Tissue reactions associated with internal derangement of the temporomandibular joint

A radiographic, cryomorphologic, and histologic study

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Ten temporomandibular joint specimens, five with clinical signs of arthropathology and five without, were examined by means of tomography, double-contrast tomography, and serial cryosectioning combined with histologic staining of sections for tissue identification. Of the five joints with signs of arthropathology four demonstrated disc displacement. The fifth joint showed a post-traumatic condition. Four of the joints with clinical signs of arthropathology demonstrated hyperplastic connective tissue retaining contrast medium in the posterior part of the fossa. This hyperplastic connective tissue contained extravasated blood and enlarged cavernous structures lacking endothelial lining. Extravasated blood is one probable source of temporomandibular joint pain. All joints with permanently displaced discs demonstrated perforation of a hyalinized posterior disc attachment. Without tissue identification such an attachment is likely to be misinterpreted as being the disc itself. □ *Arthrography; hyaline; hyperplasia; perforation*

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Internal derangement of the temporomandibular joint (TMJ) by means of anterior disc displacement is a pathophysiological abnormality of considerable frequency. In an autopsy material, histologically sectioned, Hansson et al. (1) reported a frequency of partial or total disc displacement of 11.6% in young adults (mean age, 26 years). TMJ autopsy specimens from elderly individuals (mean age, 74 years) have disclosed 34% of the discs to be anteriorly displaced and an additional 22% to be obliquely positioned (2).

Many patients with TMJ internal derangement have severe pain (3–5). The factors triggering joint pain are not fully known. In joints in which the entire disc is anteriorly displaced the posterior disc attachment and the posterior part of the capsule are pulled forward between the bony joint components and compressed (6). In such cases, pain is likely to be released from compressed nerve branches. Joint pain sometimes remains, however, after surgical disc repositioning or disc extirpation (7, 8).

A fracture of the condylar neck, although successfully healed without any radiographic signs of hard tissue changes or evidence of internal derangement, may also result in chronic joint pain.

Studies that have correlated TMJ radiology and morphology have focused on the hard tissue components (9–11) and on disc location and configuration (2).

The aim of this investigation was to gain further information about soft tissue changes of the TMJ by correlating tomographic and arthrographic findings with histology.

Materials

Fifty-five left TMJ autopsy specimens were removed *en bloc* through the middle cranial fossa from randomly chosen cadavers. The joints were consecutively numbered from 1 to 55. Information on possible TMJ symptoms before death was not available. Eighteen joints showed signs of arthropathology with regard to crepitations, clicking, or lim-

Table 1. Age, sex, and clinical signs of pathological condition in the 10 cadavers from which the TMJ specimens were obtained

Subject no.	Age, years	Sex	Signs of pathological condition
3	85	M	Slightly reduced protrusive range
5	75	M	Reduced protrusive range, crepitations
9	77	F	—
22	78	F	—
31	77	F	—
33	54	F	Reduced protrusive range
39	79	F	—
43	74	M	—
46	75	F	Crepitations
53	69	F	Clicking

ited range of movement when the mandible was moved manually forwards and backwards. Five of these (nos. 3, 5, 33, 46, and 53) were randomly selected for the present study. Another five joints (nos. 9, 22, 31, 39, and 43) without arthropathologic signs were randomly chosen to serve as reference. The TMJs were obtained from individuals with a mean age of 74 years. Sex, age, and clinical signs of arthropathology are presented in Table 1.

Methods

The joints were stored at −20 °C and thawed to room temperature before radiographic examination. The radiographic examinations included lateral corrected tomography to evaluate hard tissue changes and double-contrast arthrotomography to study the joint compartments, the articulating surfaces, and the configuration and the position of the disc.

Positioning device

During radiography the specimens were placed in a positioning device and fixed with the condylar long axis parallel to the central X-ray beam.

Lateral tomography

Lateral tomography was performed throughout the joint, using a Philips Universal Polytome and hypocycloidal movements, 55 kVp and 39 mAs. The X-ray tube was an SRO 1230, with a focal spot of 0.3 mm and a beam cross-section of 60 mm × 60 mm. Simultaneous tomography was carried out with a cassette with five pairs of intensifying screens (Siemens Simultan Verstärkerfolien) and five films (Ilford Rapid R). The interspace was 2 mm. No grid was used.

