Histological changes in temporomandibular joints from elderly individuals

An autopsy study

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Our aim was to study microscopically the disc position and structural tissue changes such as disc perforation of the temporomandibular joint (TMJ). An autopsy material comprising the right and left TMJ from 21 individuals with a mean age of 75 years was studied. Anterior disc position was found in 11 joints from 8 individuals. Discs in anterior position were most often of even thickness or convex, whereas most discs in normal position were concave. Perforation was found in the central dense part of the disc in one joint and in the posterior disc attachment of five joints. The latter five discs were in anterior position. Of the five joints with anterior disc position and perforation of the posterior attachment, four joints showed marked structural changes also in the condyle and temporal component. Such changes were found only in one of six joints with anterior disc position but without perforation. No signs of cellular inflammation were observed in any of the joints. Fibrous ankylosis was found in four joints from three individuals. Joints with anterior disc position comprised more than one fourth of the examined joints. In some of these joints there were no structural changes; in other of these joints disc perforation was combined with convex disc form and marked structural changes of the condyle and temporal component. □ *Ankylosis; histopathology; osteoarthritis; temporomandibular joint diseases*

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The central thin portion of the disc of the human temporomandibular joint (TMJ) is assumed to be ideally located between the anterosuperior part of the mandibular condyle and the posterior part of the articular eminence with occluded teeth. Deviation in disc position has been observed frequently, however, both in autopsy studies (1–3) and in patients with disorders of the stomatognathic system (4). Knowledge is lacking concerning the frequency of deviations in disc position in the symptom-free TMJ. In the clinical studies the position of the disc has been determined by arthrography or computer tomography (5, 6). In anterior disc displacement the major dense part of the disc is forced forward during mouth opening and the posterior disc attachment thereby abnormally stretched. There are reasons to suspect that structural or reactive changes might then occur, particularly of the posterior attachment.

In addition to anterior disc displacement and degenerative changes, chronic inflammatory joint diseases like rheumatoid arthritis (RA), ankylosing spondylitis, psoriatic arthritis, and gout may afflict the TMJ.

The aim of this study was to investigate the microscopic appearance of the TMJ in elderly individuals, with specific attention to disc position. In this connection the form of the disc and structural changes such as disc perforation and cellular signs of inflammation of the joint were to be studied.

Materials and methods

Autopsy material

The right and left TMJ specimens were

Table 1. Age and sex distribution of the 21 individuals

	Age, n 60–69 years	70–79 years	80–89 years	Total, n	Mean age, years
Women	2	3	3	8	76
Men	3	7	3	13	74
Total	5	10	6	21	75

removed as blocks in 21 individuals, 8 women (mean age, 76 years) and 13 men (mean age, 74 years; Table 1), who before death had donated their bodies to research. Immediately after removal, the TMJ specimens were fixed in a 10% neutralized buffered formalin solution.

Histologic technique

The specimens were demineralized in 0.5 M ethylenediaminetetraacetate (Na_2H_2-EDTA) for 16 to 20 weeks and were then embedded in paraffin. Two sagittal sections, 6 and 10 μm thick, were cut at every millimeter from the most lateral aspect of the joint to the most medial. The 6-μm sections were stained with Mayer's hemalun-eosin solution (7). The 10-μm sections were immersed in a solution of 0.1 g toluidine blue O and 100 ml 1 *N* HCl (pH 0.5) to stain the sulfated glycosaminoglycans metachromatically (8). Identically treated sections of a demineralized rabbit knee joint were used as controls for the toluidine blue staining.

Microscopic examination

The central section from the lateral, central, and medial thirds of the joints was investigated with regard to the following:

Position and form of the disc. The sagittal sections were projected and magnified 10-fold on a screen, and drawings were made of the outlines of the joint components. In the assessment of disc position, the position of the central part of the disc composed of dense connective tissue was determined in relation to the articulating posteroinferior part of the eminence and the anterosuperior part of the condyle. Position was considered to be normal when the central dense part of the disc was located between the posteroinferior part of the eminence and the anterosuperior part of the condyle (Fig. 1) and anterior when the central dense part of the disc was anterior to these structures (Fig. 2a). The form of the disc was judged as concave (Fig. 1) (minimum thickness in the central part), even thickness, or convex (Fig. 2a) (maximum thickness in the central part).

