Histometric Study of Synovial Cavity Dimensions of Human Temporomandibular Joints With Normal and Anterior Disc Position

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To evaluate effects of internal derangement, the sagittal lengths of the condylar, temporal, and disc articular surfaces, as well as those of the disc attachments, were measured in histologic sections of human temporomandibular joints obtained at autopsy, mainly from adolescent, young adult, and middle-aged subjects. While the upper joint compartment appeared little affected, anterior disc position was significantly associated with comparatively long inferior disc attachments and a short condylar articular surface, indicative of possibly aberrant insertions of the attachments. Such discrepancies in size or alignment between condyle and disc complex could primarily reflect a constitutional deviation or result secondarily from remodeling.
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Internal derangement of the temporomandibular joint (TMJ) is commonly defined as an abnormal relationship between the articular disc and the bony joint components. There seems to be a consensus that anterior or anteromedial disc displacement is the predominant form of internal derangement.[1] By using the term "displacement," most authors imply that the disc of internally deranged articulations had been in a normal position at an earlier time and was then displaced through some kind of precipitating event. Among these events, trauma and overstretching of the joint capsule and ligaments appear to be the most widely accepted.[2–4] At the subsequent initial stage of internal derangement, the disc, while displaced in the closed mouth position, would reduce on opening and thus elicit an audible click.[5,6] Although so far rarely observed in longitudinal studies,[7,8] the initial stage is generally believed to gradually develop into permanent disc displacement, in which the disc fails to reduce on opening but instead impairs condylar translation and causes locking.[1,9]

Deviating from this widely accepted view, Turell and Ruiz[10] and Hellsing and Holmlund,[11] based on findings in autopsy specimens, distinguished anterior disc position from displacement. According to the latter, anterior disc position associated with otherwise healthy joint conditions should be considered within the normal range of anatomic variability, while anterior disc displacement remains a rare phenomenon. The concept of anterior disc position as a normal anatomic variation is supported by findings of magnetic resonance imaging (MRI) and arthrography in asymptomatic joints.[12,13] The second conclusion of Hellsing and Holmlund,[11] however, contrasts markedly with repeated observations in arthrographic investigations.[5,6,14–18]

Several earlier autopsy studies have examined TMJs with normal and abnormal disc position, usually in attempts to correlate findings from direct macroscopic observation and various imaging techniques.[17,19-21] Although gross inspection alone may often result in improper identification of the articular disc as being distinct from its attachments, relatively few autopsy studies have included a microscopic evaluation of internal derangement.[21-24] Furthermore, most of the joints examined postmortem were obtained from individuals whose average ages were between 70 and 80 years, while clinically manifesting internal derangement seems to affect mainly adolescents and young adults.[3,7,8,15,16,25-27] Knowledge of the appearance of TMJs with anterior disc position in clinically relevant age groups is based on microscopic examination of surgically removed joint fragments[15,28-33] and macroscopic inspection at autopsy.[34] To the authors' knowledge, no attempts have so far been made to measure the size of the synovial cavities, except in arthrograms.[18,35] Yet, disc derangements are thought to be caused by hyperlaxity of the capsule and ligaments or a nonproportional relation between the sizes of the articulating components.[1]

The aim of the present investigation was to microscopically evaluate the sagittal lengths of the condylar, temporal, and disc articular surfaces, as well as those of the disc attachments of TMJs with normal and anterior disc position, which had been obtained from mainly adolescent, young adult, and middle-aged individuals.

Materials and Methods

Subjects and Specimens

Without being selective, left TMJs were collected postmortem from 15 females and 38 males. Individuals ranged in age from 15 to 92 years, with an average age of 42 years and exhibiting distributions as shown in Figs 1a and 1b. Medical histories of the subjects did not indicate antecedence of a general disease that, based on current knowledge, would have affected TMJ structure. However, the dental history was unknown. A complete permanent dentition was present in 28 subjects, 17 were partially edentulous, and 8 were fully edentulous. In all partially edentulous subjects there was natural molar support at least on one side, and all fully edentulous subjects had complete maxillary and mandibular dentures inserted. At the time of autopsy, the mouths of the cadavers were closed, and the maxillary and mandibular posterior teeth were in contact or at most 1 to 2 mm apart. In no instance was there an apparent protrusive or laterotrusive deviation of the mandible.