Double-contrast tomography

Double-contrast tomography (12) was performed with the condyle in the fossa and in condylar protrusion, respectively. Injections of the iodine contrast medium metrizamide (Omnipaque®, 300 mg I/ml; Nycomed AS, Oslo, Norway) and air into both joint compartments was followed by serial lateral tomography depicting 20 tomographic layers at 1-mm intervals. The level of the tomographic sections was established with an indicator device.

After radiography the air was replaced by a mixture of toluidine blue and carboxymethyl-cellulose, filling the upper and lower joint compartments to support the soft tissues during cryosectioning.

Cryosectioning

Immediately after radiography the joints, without being detached from the positioning device, were embedded in carboxymethylcellulose, immersed in CO_2-cooled hexane, and frozen to a block. The frozen block was transferred to a cryomicrotome (LKB 2250, LKB, Stockholm, Sweden), and the cutting plane was made parallel to the tomographic plane. The level of cryosectioning was checked with the previously mentioned indicator device. The block was sectioned throughout the joint, and serial frozen sections were collected on tape (No. 0154, 3M, St. Paul, Minn., USA). The cutting surface was photographed at intervals of 0.5 mm with a magnification of 1:1 and 1:2. This was performed with a macrolens and Kodachrome 64 film. An electronic flash was angled 45° to the cutting surface (2, 10). The frozen sections were fixed in neutral-buffered 4% formaldehyde solution (Histofix, Histolab, Gothenburg, Sweden) and stained with hematoxylin/eosin and hematoxylin/van Gieson for tissue identification.

Results

Joints without clinical signs of arthropathology

The five joints without any clinical signs of arthropathology showed no or minor tissue alterations, comprising flattening of the outline of the condyle and articulating tubercule and local thickening of the articulating soft tissue layer (Fig. 1). The hard tissue changes were within the expected range of remodeling found in TMJs from elderly individuals. All reference joints had the disc in a normal superior position (Fig. 1) with the posterior thick band of the disc above the condyle and in the fossa. No hyperplastic connective tissue in the fossa or vascular changes were found in any of these joints.

Joints with clinical signs of arthropathology

Four of the five joints with clinical signs of arthropathology demonstrated disc displacement, one with reduction (clicking) and three without reduction (closed lock). One joint showed a post-traumatic condition associated with a previous fracture of the condylar neck.

Joints with disc displacement

In three of the four joints with disc displacement the disc was displaced anteriorly to the condyle, whereas in the fourth joint dislocation was anterolateral.

Hard tissue changes registered in the tomograms were seen in three of the four joints with disc displacement—that is, those with nonreducing discs. The alterations consisted of thickenings and discontinuity of the compact bone layer, condylar osteophyte formation, flattening of the condyle, and articulating tubercle.

Cryomorphologic pictures and histologic sections confirmed the tomographic findings and added further information. The osteophytes were composed of normal compact bone, thicker than cortical bone from other parts of the condyle. The central portion of the osteophytes contained normal bone marrow spaces filled with hematopoietic cells. Histologic sections also disclosed local defects in the cortical bone filled with connective tissue and cartilage. In all four joints with disc displacement, the articulating collagenous cartilage layer showed extensive variations in thickness.

Changes of the disc and its attachments registered during double-contrast arthrograms were seen in all four joints. Thus disc displacement was consistently associated with an altered disc configuration. Two discs had a biconcave shape, but the posterior band was considerably thickened (Fig. 2). One disc was biconvex with bulges on the inferior surface (Fig. 3), whereas the anterolaterally displaced disc was thin and of even thickness. Because of the anterolateral displacement the joint compartments showed grossly enlarged recesses latero-inferiorly.

In three of the joints with displaced discs, extensive retention of contrast medium was seen in tissue located within the posterior part of the fossa (Fig. 2). The cryomorphologic pictures and histologic sections showed this tissue to be hyperplastic connective tissue. The hyperplastic connective tissue and the posterior disc attachment were rich in extravasated blood, giving the tissue a flashy red color, and contained cavernous structures lacking endothelial lining in two cases. No inflammatory cell aggregates were present. The disc attachment compressed between the condyle and temporal joint component showed considerable areas of connective tissue hyalinization (Fig. 4). Perforation of the posterior disc attachment was found in three of the four joints with displaced discs.

