The Correlation of Temporomandibular Joint Sounds with Joint Morphology in Fifty-five Autopsy Specimens

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Joint sounds from 55 fresh temporomandibular joint autopsy specimens were correlated with the macroscopic examination of joint morphology. Fifty-eight per cent of the joints were silent. Two thirds of these showed normal superior disc positions and remodeled articular surfaces, whereas one third exhibited anterior disc displacement. Twenty per cent of the joints elicited clicking and showed anterior disc displacement. Twenty-two per cent of the joints elicited crepitation and exhibited mostly arthrosis of the articular surfaces and perforation of the discs. Our results confirm previous statements that clicking and crepitation may be looked upon as signs of abnormal joint morphology, clicking indicating anterior disc displacement and crepitation usually indicating arthrosis. Absence of sound alone, however, should not be accepted as an indication of a normal joint.

Auscultation of the temporomandibular joint is widely used for diagnosing joint disorders. Ekensten† has pointed out that a healthy joint does not produce any sound. However, recent arthrographic studies have shown that joints with pathologic changes, i.e., those with anterior disc displacement without reduction, may also be silent.2-4

Temporomandibular joint clicking has been ascribed to a variety of causes, such as local thickenings of the articular surface layers,5,6 substantial macroscopic remodeling,7 deviation in condylar form,8 and disc displacement.5,7,9,10 Arthrographic3,4,11-17 and morphologic18 findings have supported the idea that clicking is associated with anterior disc displacement. Crepitation has been considered to be an indication of structural damage to the articular surfaces19-21 or, more specifically, as a sign of osteoarthrosis.6,22-26

Although TMJ sounds have been extensively studied1,24,25,27-34 the correlation between different joint sounds and joint morphology is not well documented. This is probably due to the few opportunities for direct inspection of the joint. Fresh autopsy specimens of the TMJ provide a chance to assess the relation between joint sounds and joint morphology.18

Materials and Methods

Fifty-five TMJ autopsy specimens in approximately 10 × 8 × 6 cm blocks were consecutively obtained from fresh cadavers. Age at death and sex of the postmortem specimens can be seen in Table 1.

Sound Recording

The temporal component of the specimen was fixed in a positioning device,35 and the mandibular component was manually moved anteroposteriorly corresponding to full protrusion and retraction. Joint sounds were recorded as vibrations in the temporal bone using a vibration transducer (Brüel and Kjaer 4335) attached to the squama temporalis with a clamp. The signal from the vibration transducer was fed into a charge amplifier (Brüel and Kjaer 2625), bandpass-filtered with filter limits of 22.5 Hz and 22.5 KHz by a second amplifier (Brüel and Kjaer 2607), and visualized on a digital storage oscilloscope (Golden Advance 4000). The memory was

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and Mackenzie, who subjected monkeys to bilateral condylotomies, did not find evidence of remodeling at three, six, and 12 months. If changes do occur, they would most likely do so in the remodeling phase, when different functional demands are placed on the condyle.

The results of this study support previous observations that thinning of the condylar cartilage is the most obvious result of immobilization. No significant differences were found between sides that were passively mobile and those that were rigidly immobilized. Degeneration was observed very early and became progressively more severe as the duration of the immobilization period increased. The fact that surface degenerative events seen in osteoarthritis and in immobilized hyaline cartilage joints were not observed to any great degree in this study points to the protective function of the fibrous layer. Reparative events were seen in the joints of animals killed at 28 days. These results suggest that, although immobilization produces destructive changes initially, these seem to be reversible.

References

connected to an XY plotter (Phillips 8041), which produced a graphic representation of the sound. To find a suitable level of amplification and an adequate filtration of the signal, ten students who had healthy, silent TMJs and ten patients who had joints with documented clicking or crepitation were examined using the equipment. To evaluate the recordings of the autopsy specimens a reference level was produced for each joint by recording joint sounds without moving the condyle. The specimens were then classified according to evaluation of the recorded sounds as: 1) Silent—amplitudes did not exceed those of the reference line (Figs. 1, 2). 2) Demonstrating clicking—rapid changes in amplitude were followed by changes of lessening magnitude, the lowest amplitude still exceeding that of the reference line. Reciprocal clicking implied two clicks, one during mandibular opening and another during retrusion (Fig. 3). 3) Demonstrating crepitation—repeated changes of amplitude of differing magnitudes were heard that exceeded those of the reference line (Fig. 4). To assess possible variations in the evaluative responses of the examiners, one of the authors reevaluated the recording a month later. The two evaluations were always in agreement.

