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ANATOMICAL VARIATIONS IN THE ARTICULAR DISC OF THE HUMAN TEMPOROMANDIBULAR JOINT

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Perforations occur in the articular discs of human temporomandibular joints. They are of three types, based on location: lateral, central, and posterior. The lateral and central perforations occur in essentially equal numbers while the posterior perforations are uncommon (less than 10%). Lateral perforations occur primarily in edentulous individuals and are equally distributed between males and females. Central perforations occur most often in dentulous females. Posterior perforations occur only in edentulous persons and are equally distributed between males and females. No clear evidence of anterior disc displacement (internal derangement) was seen.

† † †

INTRODUCTION

Temporomandibular joint (TMJ) dysfunction is a popular and controversial subject today. It is a syndrome that apparently results from many underlying causes, and a wide variety of treatments ranging from simple heat application to radical surgery is in vogue today. Yet very little is actually known about the basic anatomical and physiological functioning of this joint and the factors that affect it. The articular disc of this joint has become the focal point of research and treatment, and "internal derangement" (anterior dislocation of the disc) is today a common topic in popular lay publications. In light of this intense interest in the disc, this study examines the gross aspect of the disc and the perforations that occur within it.

As Öberg et al. (1971) noted, studies relating to the gross and histologic examination of the disc are limited. Studies by Rees (1954), Krogh–Poulsen and Mølhave (1957), Dixon (1962), Findlay (1965), Moffett (1966), El Mahdy (1971), and Cran (1976) have defined the normal appearance of the disc in detail. The study of disc variations by Carlsson et al. (1965), Blackwood (1966, 1969) and Hansson et al. (1977) has been hampered not only by a lack of material, but also by the narrow range of material available. The lack of separate basic science departments in many dental schools has restricted cooperation between clinicians and academicians and reduced the correlation of clinical treatment with basic research data.

Cadaver material, in the past, has been limited by age, socio–economic level and, as a result of these, dentition. These factors present severe restraints when one attempts to apply data from this limited pool to the population as a whole. With the advent of active body donor programs, these limitations have broadened considerably and now allow the study of a reasonably wide cross section of the older general population. Voluntary donors were the source of all material for this study.

This study reports on perforations of the articular disc, their location within the disc, and their relations to dentition, age, and sex.

METHODS AND MATERIALS

TMJs were collected bilaterally from 106 human cadavers during a three-year period. The overlying skin and superficial fascia were removed from the lateral aspect of the TMJ, and the joint capsule cleaned and defined. The condyle and adjoining neck, including the pterygoid fossa (fovea) were separated as a unit from the remainder of the mandible with an oscillating saw. The condyle was retracted downward, rendering the joint capsule taut. An incision was made through the lateral aspect of the capsule revealing the superior compartment. Since the disc invariably remains tightly adherent to the condyle, there is little danger of damage to the disc with this initial incision. The incision was carried forward through the capsule to the anterior extension of the disc, where the anterior extension becomes continuous with the fibers of the superior head of the lateral pterygoid (sphenomeniscus). It was then directed medially and somewhat posteriorly along the articular eminence to the medial limit of the glenoid (mandibular) fossa. A separate incision was made through the two heads of the lateral pterygoid, thus freeing the disc and condylar neck from the muscle. It should be noted that the medial aspect of the capsule is thickened and very firmly attached to the medial pole of the condyle, disc, and fossa. The initial incision was continued posteriorly and thence medially through the posterior temporal and mandibular attachments of the capsule to meet the anterior incision. This freed the condyle and disc and allowed their removal *en bloc*.

The disc was separated from the condyle in the following manner: an incision was made horizontally through the bilaminar area just behind the posterior band, thus opening the inferior compartment. It was continued to the lateral and medial poles, where the disc is most tightly adherent. The disc was separated from the condylar poles and the incision continued anteriorly. Here with sharp scalpel dissection, the anterior extension of the disc was separated from the condyle and the fibers of the lateral pterygoid, freeing the disc from the mandible and muscle.