Post-traumatic joint

Tomography of the joint showed bony healing comparable to that found after previous condylar neck fractures (Fig. 5A). Double-contrast arthrography showed a local thickening of the articulating collagen/cartilage layer of the posterior slope of the articular eminence. Cryomorphologic pictures and histologic examination added information concerning the extensive soft tissue changes in the posterior attachment and posterior joint tissue (Fig. 5B). The normal loose connective tissue of the posterior attachment was replaced by a hyperplastic dense collagenous tissue containing widened vessels, and large blood-filled cavernous structures lacking endothelial lining and extravasated erythrocytes were found, giving the tissue a flashy red color. However, no inflammatory cell aggregates could be detected. The pathologically altered posterior attachment had a broad-based adherence to the posterior-superior part of the fossa. Posterior to the neck of the condyle and on a level with the previous fracture, the temporal artery demonstrated advanced degeneration, and normal arterial architecture was lost. The arterial walls and surrounding structures showed fibrinoid necrosis. The vessel was surrounded by a halo of extravasated blood. No giant cells were present.

Discussion

The present investigation describes hyperplastic tissue formation in the posterior part of the glenoid fossa associated with internal derangement. This tissue retained contrast medium and could be seen clearly on double-contrast arthrograms. This arthrographic feature is a sign of a pathological condition and should be recognized.

Fig. 1. Normal TMJ relationship. A cryomorphologic picture of a TMJ. The condyle is seated in the fossa. The posterior band of the disc (arrow) superior to the condyle and central thin part between the condyle and posterior slope of the tubercle are in normal positions. The upper joint compartment is filled with toluidine blue. The diameter of the indicator circles is 1 mm.

Fig. 2. Anteriorly displaced disc with deformity and perforation of posterior attachment. Lateral double-contrast arthrotomogram (A) with a corresponding cryomorphological picture (B). The arthrotomographic picture of a biconcave disc with thickened posterior band (arrow) and anteriorly displaced is confirmed after cryosectioning. The posterior attachment is perforated. Thickening of the compact bone layer of the fossa and articular tubercle together with osteophyte formation on the anterior part of the condyle is seen. The posterior part of the glenoid fossa is occupied by hyperplastic connective tissue (C), which retains the contrast medium. The diameter of the blue indicator circles is 1 mm.

Fig. 3. Anteriorly displaced, deformed disc. Lateral double-contrast arthrotomogram (A) and a corresponding cryomorphologic picture (B). The arthrotomographic diagnosis of a biconvex disc, anteriorly displaced (large arrow), was confirmed after cryosectioning. The posterior attachment is perforated. Tissue irregularities are seen on the inferior disc surface (small arrows). The diameter of indicator circles is 1 mm.

Our study suggests that disc displacement and also trauma can be associated with tissue changes in the TMJ area not detectable by radiography. Concomitant with disc displacement, but not in joints with normal disc position, the posterior disc attachment and joint capsule were shown to contain tissue with widened vessels and large, blood-filled, cavernous structures lacking endothelial lining. In joints with displaced discs, the condyle is likely to compress this area during mouth closure and cause rupture of vessels, resulting in extravasation of erythrocytes.

Sources of joint pain associated with disc displacement could be compression of nerves in the posterior attachment/capsule and also breakdown products from the extravasated blood. The temporal artery in one of the cases showed advanced degenerative changes related to TMJ abnormality. This vascular reaction could be another source of pain.