Histologic Processing

All joints were removed in toto through the middle cranial fossa within 12 to 36 hours after death. The entire specimens were fixed histologically and then divided into five to eight sagittal slices about 2 mm thick, using a diamond-coated disc. Of these slices, some were decalcified and embedded in either 2-hydroxypropyl methacrylate (HPMA) or celloidin. The former sections were cut to 7 μm thick and stained with Toluidine blue O (Merck, Darmstadt, Germany), while celloidin sections were cut to about 25 μm thick and stained with Goldner's trichrome stain. Undecalcified slices were embedded in light-polymerizing resin (Technovit 7200 VLC). From these blocks, ground sections about 30 to 40 μm thick were made using a cutting-grinding system (EXAKT Apparatebau, Norderstedt, Germany) and stained with Goldner's trichrome stain.[36] Further processing information was provided previously.[37]

Analysis

Sections representing the lateral, central, and medial segments of all joints were selected for further analysis and microphotographed on a macroscope (M400, Leitz, Wetzlar, Germany). The position of the articular disc relative to the condyle was assessed separately in each segment of a particular joint. On the basis of visual inspection and criteria given by Westesson et al[17] and Dittmer and Ewers,[24] normal superoanterior position, as opposed to anterior and posterior position, was distinguished. The shape of the disc was recorded as normally biconcave, moderately deformed (flat or thickened locally), and severely deformed (biconvex or plicated) (Fig 2).

Measurements were made on photographic prints at a final magnification of approximately 8×, using an image analysis system (Videoplan, Kontron, Munich, Germany). The exact final magnification of each print used for calculating the real values of the measurements was determined by photographing and reproducing an object micrometer together with the histologic specimens. The contours of the upper and lower joint compartments were marked on the photographs prior to

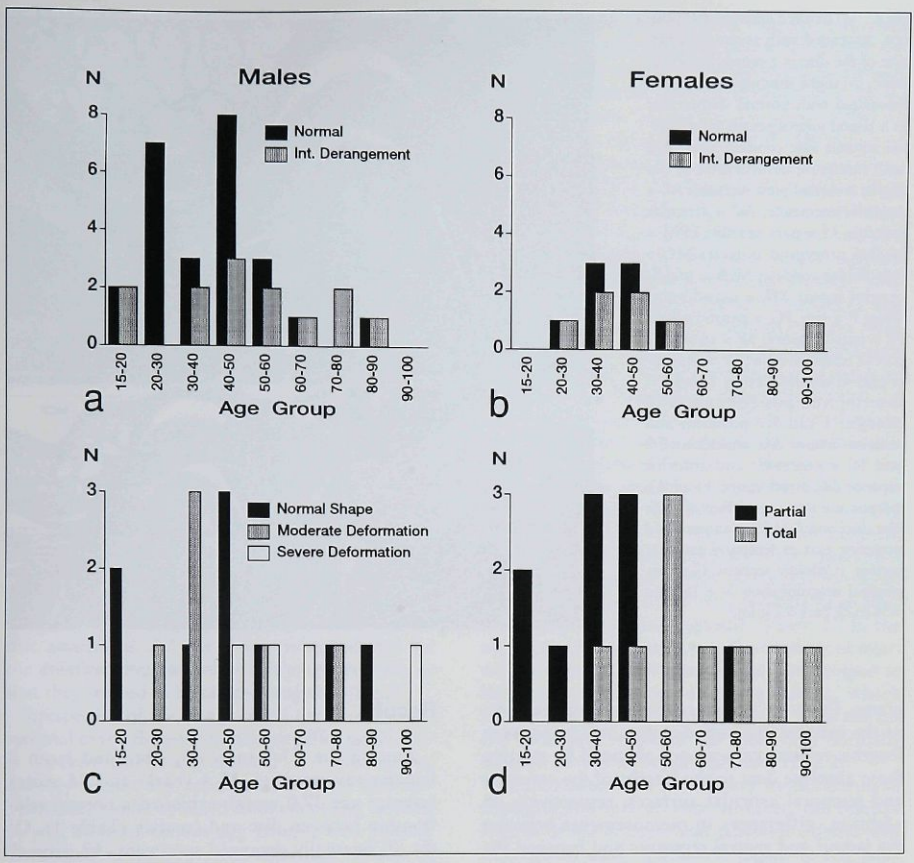


Fig 1 Age distribution of males (*a*) and females (*b*) from whom normal joints and specimens with internal derangement were obtained; internal derangements associated with normal shape as well as moderate and severe deformation of the disc (*c*) and partial and total anterior disc position (*d*).