Structural changes in the articulating surfaces. Structural changes in the disc including

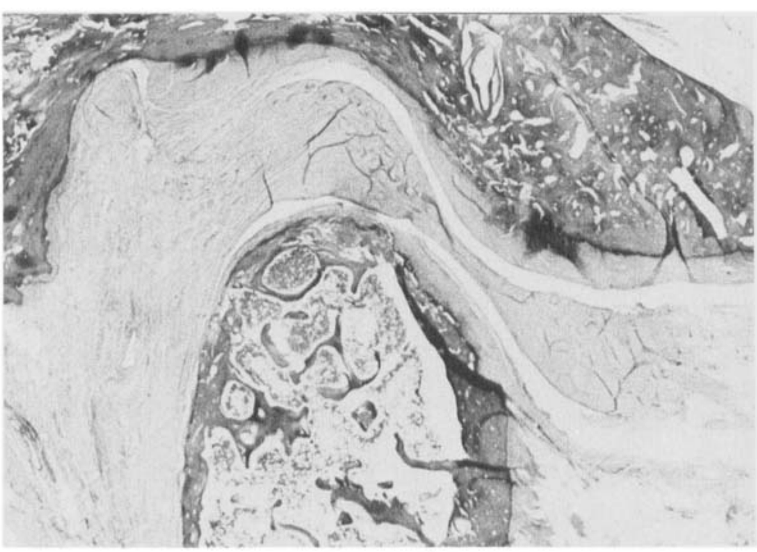

Fig. 1. Photomicrograph of the lateral third of a right TMJ with the disc in normal position and with concave form.