Fig 1

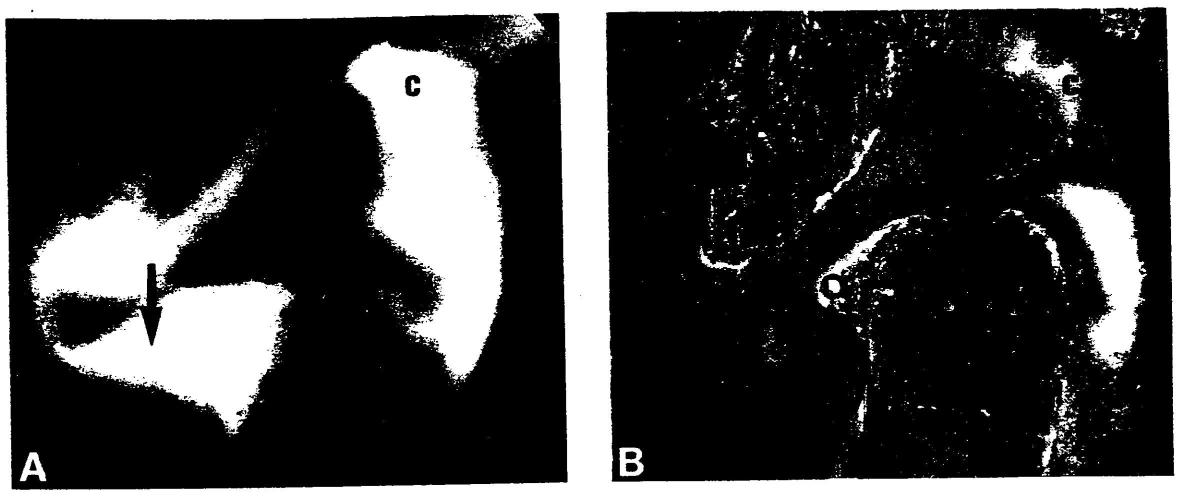

Fig 2

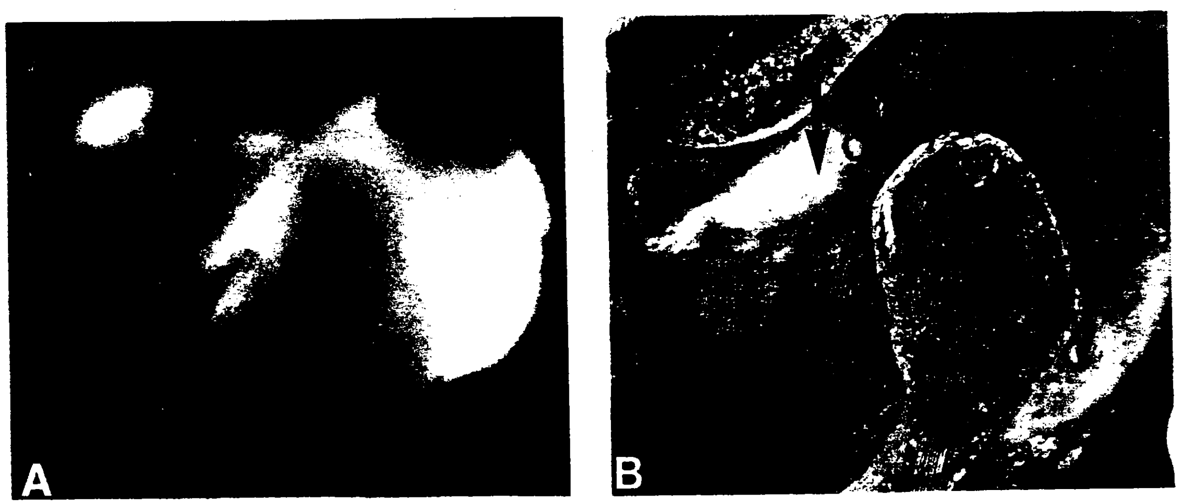

Fig 3

Fig 4

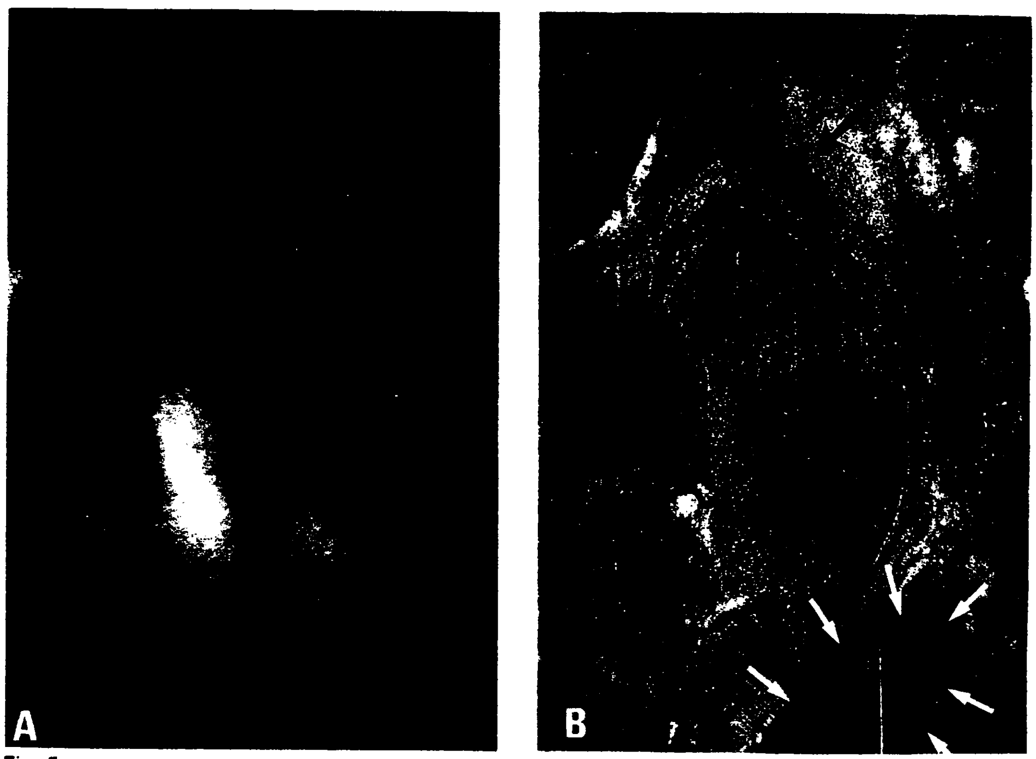

Fig 5

Fig. 4. Anteriorly displaced disc with trapped hyalinized attachment. Cryomorphologic picture demonstrating a biconcave anteriorly displaced disc. The large arrows indicate the anterior and posterior bands. The small arrows indicate an elongated hyalinized posterior disc attachment above a flattened condyle. The fossa is filled with hyperplastic vascularized connective tissue (C). The diameter of indicator circles is 1 mm.

Fig. 5. Temporomandibular joint with healed fracture. Lateral tomogram (A) and a corresponding cryomorpological picture (B). The disc (D) is in a normal position between the articular tubercle and condyle. The neck of the condyle demonstrates healing of the condylar fracture. The cryomorphologic picture shows that the posterior joint compartments are filled with hyperplastic connective tissue containing large cavernous structures (black arrows) surrounded by extravasated erythrocytes, giving the tissue its red color. The walls of the temporal artery exhibit a pronounced fibrinoid necrosis and a halo of extravasated blood (white arrows).

In the cases of disc displacement the posterior disc attachment/capsula was pulled between the bony joint components and thus compressed. The hyalinization of the attachment seen in these cases is interpreted as a tissue adaptation to load. This tissue does not, however, seem fit to resist compression, since perforations had developed in all three cases of permanently displaced discs but not in joints with normal disc position.