Discs were examined for perforations and subsequently categorized as follows: dentulous–edentulous, male–female, perforated–nonperforated, and by location of perforation within the disc.

RESULTS

TABLE I. Population age distribution.

AGE	NUMBER (%)
30–40	2 (1.9)
41–50	5 (4.7)
51–60	14 (13.2)
61–70	27 (25.5)
71–80	36 (34.0)
81–90	19 (17.9)
91–97	3 (2.8)

The age range of the population was 30–39 yr (Table I). It is obvious that it is skewed to the low side, with only 19.8% aged 60 or less. The age range for those with perforations was 53–90 yr. A total of 43 perforations was found in 30 of the 106 cadavers. Distribution of the perforations based on sex, sex plus dentition, or sex and the lack of dentition was quite uniform, with less than eleven percentage points separating any of these categories (Table II). The widest variation (10.6%) occurred between dentulous males and females, with the other categories showing variations of 8.3% or less. Perforations were observed both uni– and bilaterally and were located in one of three positions: central (41.8%), lateral (48.9%), and posterior (9.3%). The actual number of perforations in any one subcategory was so small as to preclude statistical analysis, and therefore only a descriptive analysis was considered (Table III).

TABLE II. Population characteristics.

POPULATION		PERFORATIONS
TOTAL	106 (100%)	30 (28.3%)
MALE	57 (53.8%)	14 (24.5%)
FEMALE	49 (46.2%)	16 (32.6%)
DENTULOUS	48 (45.2%)	12 (25.0%)
EDENTULOUS	58 (54.7%)	18 (31.0%)
MALE DENTULOUS	21 (19.8%)	4 (19.0%)
FEMALE DENTULOUS	27 (25.4%)	8 (29.6%)
MALE EDENTULOUS	36 33.9%)	10 (27.7%)
FEMALE EDENTULOUS	22 (20.7%)	8 (36.3%)

TABLE III. Distribution of perforations.

	Perforation position		
	Lateral	Central	Posterior
TOTAL NUMBER	21	18	4
MALES	11	4	2
FEMALES	10	14	2
DENTULOUS MALES	3	1	0
DENTULOUS FEMALES	2	10	0
EDENTULOUS MALES	8	3	2
EDENTULOUS FEMALES	8	4	2

The 18 central perforations were invariably large, resulting in almost total destruction of the disc (Fig. 1). These perforations, which occurred both uni– and bilaterally, were always accompanied by pronounced underlying condylar changes including osteoarthritis, eburnation, and osteophyte formation (Fig. 2). About half of these perforations occurred in dentulous females.

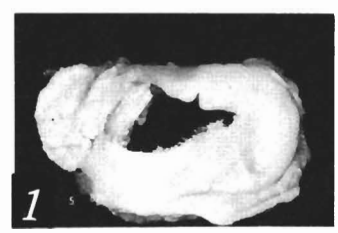

FIGURE 1. Central perforation.

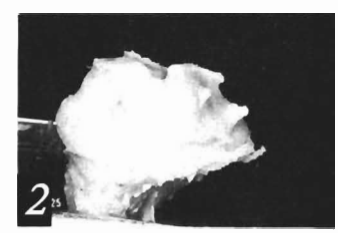

FIGURE 2. Osteophytes, osteoarthritis.

The 21 lateral perforations varied in size from 1–2 mm to almost complete loss of the lateral aspect of the disc. These perforations were accompanied by condylar remodeling (osteoarthritis) that appeared related to the size of the perforation. The more minimal the perforation, the more minimal the condylar change. Figure 3 shows almost total destruction of the lateral aspect of the disc. Seventy–six percent of these perforations occurred in the edentulous, being equally distributed between males and females.

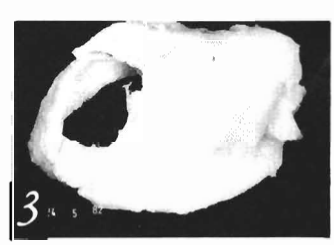

FIGURE 3. Lateral perforation.

