Diagnostic Accuracy of Double-Contrast Arthrotomography of the Temporomandibular Joint: Correlation with Postmortem Morphology

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The diagnostic accuracy of double-contrast arthrotomography in the evaluation of internal derangement of the temporomandibular joint is unknown. Therefore, findings from double-contrast arthrotomograms of 48 temporomandibular joint autopsy specimens were correlated with postmortem morphology seen from dissections or cryosections. Arthrotomographic diagnosis was confirmed in 41 joints, signifying a diagnostic accuracy of 85%. Misinterpretations were made in seven joints (three concerning the configuration, three concerning the position, and one concerning the configuration and position of the disk). False-positive reports due to observation errors can be avoided with improved knowledge of the joint anatomy as well as with increased experience in the technique. False-negative examinations were due to limitation of the tomographic reproduction of the lateral part of the joint.

Temporomandibular arthrography [1] has recently gained increasing acceptance as a diagnostic tool for evaluating internal derangements of the joint, such as changes in the configuration and position of the disk [2–9]. Tomography [10, 11] simplifies the interpretation of the arthrograms by eliminating overlapping structures. Further, the double-contrast technique, shown to be superior for the examination of other joints [12–14], has also been introduced for the temporomandibular joint [15–19].

Due to the anatomy and location of the temporomandibular joint, it is difficult to accurately evaluate the configuration and position of the disk during surgery. Nevertheless, attempts have been made to correlate single-contrast arthrographic and surgical findings. On the basis of such correlations, arthrographic accuracy has been reported as 81%–97% [1, 7, 20]. Three examples of disk perforations diagnosed by arthrography, but not revealed during surgery, are the only specific errors reported [6, 7].

With due respect to these earlier reports, it is apparent that a systematic correlation between arthrography and morphology cannot be carried out successfully on patients, because only selected temporomandibular joint disorders are treated surgically. Furthermore, a positive arthrogram is usually one of the prerequisites for surgical intervention, thereby eliminating the recognition of false-negative diagnoses. We studied temporomandibular joint autopsy specimens and compared the findings from dissections and cryosections of the joint with double-contrast arthrotomograms obtained after the joint was removed.

Materials and Methods

Sixty-one temporomandibular joint autopsy specimens were removed in blocks from fresh cadavers without infectious diseases. No other attempts were made to be selective. The blocks were taken from the middle cranial area and measured 10 x 8 x 6 cm. In all but five cases the right joint was obtained. In 13 of the specimens the arthrotomographic procedure (see below) was unsuccessful because of the use of insufficient amounts of contrast material (four joints); leakage through the capsule preventing proper filling with air (four joints);
unsuccessful injections of contrast media into the upper compartment (three joints); and extensive extravasation of iodine contrast medium (two joints). These 13 joints were excluded from further analysis. Distribution of the material with respect to age and gender in the other 48 joint specimens is presented in Table 1. The mean age of the 48 individuals was 73 years (range 50–93) and of the 13 individuals excluded, 74 years (range 38–92). During dissection or cryosectioning seven joints exhibited normal disks, while the disks in the other 41 joints showed altered configuration and/or altered position. The soft tissue covering the capsule was removed and the fresh specimen attached to a positioning device [16]. The approximate direction of the condylar long axis was determined by palpation. The specimen was oriented with the condylar long axis at right angles to the tomographic plane, that is, sagittal tomography. Double-contrast arthrotomography was performed with the condyle in the fossa. The first 36 joints were examined by an arthrotomographic technique described by Westesson et al. [16], which included a sequence of three injections: air, Conray (sodium iothalamate 400 mg/ml), and air. First the lower compartment was injected in its posterior recess,

<table>
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Fig. 1.—Temporomandibular joint with biconcave disk in superior position. A, Double-contrast arthrotomogram from central third of joint. Posterior band of disk (arrow) is superior to condyle and central thin part is between condyle and tubercle. B, Corresponding cryosection confirms arthrographic diagnosis.

Fig. 2.—Temporomandibular joint with biconcave disk in anterior position. A, Double-contrast arthrotomogram from central third of temporomandibular joint. Posterior band of disk (arrow) is anterior to condyle and central thin part is inferior to articular tubercle. Accidental deposit of iodine contrast medium in elongated posterior attachment. B, Corresponding cryosection confirms arthrographic diagnosis.
Fig. 3.—Temporomandibular joint with deformed disk in partial anterior position. A, Double-contrast arthrotomogram from central third of temporomandibular joint. Biconcave disk in superior position with posterior band (arrow) superior to condyle and central thin part between condyle and tubercle confirmed in corresponding cryosection (B). Abnormal configuration of disk in lateral third of joint (C) is not disclosed arthrographically. Posterior part of disk is biplanar, whereas anterior part demonstrates marked thickening (arrows).

