to check the validity of most of the answers because the questions

concerned subjectively experienced symptoms.

In this paper symptoms in other joints are to be understood as recurrent episodes of stiffness or pain of varying aetiology, which have occurred within the last month. Such so-called rheumatic symptoms are common in the general population, but are mostly of transient nature (*Hegna et al.*, 1973).

Recurrent stiffness or pain of the hands and difficulty in moving the fingers were significantly more common in the E₂-group, which suggests the presence of a common factor associated with these symptoms and palpatory tenderness of the TMJ. No significant correlation was, however, found between symptoms in other joints and symptoms of mandibular dysfunction, which indicates that symptoms of mandibular dysfunction in general develop independently of symptoms in other joints.

The relation between symptoms of mandibular dysfunction and general joint/muscle symptoms has been discussed in earlier epidemiologic studies. *Agerberg & Carlsson* (1973, 1975) and *Helkimo* (1974c) found general joint/muscle symptoms to appear more commonly among persons with subjective or clinical symptoms of mandibular dysfunction. The effect of age was, however, not taken into account. *Molin et al.* (1976) found no correlation between subjective symptoms of mandibular dysfunction and general joint/muscle symptoms in a material consisting of 19-year-old men, but they, too, found a correlation between tenderness to palpation of the TMJ and masticatory muscles and general joint/muscle symptoms.

The relatively large number of tests and the relatively few statistically significant tests may result in false significances, especially at the 5% level. As for most age and sex differences, they agreed with those found in earlier epidemiologic and clinical studies. The results of the two tests of differences between groups E₂ and R regarding pain in hands/fingers and difficulty in moving the fingers support each other.

The present results indicate that patients

with TMJ OA differ from other patients with mandibular dysfunction with respect to their higher age but not with respect to sex, local symptoms (other than joint sounds), duration of symptoms, headache or symptoms in other joints. The results also indicate that subjective symptoms of mandibular dysfunction and those of other joints in general develop independently.

Acknowledgments. This investigation was financially supported by research grants from Göteborgs Tandläkare-Sällskap, the University of Gothenburg and the Swedish Medical Research Council (project No. B-74-76-24X-4238).

REFERENCES

- Agerberg, G., Carlsson, G.E., Ericson, S., Lundberg, M. & Öberg, T.* 1970. Funktionsrubbnings i tuggapparaten. En bettfysiologisk, röntgenologisk och serologisk undersökning. *Tandläk. Tidn.* 62, 1192-1211
- Agerberg, G. & Carlsson, G.E.* 1972. Functional disorders of the masticatory system. I. Distribution of symptoms according to age and sex as judged from investigation by questionnaire. *Acta Odont. Scand.* 30, 597-613
- Agerberg, G. & Carlsson, G.E.* 1973. Functional disorders of the masticatory system. II. Symptoms in relation to impaired mobility of the mandible as judged from investigation by questionnaire. *Acta Odont. Scand.* 31, 335-347
- Agerberg, G. & Carlsson, G.E.* 1975. Symptoms of functional disturbances of the masticatory system. A comparison of frequencies in a population sample and in a group of patients. *Acta Odont. Scand.* 33, 183-190
- Blackwood, H.J.J.* 1963. Arthritis of the mandibular joint. *Br. Dent. J.* 115, 317-326
- Bollet, A.I.* 1969. An essay on the biology of osteoarthritis. *Arthritis Rheum.* 12, 152-163
- Carlsson, G.E. & Svärdröm, G.* 1971. Ett bettfysiologiskt patientmaterial. *Sven. Tandläk. Tidskr.* 64, 889-899
- Carlsson, G.E. & Helkimo, M.* 1972. Funktionell undersökning av tuggapparaten. In *Nordisk Klinisk Odontologi*. Ed. Holst, J.J. et al. M/S Forlaget for faglitteratur, Copenhagen, 8-1, pp 5-6
- Carlsson, G.E. & Öberg, T.* 1974. Sjukdomar och förändringar som har samband med funktionsrubbnings i tuggapparaten. In *Bidfunktion/Betfysiologi*. Ed. Krogh-Poulsen, W. & Carlsen, O. Copenhagen. pp 353-395