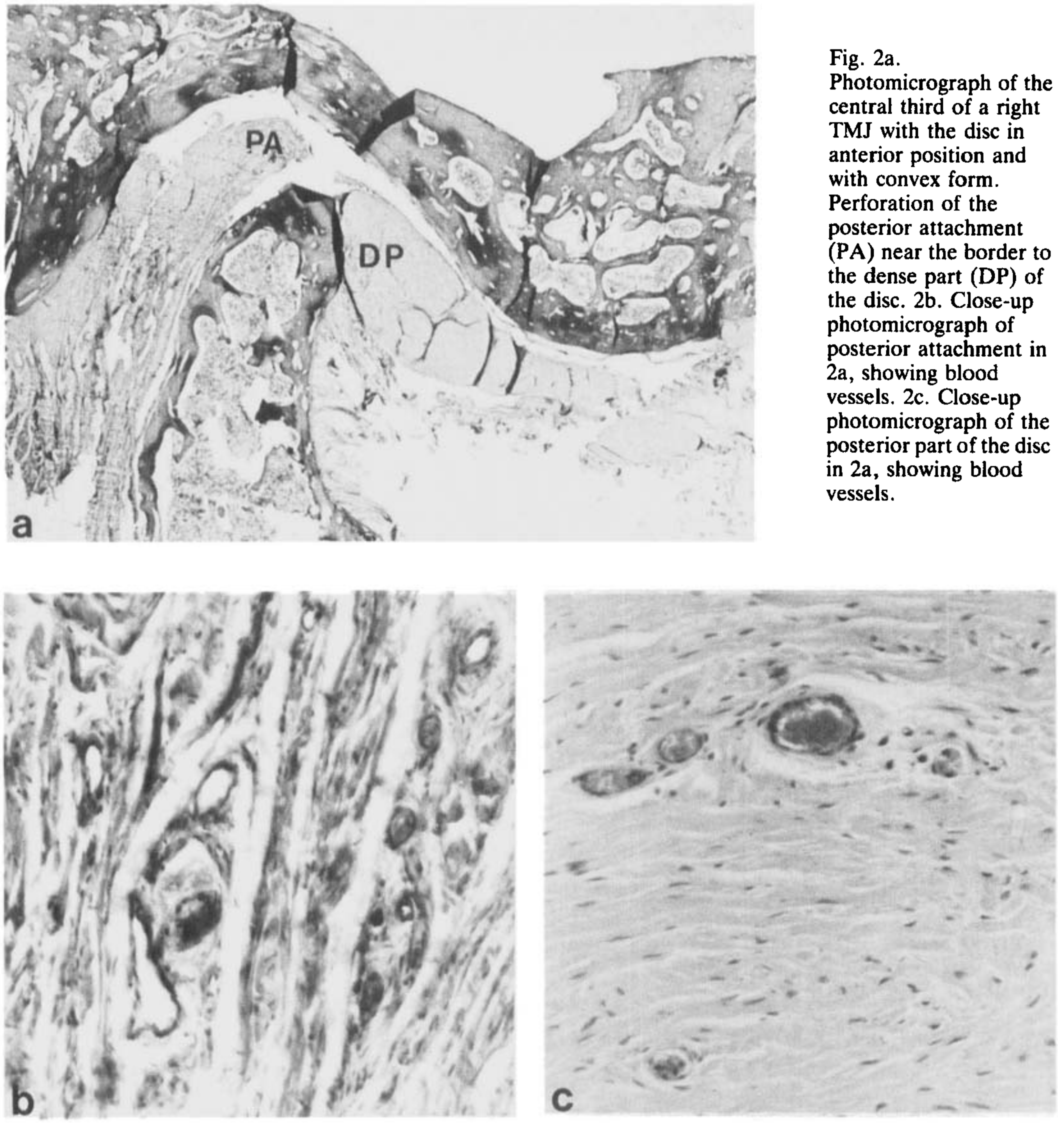

Fig. 2a. Photomicrograph of the central third of a right TMJ with the disc in anterior position and with convex form. Perforation of the posterior attachment (PA) near the border to the dense part (DP) of the disc. 2b. Close-up photomicrograph of posterior attachment in 2a, showing blood vessels. 2c. Close-up photomicrograph of the posterior part of the disc in 2a, showing blood vessels.

the posterior attachment were classified as mild when superficial fraying and disruption of fiber bundles were observed and as marked when perforation was present. In the condyle and temporal component superficial structural changes were classified as mild, and total loss of the articular soft tissue surface was classified as marked. Changes in soft tissues and bone were determined by tissue morphology after staining with Mayer's hemalun-eosin solution and by metachromasia after staining with toluidine blue.

Inflammation and repair. The presence of blood vessels and cell-rich connective tissue was recorded in the articulating joint surfaces. The presence of polymorphonuclear or mononuclear cells was considered cellular signs of inflammation.

Statistics

The interindividual correlation between disc position, disc form, and structural changes was tested for statistical significance with the chi-square test for two independent samples.

Results

Position, form, and histologic appearance of the disc

The position and form of the disc could not be assessed in four joints with fibrous ankylosis and in one joint because of oblique embedding of the specimen. The frequency of the disc positions is shown in Table 2. Most discs had a normal position in the entire joint. Totally, the disc was found in anterior position in 11 joints from 8 individuals, including 6 joints in which the position varied with location within the joint. Half of the women and one third of the men had anterior disc position. The form of the disc varied greatly, and it was difficult to systematize the form of all discs into only a few categories. The upper and lower contours of the disc differed. The upper contour of the disc was well adapted to the surface of the S-shaped temporal component in all joints except the four joints with fibrous ankylosis. The lower contour of the disc was adapted to the upper surface of both the condyle and the lateral pterygoid muscle. When the muscle was inserted superiorly on the condyle, the anterior part of the disc was of even thickness. The frequency of the disc forms is shown in Table 2. Eleven discs were concave and one was convex through the entire joint. No disc was of even thickness through the entire joint. Even thickness of the disc was more frequent in the lateral and medial thirds than in the central third of the joint. Ten of the 13 discs with even thickness in the lateral third were concave in the central third.