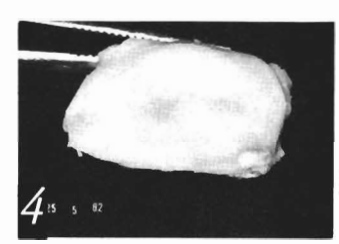

FIGURE 4. Normal disc.

Seventy–seven percent of the nonperforated discs showed lateral thinning, indicating a potential for perforations in this area. This phenomenon was seen only rarely in the central part of the nonperforated discs and was not seen posteriorly. Aside

FIGURE 5. Normal condyle.

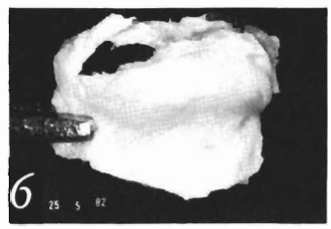

FIGURE 6. Posterior perforation.

from lateral thinning, nonperforated discs appeared normal, as did the underlying condyles (Fig. 4, 5).

The four posterior perforations were intermediate in size and centrally located directly behind the posterior band (Fig. 6). As in the central and lateral perforations, condylar remodeling (osteoarthritis) was present in the area under the perforation. A further condylar change noted in these four cases was an indentation of the posterior aspect of the condyle that appeared to conform to the posterior wall of the glenoid fossa. These four perforations all occurred in edentulous individuals and were equally distributed between males and females.

Discs, regardless of the location of the perforation and regardless of the amount of destruction, always remained firmly attached to the peripheries of the condyles.

Contrary to popular thought, no conclusive or convincing evidence of anterior disc displacement (internal derangement) was seen in any of the specimens examined.

DISCUSSION

It was thought, originally, that this extensive collection of TMJs would allow statistical analyses of various components of the joint, in particular the disc, which is now the center of so much clinical controversy, theory, research, and surgery. One might anticipate joint changes based on numerous criteria or combinations thereof, e.g., age, sex, dentition, chewing patterns, occlusion, diet, stress, etc. With increased orthodontia and occlusal equilibration in all age categories, and increased restorative work in the older population, one may, in the future, anticipate further morphological changes in the TMJ in addition to the ones mentioned.

The living can provide us with detailed accounts of these variables as they pertain to their particular lifestyles, but obviously their TMJs are unavailable, except in rare circumstances. Current methodology, including lateral transcranial radiography, hypocycloidal tomography, and CAT scans allows limited observation of joint hard structures, but provides little, if any, disc information. Arthrography may provide some disc information such as displacement or perforation, but interpretation of arthrograms remains somewhat controversial. Nuclear magnetic resonance imaging may provide our first definitive examination of the disc *in situ*.

Cadavers, on the other hand, provide an ample supply of joints, but aside from age and to some extent dentition, they provide little else in the way of background information. Consequently, clinical and academic research continues with much theorizing and little firm data.

From cadaver studies, one can now only report the changes seen, eventually analyze the variations, and then apply this knowledge clinically. With the increase in donor programs, it is suggested that every effort be made to obtain background dental information on the donor bequethal forms. This may allow correlation of joint findings with known dental records.

In the populations studied, central perforations occurred more often in dentulous females. Ten of the 18 perforations, or 55.5%, occurred in this category and were bilateral in four of the six individuals. All central perforations were extensive, resulting in almost total obliteration of the disc intermediate zone. They were accompanied by severe condylar changes in the area of the perforations. There were two types of change: osteoarthritis and eburnation. The osteoarthritis was characterized by irregularity of the condylar surfaces, which resulted in widely diverse alterations to the size and/or shape of the condyles. In cases of bilateral perforations with concomitant osteoarthritis, there was not necessarily any correlation in the condylar changes seen from one side to the other. Eburnation, in contrast to the highly irregular surfaces seen in osteoarthritis, presented smooth, highly polished surfaces of thickened cortical bone.