- Carlsson, G.E., Helkimo, M. & Agerberg, G. 1974. Observatorsskillnader vid bettfysiologisk undersökning. *Tandläk. Tidn.* 66, 565–572
- Carlsson, G.E., Magnusson, T. & Wedel, A. 1976. Patientmaterialet vid en bettfysiologisk avdelning. En översikt av remissväg, symptombild och behandling av 1213 patienter. *Sven. Tandläk. Tidskr.* 69, 115–121
- Eklund, G. & Seeger, P. 1965. Masssignifikansanalys. *Stat. tidskr.* 3, 353–365
- Findlay, I.A. & Kilpatrick, S.J. 1960. An analysis of the sounds produced by the mandibular joint. *J. Dent. Res.* 39, 1163–1171
- Hansson, T. & Öberg, T. 1971. En kliniskt-bettfysiologisk undersökning av 67-åringar i Dalby. *Tandläk. Tidn.* 63, 650–655
- Hegna, H., Jarlov, N.V., Laine, V. & Lövgren, O. 1973. *Reumatologi. Praktisk vägledning.* Almqvist & Wiksell, Stockholm. 2nd revised edition. pp 9–10
- Helkimo, M. 1974a. Studies on function and dysfunction of the masticatory system. I. An epidemiological investigation of symptoms of dysfunction in Lapps in the north of Finland. *Proc. Finn. Dent. Soc.* 70, 37–49
- Helkimo, M. 1974b. Studies on function and dysfunction of the masticatory system. II. Index for anamnestic and clinical dysfunction and occlusal state. *Sven. Tandläk. Tidskr.* 67, 101–119
- Helkimo, M. 1974c. Studies on function and dysfunction of the masticatory system. III. Analyses of anamnestic and clinical recordings of dysfunction with the aid of indices. *Sven. Tandläk. Tidskr.* 67, 165–182
- Kellgren, J.H. & Moore, R. 1952. Primary generalized osteoarthritis. *Br. Med. J.* 1, 181–187
- Kellgren, J.H., Lawrence, J.S. & Bier, F. 1963. Genetic factors in generalized osteo-arthritis. *Ann. Rheum. Dis.* 22, 237–255
- Kopp, S. 1972. Käkledsartros. Litteraturstudie och undersökning av 20 patienter. *Tandläk. Tidn.* 64, 534–544
- Kopp, S. 1976. Reproducibility of response to a questionnaire about symptoms of masticatory dysfunction. *Community Dent. Oral Epidemiol.* 4, 205–209
- Kopp, S. 1977. The constancy of clinical signs in patients with mandibular dysfunction. *Community Dent. Oral Epidemiol.* 5, 94–98
- Krogh-Poulsen, W. 1974. Klinisk undersøgelse. In *Bidfunktion/Bettfysiologi.* Ed. Krogh-Poulsen, W & Carlsen, O. Copenhagen. pp 353–395
- Laine, V. 1968. Report from the subcommittee on diagnostic criteria for osteoarthritis. In *Population studies of the rheumatic diseases.* Ed. Bennett, P.H. & Wood, P.H.N. International congress series No. 148. Excerpta Medica Foundation. Chapter 58. pp 417–419
- Moffett, B.C., Johnson, L.C., McCabe, I.B. & Askew, H. 1964. Articular remodelling in the adult human temporomandibular joint. *Am. J. Anat.* 115, 119–142
- Molin, C., Carlsson, G.E., Friling, B. & Hedegård, B. 1976. Frequency of symptoms of mandibular dysfunction in young Swedish men. *J. Oral Rehabil.* 3, 9–18
- Öberg, T., Carlsson, G.E. & Fajers, C.M. 1971. The temporomandibular joint. A morphologic study on a human autopsy material. *Acta Odont. Scand.* 29, 349–384
- Odén, A. & Wedel, H. 1975. Arguments for Fisher's permutation test. *Ann. Stat.* 3, 518–520
- Ramfjord, S.P. & Ash, M.M. 1971. *Occlusion.* W.B. Saunders Co., Philadelphia, pp 185–192
- Rosell, C.-G. & Öberg, T. 1975. Remissorsak: «Käkledsbesvär». Undersökning av ett patientmaterial vid en centraltandpoliklinik. *Tandläk. Tidn.* 67, 941–950
- Scott, W.A. 1955. Reliability of content analysis: The case of nominal scale coding. *Public Opinion Q.* 19, 321–325
- Sokoloff, L. 1969. *The biology of degenerative joint disease.* The University of Chicago Press. Chicago. pp 1–4, 24–30
- Toller, P.A. 1974. Temporomandibular arthropathy. *Proc. R. Soc. Med.* 67, 153–159