tracing with the electronic cursor. Direct-light microscopic examination of the sections at a magnification of 40× helped to delineate the condylar and temporal articular surfaces, as well as the disc against the posterior and anterior, superior, and inferior disc attachments. The condylar articular surface at its most superior point with reference to the vertical axis, and the temporal articular surface at the point where its contour changed from convex to concave, were arbitrarily divided into anterior and posterior parts (Fig 2a). Criteria to distinguish the disc from its attachments were the density of the tissue, the intensity of metachromatic staining, and the extension of the synovial lining. Folds on the disc attachments were traced along their surfaces when fiber orientation suggested that they could be unfolded during function. In synovial villi that did not appear to be stretchable, the shortest distance at their base was recorded.

Further processing of the data was done using a personal computer (Deskpro 386/25e, COMPAQ, Basserdorf, Switzerland) and commercial pro-

Fig 2 (*a*) marked anterior disc position associated with severe deformation of the disc in a central joint segment; (*b*) slight anterior disc position associated with normal shaped disc in a lateral joint segment; (*c*) moderate anterior disc position associated with moderate deformation of the disc in a medial joint segment. AE = articular eminence; AT = articular tubercle; G = pars gracilis; LPM = lateral pterygoid muscle; MC = mandibular condyle; MCF = middle cranial fossa; MF = mandibular fossa; P = pes; PG = parotid gland; PP = pars posterior; SP = squamous part of temporal bone; TP = tympanic part of temporal bone; 1 and 2 = anterior and posterior slope of condyle; 3 and 5 = posterior and anterior inferior disc attachments; 8 and 10 = posterior and anterior superior disc attachments; 4 and 9 = inferior and superior surface of articular disc; and 6 and 7 = anterior and posterior part of temporal articular surface. (Celloidin sections, Goldner, original magnification × 6 [*a*] and × 4 [*b,c*]; bars = 2 mm).

grams. From the primary absolute measurements of the inferior and superior disc and attachment lengths, relative values were obtained by relating these absolute data to the lengths of the condylar and temporal articular surfaces, respectively. In addition, differences in measurements between the lateral and central segments and between the central and medial segments of each particular joint were determined. For all of these values, means and standard deviations were calculated. Student's *t* tests served to statistically evaluate differences between genders, between normal and internally deranged specimens, and between joints with partial and complete anterior disc position. These tests were made separately for the lateral, central, and medial segments. For comparisons between normal and internally deranged specimens in general, normal segments of joints with partial anterior disc position were excluded from the test, as they could not, a priori, be assumed to be unaffected by the partial internal derangement. However, when comparing partial and complete anterior disc position, data from all segments of the respective specimens were included in the analysis.

Results

Among the 53 joints, 33, obtained from 8 females (average age 37.4 years) and 25 males (average age 37.0 years), exhibited a normal relationship between disc and condyle (Table 1). Of the 20 internally deranged specimens, 19, from 7 females (average age 49 years) and 12 males (average age 53.9 years), showed anterior disc position (Table 1). Most cases of internal derangement occurred in subjects from 30 to 60 years of age (Figs 1a and 1b). In males, two cases were found in the age group 15 to 20 years, but none in the age group 20 to 30 years (Fig 1a). Anteriorly positioned discs in individuals up to about 40 years of age either exhibited normal shapes or were moderately deformed, while severe disc deformation was observed only in subjects older than 40 years (Fig 1c). Likewise, partial anterior disc position in various combinations of joint segments (Table 1) was found predominantly in younger subjects, while total anterior disc position involving all segments was found primarily in older individuals (Fig 1d).