A hyalinized and perforated attachment, if viewed from above, and not in a cross-section, may be interpreted as the disc itself. During arthroscopy, surgery, or dissection of such cases the diagnostic interpretation would then be osteoarthrosis with a perforated disc in a normal superior position. The disc is in fact anteriorly displaced with a hyalinized and perforated posterior disc attachment. This is a probable explanation for the differing evaluations of disc position reported during arthroscopy of patients with typical clinical signs of anterior disc displacement (14).

Local soft tissue thickenings of the temporal joint component, as seen in this study, may cause radiographic misinterpretation if double-contrast arthrography is not used. After disc perforation a reduced joint space is expected. A soft tissue thickening of the articulating surfaces will create a false image of a normal joint space, since this thickening is radiolucent. This should be borne in mind when using the radiographic width of the joint space as an indicator of the presence or absence of disc perforation in interpreting TMJ radiographs without contrast medium.

Osteoarthrosis has been shown to be associated with TMJ disc displacement and suggested to be a late manifestation of disc displacement (15, 16); this is supported by the findings in our study. The one joint with disc displacement with reduction (clicking) demonstrated less alteration than the three joints with non-reducing discs. The latter consistently showed histological features suggesting degenerative changes of the articulating surfaces. Such alterations were not present in the reference joints with a normal disc position and of equivalent mean age.

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