Anterior disc position was positively correlated to convex disc form in the lateral (right/left: $p < 0.01$), central (right: $p < 0.05$; left: $p < 0.01$), and medial (right: $p < 0.02$; left: $p < 0.1$) thirds of the joints. Most discs in normal position were concave. Three discs were concave and positioned anteriorly in the central or medial third of the joint.

Table 2. Form and position of the disc in the lateral, central, and medial thirds of the right and left temporomandibular joints of 20 individuals. No. of joints = 37

	Disc position											
	Lateral				Central				Medial			
	Right		Left		Right		Left		Right		Left	
Disc form	Normal	Anterior	Normal	Anterior	Normal	Anterior	Normal	Anterior	Normal	Anterior	Normal	Anterior
Concave	7	0	12	0	10	2	15	1	7	1	11	0
Even thickness	8	0	3	2	1	1	1	1	5	1	4	1
Convex	0	2	0	3	0	3	0	2	0	3	2	2
Total	15	2	15	5	11	6	16	4	12	5	17	3
	17		20		17		20		17		20	

The disc was composed of dense fibrous connective tissue with chondroid cells. A hyaline zone was seen in some joints on the inferior surface, with numerous chondroid cells and abundant ground substance metachromatic at pH 0.5.

In most joints the posterior disc attachment was composed of an upper fibrous stratum attached at different levels to the posterior wall of the glenoid fossa and a lower fibrous stratum attached to the back of the condylar neck. The bilaminar region between these strata consisted of a loose fibrous connective tissue containing blood vessels (Fig. 2b) and was thereby separated from the disc. In some of the joints with the disc in anterior position the posterior attachment was thin and elongated.

Structural changes

The distribution of structural changes is shown in Tables 3 and 4. Most of the discs showed no structural changes. In six joints—that is, one-sixth of the joints—there was a perforation. The perforation was localized to the posterior disc attachment in five joints and to the central dense part of the disc of one joint. There was a positive correlation between anterior disc position and perforation of the posterior attachment ($p < 0.02$). Around the perforations in the posterior

Table 3. Structural changes and position of the disc of the right and left temporomandibular joints of 20 individuals. No. of joints = 37

Structural changes of the disc	Disc position				
	Right		Left		
	Normal	Anterior	Normal	Anterior	Total
Absent	9	1	10	2	22
Mild	2	1	5	1	9
Marked (perforation)					
Central	0	1	0	0	1
Posterior	0	3	0	2	5
Total	11	6	15	5	37

Table 4. Structural changes of the condyle and temporal component and disc position of the right and left temporomandibular joints of 20 individuals. No. of joints = 37

Structural changes	Disc position				
	Right		Left		
	Normal	Anterior	Normal	Anterior	Total
Absent					
Condyle	8	2	6	1	17
Temporal component	5	2	6	1	14
Mild					
Condyle	3	3	7	1	14
Temporal component	6	2	5	1	14
Marked					
Condyle	0	1	2	3	6
Temporal component	0	2	4	3	9

attachment the edges were either thick or thin, whereas the edges around the perforation of the central dense part were thin.

The correlations between anterior disc position and structural changes of the condyle and of the temporal component were not statistically significant, although four of the five joints with both anterior disc position and perforation of the posterior attachment showed marked structural changes in the other components. In these joints the disc was convex. Numerous blood vessels could be observed, especially in the posterior part of the disc (Fig. 2c) but also in the articular soft tissue lining of the posteroinferior part of the eminence (Fig. 3). Furthermore, increased thickness of the soft tissue articular lining on the inferior part of the eminence and the superior part of the condyle with associated bone resorption was found at the border between the bone and the mineralized soft tissue layer. In two of the joints with perforation of the posterior attachment there was a markedly thickened soft tissue lining in the roof of the fossa (Fig. 4) which contained numerous chondroid cells with surrounding metachromatic staining. Of the five joints with anterior disc position but without disc perforation there were mild structural changes in the condyle and temporal component in four joints. There were no structural changes of the condyle and temporal component in 6 of 26 joints with normal disc position and in 2 of 11 joints with anterior disc position.