Whereas a detailed description of the microscopic appearance of the articular tissues is beyond the

Table 1 Numbers of Joints/Subjects Found With Normal Disc Position and Various Forms of Internal Derangement (Average Age)

	Females	Males	Total
Normal disc position	8	25	33
	(37.4 y)	(37.0 y)	(37.1 y)
Internal derangement	7	13	20
Posterior disc position		1	1
Anterior disc position	7	12	19
	(49.0 y)	(53.9 y)	(52.0 y)
Lateral	1		1
Lateral + central	2	3	5
	(34.4 y)	(24.8 y)	(28.6 y)
Lateral + central + medial	3	6	9
	(65.9 y)	(61.1 y)	(62.7 y)
Central+medial		1	1
Medial	1	1	2
Central		1	1

scope of this report, it is worth noting that in no joint with internal derangement did the disc attachments appear mechanically torn. Even when the disc was in a marked anterior position (Fig 2a), the posterior superior attachment followed a normal, curved course along the posterior slope of the mandibular fossa. Likewise, the posterior inferior disc attachment did not appear stretched, nor did the anterior attachments exhibit excessive folds so that they seemed to be rammed together (Fig 2).

Irrespective of the disc position, measurements of synovial cavity dimensions did not differ significantly between females and males ($P > .1$) and neither did they suggest any apparent association with age. Therefore, results obtained from males and females, as well as from various age groups, were pooled. These pooled data revealed significant effects of internal derangement on synovial cavity dimensions, particularly of the lower joint compartment (Figs 3 and 4; Tables 2 and 3). In condyles of specimens with anterior disc position, the articular surface in the central segment was shorter than normal, while in the medial segment this surface was longer than normal. The differences between normal and internally deranged joints were due mainly to discrepant lengths of the posterior condylar slope in both joints (Fig 3a). In contrast, the entire inferior surface of the disc complex, especially the posterior inferior disc attachment, was longer in joints with anterior disc position than those with normal disc position (Fig 3b). In the upper joint compartment, the lengths of the temporal articular surface (Fig 3c), as well as those of the superior disc and attachment surfaces (Fig 3d), were comparable in the two groups of specimens.

Similar to the absolute data, changes in synovial cavity dimensions from the lateral to central segments and the central to medial segments revealed different effects of internal derangement on the upper and lower joint compartments (Table 2). Intra-articular changes agreed well with the visual impressions obtained from the graphic representations in Fig 3. Thus, the length of the posterior slope and the entire articular surface of the condyle normally increased from the lateral to central segments and decreased from the central to medial segments (Table 2). In joints with anterior disc position, however, the increase from the lateral to the central segment was smaller, while for the central to the medial segments the condylar dimensions remained more or less constant. Similar changes from segment to segment and similar differences between normal and internally deranged joints as those noted in the condyle were seen with respect to the posterior inferior disc attachment (Table 2). The length of the anterior inferior attachment, however, did not normally change from the lateral to central segments, but decreased from the central to medial segments; whereas in association with anterior disc position, it increased considerably from the lateral to central segments and decreased correspondingly more from the central to medial segments (Table 2). In the upper joint compartment, significant effects of internal derangement were observed only with respect to the anterior superior disc attachment, which increased in length less than normally from the lateral to central segments and more than normally from the central to medial segments (Table 2).

In accordance with the absolute measurements of condylar and inferior disc surfaces, the relative lengths of the anterior and posterior inferior disc attachments were significantly higher in internally deranged joints than in normal joints (Fig 4a). The only exception from this general trend was seen regarding the anterior attachment in the medial joint segment. Again, in contrast to those of the inferior disc and attachment surfaces, the relative lengths of the superior disc and attachment surfaces seemed little affected by anterior disc position (Fig 4b). When changes in relative lengths of the disc complex from segment to segment were analyzed (Table 3; Fig 4), significant differences between normal and internally deranged joints were found with respect to the alteration from the lateral to the central segment in the posterior inferior disc attachment, as well as with respect to the changes from the central to the medial segment in the anterior inferior disc attachment, the inferior surface of the disc, and the total inferior surface of the disc complex (Table 3).