**DISSECTION**

After completion of the recordings the temporal component was separated from the disc and condyle by a circumferential incision in the capsule. The lower compartment was opened laterally, anteriorly, and medially, the disc remaining attached to the condyle posteriorly. The disc was sagittally sectioned into lateral, central, and medial thirds without detachment from the condyle posteriorly (Fig. 5).

The joints were studied simultaneously by the authors. The anteroposterior position of the disc relative to the condyle was classified according to the criteria of Westesson and Rohlin as superior, partially anterior, or completely anterior. A partially anterior position of the disc implied an anterior position either laterally or both laterally and centrally combined with a superior position medially. Partially or completely anterior disc positions were considered to be disc displacement. The configuration of the disc in the sagittal plane was classified as biconcave, biplanar, or biconvex. The presence of marked thinning or uneveness were noted, and perforation was classified as arthrosis. Discs

<table>
<thead>
<tr>
<th>Table 1. Age at Death and Sex of 55 Postmortem Specimens from which 55 Temporomandibular Joints were Obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (Years)</strong>                                                                                     <strong>Mean Age</strong></td>
</tr>
<tr>
<td>40–49</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>(n = 28)</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>(n = 27)</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

FIGURE 1. A, Sagittal section from central part of temporomandibular joint autopsy specimen with biconcave disc in superior position. Arrow indicates posterior band superior to the condyle. B, Frontal view of condyle demonstrating remodeling (arrows) in lateral part. C, Sound recording. Amplitudes during movement did not exceed the amplitudes of reference line, meeting the definition of a silent joint.
Results

Silent Joints

Thirty-two joints (58%) were silent (Tables 2, 3; Figs. 1, 2). The disc was in the superior position in two thirds and anteriorly displaced in one third of the joints. The majority of the discs were biconcave without extensive thinning, unevenness, or perforation. Remodeling of the articular surface was found in all but four joints. Two of these joints exhibited arthrosis, which was limited to the temporal component.

Clicking

Eleven joints (20%) demonstrated clicking. Ten had reciprocal clicking and one a single click. The single click occurred during retractive condylar movement in the fossa. The disc of this joint was partially anteriorly displaced and exhibited unevenness laterally. The articular surfaces were remodeled. The cause of this single click was not evident.

The ten remaining joints had reciprocal clicking (Tables 2, 3; Fig. 3), which was specific for anterior displacement of the disc. In four joints the disc was partially anteriorly displaced, and in six joints it was completely anteriorly displaced. The configuration of the disc was most often biplanar or biconvex. About half of the discs exhibited marked thinning or unevenness. Four joints exhibited arthrosis. This was limited to one component in three joints; the condyle was affected in two and the temporal component in one. In the fourth joint with arthrosis all three components were involved.

Crepitation

Twelve joints (22%) exhibited crepitation (Tables 2, 3; Fig. 4). In all but two the disc was anteriorly displaced, and, most often, the configuration was biplanar or biconvex. Ten joints demonstrated arthrosis that included perforation of the disc. In eight joints all three components were affected, whereas in two joints any arthrosis was found only in the temporal component and the disc. Thus, in joints with crepitation, arthrosis was generally more extensive than in joints with clicking. In the two remaining joints with crepitation no arthrosis was found, but there was extensive remodeling of the superior surface of the condyle.