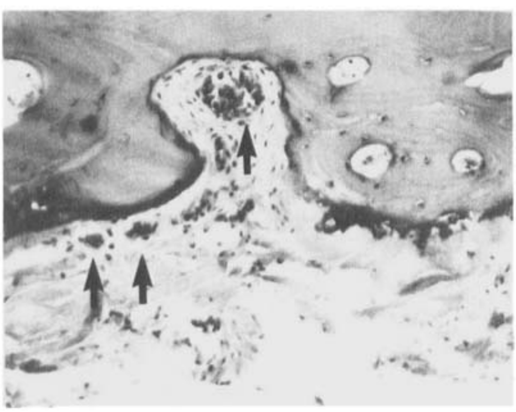

Fig. 3. Photomicrograph of the soft tissue lining of the posterior slope of the eminence, which is highly vascularized (arrows). Section taken from a TMJ with perforation of the posterior attachment and vascularization in the posterior part of the disc and structural changes of the eminence and condyle.

Fig. 4. Photomicrograph of a right TMJ with a large disc perforation, showing increased thickness of the soft tissue lining in the roof of the fossa into a dense fibrous connective tissue with numerous chondroid cells and metachromasia with toluidine blue at pH 0.5.

Inflammation and repair

No cellular signs of inflammation could be found in any of the joints. Fibrous ankylosis was found in four joints from three women. Information about medical history was available for two of them, and they were diagnosed as having RA. In the joints with fibrous ankylosis the ordinary articulating soft tissue lining was absent. A connective tissue rich in fibers, cells, and blood vessels filled the space between the bony surfaces of the condyle and temporal component (Fig. 5). The bony surfaces showed marked resorption, sometimes with osteoclasts. In these joints no signs of progressive remodeling could be observed on the bony surface, in contrast to the joints with structural changes of degenerative nature.

Discussion

The determination of disc position in this study was made with the condyle in a single position—that is, in the center of the fossa. However, in histological sections the relation between the disc, condyle, and temporal component is more accurately determined

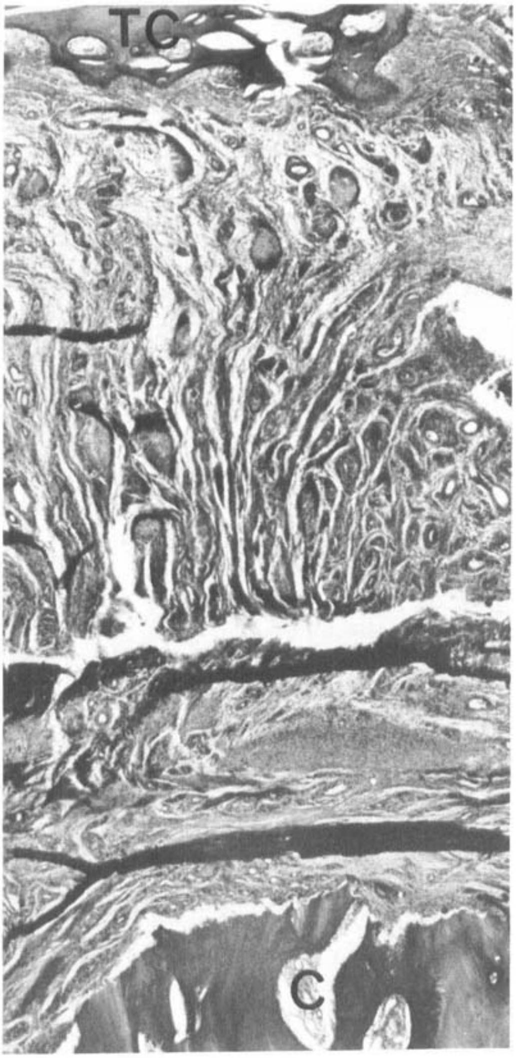

Fig. 5. Photomicrograph of a TMJ with fibrous ankylosis. The joint space between the temporal component (TC) and the condyle (C) is filled with a connective tissue rich in fibers, cells, and blood vessels. The bony surfaces show marked resorption.