Fig. 4.—Temporomandibular joint with perforated biconvex disk in anterior position. A, Double-contrast arthrotomogram from lateral third of temporomandibular joint. Disk (arrow) is anterior to condyle. B, Corresponding cryosection confirms arthrographic diagnosis and shows perforation between disk (arrow) and posterior attachment.
a single control radiograph was obtained, and then the upper compartment was injected in its anterior recess. In the last 12 joints, Conray was replaced by Amipaque (metrizamide 300 mg I/ml), and the sequence of injections changed to Amipaque, air [17–19]. Serial tomography at nine layers with 2.5 mm interspaces followed the injections. A Philips Universal Polytome and hypocycloidal movement were used. The level of tomographic sectioning was established with an indicator device.

Interpretation of Double-Contrast Arthrotomograms

The configuration and position of the disks were interpreted simultaneously by the authors and the findings were recorded. The configuration of the disk in the sagittal plane was classified into one of four groups: biconcave, biconcave with lateral thinning, blplanar, or biconvex. The position of the disk in the sagittal plane was classified into one of three groups: (1) superior position—the posterior band (i.e., the posterior thick part anterior to the bilaminar zone [5, 21]) of the disk was superior to the anatomically most superior point of the condyle (fig. 1); (2) completely anterior position—the posterior band of the disk was anterior to the anatomically most superior point of the condyle (fig. 2); and (3) partly anterior position—the posterior band was in superior position in the medial part of the joint and in anterior position in the lateral part of the joint (fig. 3).

Perforation of the disk was diagnosed when the upper compartment was opacified after injection of contrast material into the lower compartment (fig. 4). Fibrous ankylosis was diagnosed when the free flow of contrast material was replaced by several small, well defined pools of contrast media located between the condyle and the temporal joint component. Fibrous ankylosis was distinguished from extravasation of contrast media by the location and appearance of the contrast medium. Extraarticular contrast medium was generally not located close to the bone and appeared as a single radiopacity with a diffuse boundary (fig. 2).

Dissection

Dissections followed the interpretation of the double-contrast arthrotomograms of the first 36 joints. The joints were studied simultaneously by the authors and the findings were recorded. The temporal fossa component was separated from the disk and condyle by a circumferential incision in the capsule into the upper compartment. The lower compartment was opened laterally, anteriorly, and medially. The disk specimens were sagittally sectioned into lateral, central, and medial thirds without detaching them from the condyle posteriorly. This facilitated the study of the anteroposterior relation between the posterior band of the disk and the anatomically most superior point of the condyle. Configuration and position of the disk were classified according to the criteria used for the interpretation of double-contrast arthrotomograms.

Cryosectioning

Immediately after radiography, 12 joints were frozen by repeated application of hexane and cooled to −70°C by carbon dioxide ice without being detached from their positioning devices. The joints were embedded in a gel of carboxymethyl cellulose (CMC) and frozen to form a square support around the specimen. The base of the CMC block was placed perpendicular to the tomographic plane. An indicator device was used to mark the levels of tomographic sectioning on the posterior and anterior surfaces of the CMC block. The CMC block was then mounted on a large microtome stage and sectioned on a heavy duty-microtome (LKB 2250, CryoMicrotome, Bromma, Sweden). The method of freezing, embedding, and sectioning was described by Ullberg [22]. The block was cut in 25-μm-thick sections. The newly cut surface of the specimen was photographed at intervals of 0.5 mm, as described earlier for the temporomandibular joint by Eckerdal [23] and for the knee by Rauschning [24]. The photographs were studied under different magnifications by both investigators. The configuration and position of the disk were classified according to the criteria presented for interpretation of the double-contrast arthrotomograms.

Comparison between Radiologic and Morphologic Findings

The radiographic appearance of the configurations and positions as well as perforations of the disks were compared with the morphology as seen during dissection or cryosectioning. When the radio-
logic interpretation differed from the morphology, the radiographs and specimens were studied once more by the authors in an attempt to explain the disparity.

Results

The two different contrast materials did not show any appreciable differences in image quality. With increasing experience the amount of contrast material injected was adjusted, with improvement of the image quality.

Table 2 presents the correlation between the arthrotomographic and morphologic findings. The arthrotomographic diagnosis was confirmed, signifying a diagnostic accuracy of 85% in 41 joints. Figures 1, 2, and 4 illustrate examples in which the arthrotomographic diagnosis was confirmed at dissection or cryosectioning.

There were disparities between the arthrotomographic and the morphologic findings in seven joints. The configuration was misinterpreted in three joints (fig. 3C); the position in three joints; and the configuration and position in one joint. The errors were due to incorrect observations (two joints) and the limitation of tomographic reproduction of the lateral part of the joint (five joints) (fig. 3C). There were two false-positive reports due to observation errors, whereas limitation of tomographic reproduction resulted in six false-negative reports in five joints.