Discussion

Our findings indicated that the clicking and crepitation as heard in TMJ autopsy specimens and in
Table 3. Temporomandibular Joint Sounds Related to Status of the Disc*

<table>
<thead>
<tr>
<th>Status of the Disc</th>
<th>Marked Thinning or Unevenness</th>
<th>Perforation (Arthrosis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td>Reciprocal clicking</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Crepitation</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

* One joint with a single click was excluded from this data.

modeling was frequently seen in silent joints, as well as in joints with clicking. Therefore, the suggestion that local thickening of the articular surface and deviations in form are the cause of clicking could not be verified in our study. On the other hand, all the joints in our study that had clicking exhibited anterior disc displacement. This supports recent observations that clicking is caused by the condyle hitting the disc and temporal component after having rapidly passed the posterior band of the disc.18

In our study, crepitation was concomitant with arthrosis, it was therefore regarded as a sign of this condition. This is in agreement with the findings of several authors. However, two joints with extensive remodeling, but without arthrosis, also elicited crepitation. Crepitation should usually be considered to represent abnormal joint morphology and is likely to occur as a result of movement across irregular surfaces, as Dolwick has pointed out. In our material, however, two silent joints and four joints with clicking also showed arthrosis, indicating that arthrosis may exist without crepitation.

In summary, joints producing sound consistently showed disc displacement, which occurred concomitantly with arthrosis in more than half of the cases. Joint sound may, therefore, be looked upon as a sign of abnormal joint morphology. Reciprocal clicking indicated anterior disc displacement and crepitation usually indicated arthrosis. As only two thirds of the silent joints were normal, the absence of joint sounds should not be accepted as an indication of a normal joint.

References

27. Ekensten B: Jãmforande undersökningsar 400 st kãklåder i kliniskt, röntgenologiskt och fonogrammetriskt hänseende. Odontol Tidskr 65:18, 1955
FIGURE 3. A, Sagittal section from central part of temporomandibular joint autopsy specimen with biconcave disc in anterior position. Arrow indicates border between dense part of disc and elongated posterior attachment. B, Frontal view of condyle demonstrating normal articular surface. C, D, Sound recordings show rapid amplitude changes, followed by amplitudes of decreasing magnitude that exceeded amplitudes of reference line, meeting the definition of clicking. Clicking during mandibular retraction (D) did not occur unless preceded by clicking during mandibular opening (C), meeting the definition of a joint with reciprocal clicking.

Table 2. Temporomandibular Joint Sounds Related to Position and Configuration of the Disc as well as Macroscopic Appearance of the Articular Surfaces*

<table>
<thead>
<tr>
<th>Disc Position</th>
<th>Disc Configuration</th>
<th>Sound and Appearance of Articular Surfaces</th>
<th>Crepititation</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Silent</td>
<td>Reciprocal Clicking</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal</td>
<td>Remodeling</td>
<td>Arthrosis</td>
<td>Remodeling</td>
</tr>
<tr>
<td>Superior</td>
<td>Biconcave</td>
<td>2</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Superior</td>
<td>Biplanar</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Partially</td>
<td>Biconcave</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>anterior</td>
<td>Partially</td>
<td>Biplanar</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>anterior</td>
<td>Partially</td>
<td>Biconvex</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>anterior</td>
<td>Completely</td>
<td>Biconcave</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>anterior</td>
<td>Completely</td>
<td>Biplanar</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>anterior</td>
<td>Completely</td>
<td>Biconvex</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2</td>
<td>28</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

* One joint with a single click was excluded from this data.
There is a possibility, however, that clicking or crepitation occurring when the individual was alive was not reproduced during our postmortem examination. Therefore, a false-negative diagnosis among silent joints cannot be excluded. Further indications of the similarity between reciprocal clicking recorded from autopsy joint specimens and patients have been listed by Isberg-Holm and Westesson. The possibility that the sounds produced by manipulation did not occur in vivo must also be considered.

It is evident that a silent joint is not necessarily a healthy joint, as one third of the silent joints in our sample exhibited anterior disc displacement. This is in agreement with clinical observations of patients who have anterior disc displacement without reduction.

Only two joints in our sample showed articular surfaces without remodeling or arthrosis, which probably was due to the age of the individuals from whom these autopsy specimens were obtained. Re-