than in macroscopic examination. In some joints with anterior position the disc was concave, which was also found by Westesson & Rohlin (2) and Solberg et al. (9), and in addition, half of the joints with the disc in anterior position showed no or mild structural changes. These findings indicate that anterior disc position in some joints can exist as a variant of normal anatomy. Clinical follow-up studies of joints with anterior disc position in individuals free from symptoms of the stomatognathic system other than clicking might elucidate these assumptions.

Since the disc form varied greatly, it was difficult to classify it in accordance with recently described definitions—that is, as biconcave, biplanar, or biconvex (2, 10). Choukas & Sicher (11) claimed that the description of the disc in the literature as a biconcave plate is not correct. In the present study, as in previous studies (3, 11–14), the form of the disc was found to be adapted to the surrounding joint components. The disc was relatively even in thickness in the newborn (12, 15, 16) and later developed into different forms. In describing these forms, we found the thickness of the central part of the disc to be the crucial point. A lower height of the eminence laterally and medially than centrally (17) corresponded well with the more frequent even thickness of the disc in the lateral and medial thirds than in the central third. Remodeling of the articular surfaces might also result in more discs of even thickness in elderly individuals than in the average population. As a consequence of this even thickness, assessment of disc position with tomoarthrography or computer tomography will be more difficult in the lateral and medial parts of the joint, where the tomographic imaging also is limited (18). The even thickness and convex form was more frequent in discs in anterior position than in normal position, an observation also made by Westesson & Rohlin (2).

In autopsy studies perforation of the disc has been reported to occur most frequently in the lateral aspect of the central thin, dense part (2, 19–21). However, in clinical studies (11, 14, 22, 23) perforation in the posterior part of the disc has been reported to be a frequent finding, in accordance with this study. The ability to detect disc perforations located at the junction between the posterior band and the posterior attachment and within the posterior attachment in autopsy studies depends partly on the dissection technique. The most probable reason that perforations of the posterior attachment have not been observed in most previous autopsy studies is that the posterior attachment of the disc has been cut at dissection, to facilitate the macroscopic analysis of the joint. When no systemic inflammatory joint disease is involved, disc perforations in the central part are generally ascribed to degenerative joint disease (24). This is probably true also for the posterior perforations in discs with anterior position, since an anterior position of the disc can be expected to result in loading of the soft vascularized posterior attachment. The observation that four of five joints with anterior disc position and perforation of the posterior attachment also had marked structural changes in the condyle and temporal component indicates that joints with anteriorly positioned discs and perforation of the posterior disc attachment are vulnerable to further degenerative changes.

No signs of cellular inflammation were found in the posterior attachment of discs in anterior position or in the vicinity of disc perforations. This finding is in accordance with the report by Hall et al. (25) that no significant inflammation was observed in specimens of the bilaminar zone of discs removed from 26 joints of patients with internal derangement and pain in the TMJ.

Ankylosis of the TMJ is rarely reported in patients with degenerative or inflammatory joint disease of the TMJ (26), although the terminal stage in the progression of RA is more or less fibrous or bony ankylosis (27). Reports of ankylosis are also scant in autopsy studies, and we found only one such joint reported by Bean et al. (28) and another by Solberg et al. (9). The number of joints with fibrous ankylosis in this study is notable but may be due to the advanced age of the individuals, since the prevalence of inflammatory joint diseases increases rather sharply with age (29). Fibrous adhesions between the joint surfaces often occur as a result of healing of an inflammatory joint disease, which was probably the case for the two individuals with RA in this study.

The results of this study warrant the following conclusions about TM joints from the elderly: Anterior disc position and structural changes such as disc perforation are common. The form of the disc frequently deviates from the concave in the lateral and medial part of the joint. Anterior disc position is frequently associated with convex disc form and perforation of the posterior attachment of the disc.

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