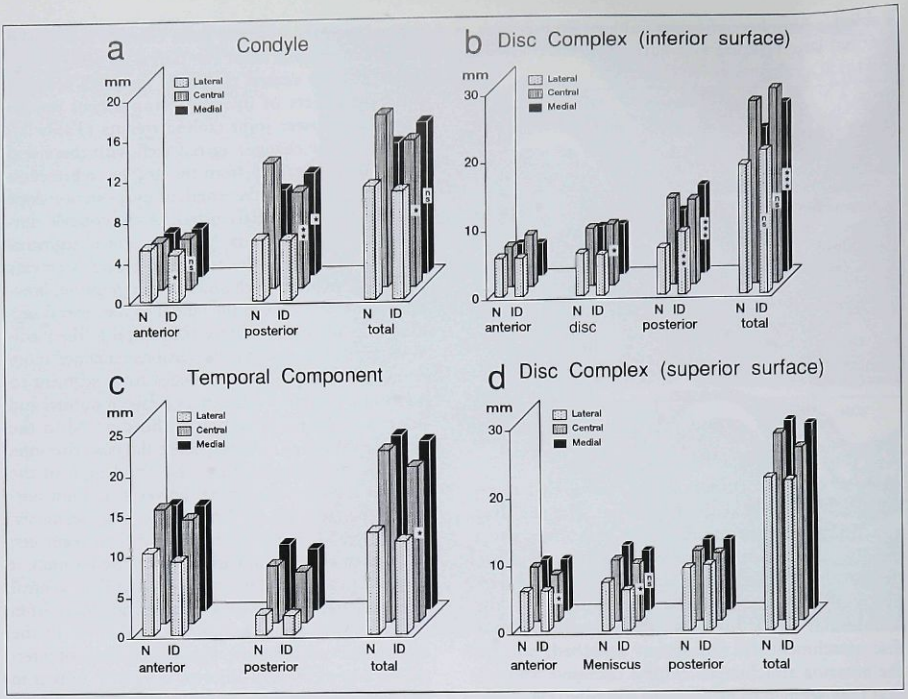


Fig 3 Absolute lengths of components of condyles (*a*); inferior surface of disc complex (*b*); temporal component (*c*); and superior surface of disc complex (*d*). (N = normal joint, ID = internally deranged joint. ns = .1 ≥ *P* > .05; * = .05 ≥ *P* > .01; ** = .01 ≥ *P* > .001; *** = .001 ≥ *P*.)

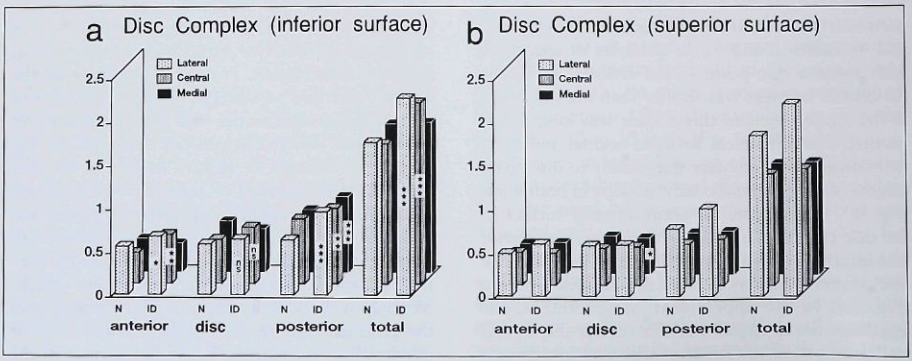


Fig 4 Relative lengths of inferior (*a*) and superior (*b*) surface components of disc complex. (N = normal joint, ID = internally deranged joint. NS = .1 ≥ *P* > .05; * = .05 ≥ *P* > .01; ** = .01 ≥ *P* > .001; *** = .001 ≥ *P*.)