It was not possible to determine the position of the disk in seven instances. In two of these the arthrogram revealed fibrous ankylosis, which was confirmed by subsequent dissection and cryosection. In two others perforation involved the entire disk, and in three specimens the disk was bilocular. Since there was no posterior band in these five cases, it was impossible to determine the position radiographically. At the time of dissection the densest part of the disk was observed overlying the superior surface of the condyle.

Eleven disk perforations were diagnosed by opacity of the upper compartment after injection of contrast media into the lower compartment (fig. 4). All perforations were verified at dissection or cryosectioning. Eight perforations were extensive enough to be arthrotomographically outlined. In two of these, the perforation involved the entire disk.

Discussion

Temporomandibular joint arthrography has recently gained renewed acceptance but is currently a routine procedure at only a few centers. It is beyond the scope of our study to compare systematically the information yielded by single- and double-contrast arthrography. Judging from personal experience and published single-contrast arthrograms, the double-contrast technique offers an improved radiographic representation of the intra-articular anatomy. This improvement should be valuable for further analysis of temporomandibular joint disorders and may help to form a rational basis for treatment. Lower-compartment single-contrast arthrography, routinely performed by some clinics [4, 8], demonstrates the extension of the lower joint compartment and thereby the position of the disk at a functional examination [4]. However, complete demonstration of the configuration of the disk requires two-compartment arthrography. In our study injection into the upper compartment was unsuccessful in three joints. These were excluded, as our aim was to study the diagnostic accuracy of bicompartimental double-contrast arthrotomography.

Our attempt at the beginning of this study was to perform a subjective radiographic interpretation based on recently described diagnostic criteria for normal and anterior disk positions [2–6]. This resulted in difficulties for maintaining a consistent observer performance because we found disks in various positions between normal superior and completely anterior. Therefore, the position of the disk in the sagittal plane was determined by relating the posterior band of the disk to the anatomically most superior point of the condyle, which is easily identified both radiographically and morphologically.

The disk is clearly shown by double-contrast arthrotomography, and its status is of great diagnostic significance, since partial or complete anterior displacement is a frequent finding in patients with pain, tenderness, clicking, or locking of the temporomandibular joint [2–7, 17, 18, 25]. Deviation from the normal biconcave configuration appears to be secondary to an altered position [26]. Perforation of the disk has been considered pathologic and a sign of arthritis [27].

In our study the interpretation of double-contrast arthrotomograms agreed with the morphology in 41 of 48 temporomandibular joints. Our results indicated a diagnostic accuracy of 85%, which is comparable to more than 90% found in several large series of double-contrast arthrography of the knee [12, 28–30].

Abnormalities of the disk were demonstrated in 37 of 48 temporomandibular joints in our series. As these joints were not selected for the presence of temporomandibular symptoms or pathology during life, the clinical significance of these observations requires further study. Perhaps the accuracy could be further improved by arthrotomograms obtained in open- and closed-mouth positions [1, 7, 20] and by further experience [31]. Whether clinical application of this technique will be equally satisfactory must await further study.

In our present study, errors due to the limitation of tomographic reproduction concerned the lateral part of the joint. As the lateral part of the temporomandibular joint is frequently affected by arthritis [27] and by changes in configuration and position of the disk [26], depiction of the lateral part of the joint is essential for the diagnosis. The limitation of tomographic reproduction of the lateral and medial parts of the temporomandibular joints has also been found for the mineralized parts of this joint [23]. This limitation contributes to false-negative diagnoses. By supplementing sagittal imaging with transcranial imaging (transverse) as described by Farrar and McCarty [4] the number of false-negative diagnoses might be reduced.

In our study the morphology of the temporomandibular joint was studied by both dissection and cryosectioning. One disadvantage of dissection was that the tomographic interrelationship of condyle, disk, and temporal fossa could not be studied since the components were separated. By the use of
considerably more time-consuming cryosectioning these advantages were overcome. Freezing the specimen immediately after arthrotomography without detachment from the positioning device maintained the orientation of the specimen and the relation between the joint components. A slight expansion of the tissues cannot be avoided during freezing, resulting in slightly narrowed joint compartments in the cryosections. This minor difference was obvious when comparing the tomogram with the corresponding cryosection. Injections followed by deep-freezing and radiography were tested but not used in this study since the iodine contrast medium in association with the corresponding cryosection.

In summary, the diagnostic accuracy of double-contrast arthrotomography of the temporomandibular joint was 85%. The diagnostic errors were from observation errors or limitation of tomographic reproduction.

REFERENCES