Osteophytes were seen in conjunction with central perforations, but not in direct relation to the disc defect. They generally occurred on the medial aspect of the condyle and were always covered by the disc. In some cases, the discs actually thickened over the osteophytes and appeared to provide an increased protective covering which prevented them from impinging on the articular eminence. This indicated that discs were capable of undergoing degeneration in the area of a perforation while at the same time exhibiting a stimulatory response to osteophyte formation.

Several aspects of central perforations bear continued investigation: why this type of lesion should be seen predominantly in dentulous females, and why there is little evidence of central disc thinning as is seen laterally.

Lateral perforations presented a picture that contrasted sharply with that of central perforations. Lateral perforations were seen primarily in edentulous individuals and were equally distributed between the sexes. They appeared to be the product of a long–term process which began as a gradual thinning of the disc followed by a perforation that continued to increase in diameter with time. Once the perforation had occurred, condylar changes likewise began and the two processes proceeded simultaneously, culminating in total disc destruction and marked osteoarthritic changes in the condyle. Central per-

forations gave no indications of such a progressive pattern. Eburnation and osteophyte formation did not characteristically accompany lateral lesions as they did some of the central ones.

Posterior perforations shared some characteristics of both lateral and central perforations. In common with the lateral perforations, they were equally distributed between the sexes, and condylar changes were osteoarthritic with no eburnation or osteophyte formation. Like central defects, they were centrally located and showed no evidence of progressive thinning. All the condyles associated with the posterior perforations exhibited a posterior indentation that appeared related to the posterior wall of the glenoid fossa, thus indicating a rearward location of the condyle. The tendency by some dentists, in recent years, to equilibrate from the terminal hinge position (most posterior-superior or "bone to bone" position) might cause speculation as to whether this defect could become more prevalent with the passage of time.

The most interesting facet of this study is that regardless of the locations of the perforations, of the size of the perforations, and of the amount of condylar change, the disc, in all cases, remained tightly attached to the periphery of the condyle and always required sharp dissection circumferentially to free it from the condyle. Furthermore, there was no clear evidence of anterior disc displacement. The disc, without regard for its condition, always covered the condyle and was never seen anterior to the articular eminence. This is, of course, contrary to current clinical thought. Speculation as to why one does not see this phenomenon in the cadaver could lead to extensive discussion. One of the authors (Barton), in 20 years of dissecting TMJ's, does not recall seeing this commonly described clinical problem in the laboratory.

SUMMARY

The purpose of this investigation was to study TMJ disc perforations. TMJs were removed bilaterally from 106 cadavers and the discs were separated from the condyles and examined for defects.

The following observations were noted:

1. Perforations occurred in 30 (28%) of the individuals.
2. There were 43 perforations in the 212 joints.
3. The age range for those with perforations was 53–90 years.
4. Perforations occurred centrally, laterally, and posteriorly.
5. Central and lateral perforations occurred in essentially equal numbers, however central perforations occurred more often in dentulous females (55.5%), while lateral perforations occurred primarily (76%) in edentulous individuals and were equally distributed between males and females.
6. Posterior perforations were least common (9.3%), occurred only in edentulous individuals and were equally divided between males and females.
7. Central perforations were large, resulting in almost complete destruction of the disc intermediate zone, and were accompanied by severe condylar remodeling under the area of the perforation.
8. Lateral perforations varied from small to large. Condylar changes appeared to vary with the size of the defect; the smaller the defect, the less the condylar change and vice versa.
9. Lateral thinning occurred in the majority (77%) of non-perforated discs, indicating a possible continuous process leading to eventual perforation.
10. Posterior perforations may be related to a rearward displacement of the mandible as evidenced by condylar indentations related to the posterior wall of the glenoid fossa.
11. The disc, regardless of the amount of destruction, remained firmly attached to the periphery of the condyle and covered the condyle.
12. No evidence of anterior disc displacement was noted.

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