Table 2 Means (SD) of Changes in Synovial Cavity Dimensions (mm) From Lateral to Central and Central to Medial Segments of Normal (N) Joints and Joints With Anterior Disc Position (ID)

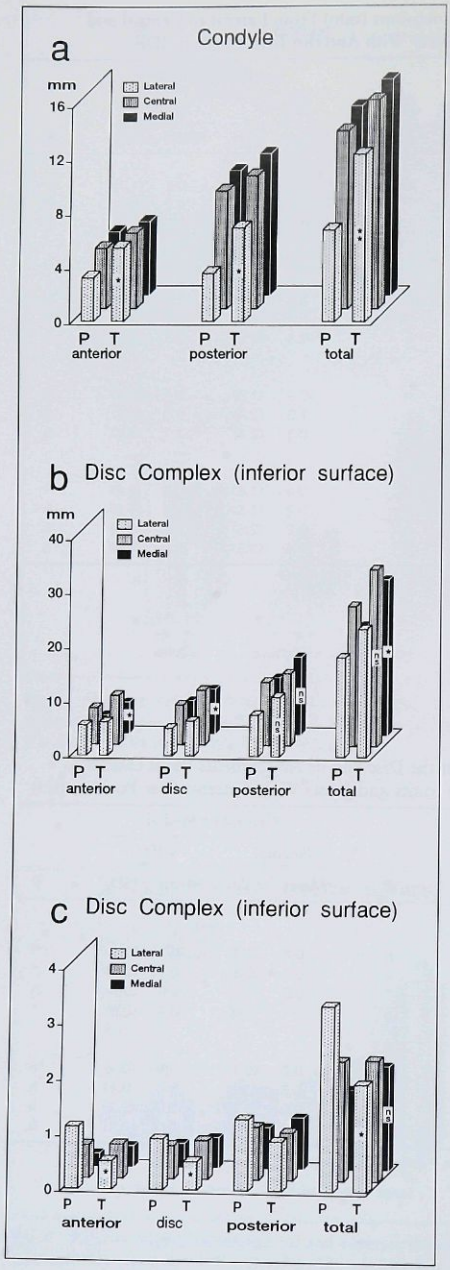
	Lateral to Central					Central to Medial				
	Normal		ID			Normal		ID		
	Mean	(SD)	Mean	(SD)	*P*	Mean	(SD)	Mean	(SD)	*P*
Condyle										
Anterior slope	−0.5	(1.8)	0.5	(1.9)	ns	−0.2	(1.1)	−0.1	(1.7)	h
Posterior slope	6.3	(2.7)	3.5	(2.4)	***	−3.8	(3.7)	0.7	(3.9)	***
Total	5.8	(3.4)	4.1	(3.3)	ns	−4.0	(3.7)	0.6	(4.9)	***
Disc complex (inferior surface)										
Anterior attachment	0.3	(2.4)	1.9	(3.6)	*	−1.1	(2.2)	−2.7	(3.2)	*
Disc	2.2	(1.9)	3.0	(4.8)	h	−1.2	(1.8)	−1.5	(2.7)	h
Posterior attachment	5.7	(3.0)	3.2	(2.6)	**	−3.2	(3.5)	0.6	(4.8)	**
Total	8.2	(4.3)	8.1	(7.2)	h	−5.5	(4.2)	−3.7	(5.3)	h
Temporal component										
Anterior part	4.0	(2.6)	3.8	(3.1)	h	−0.9	(1.9)	0.5	(3.2)	ns
Posterior part	4.6	(2.5)	3.9	(2.5)	h	1.3	(2.4)	1.3	(3.5)	h
Total	8.8	(3.4)	7.8	(3.9)	h	0.3	(2.4)	1.7	(5.4)	h
Disc complex (superior surface)										
Anterior attachment	2.2	(1.6)	1.0	(1.1)	*	−0.4	(1.6)	0.9	(2.2)	*
Disc	1.8	(2.4)	2.3	(3.0)	h	0.7	(1.5)	0.4	(1.4)	h
Posterior attachment	1.0	(3.3)	0.2	(3.8)	h	0.2	(2.3)	0.5	(3.5)	h
Total	5.2	(5.0)	3.3	(4.5)	h	0.4	(3.5)	2.0	(4.9)	h

Levels of significance: h = $P > .1$, ns = $.1 \geq P > .05$, * $.05 \geq P > .01$, ** $.01 \geq P > .001$, *** $.001 \geq P$.

Table 3 Means (SD) of Changes in Relative Lengths of the Disc and its Attachments From Lateral to Central and Central to Medial Segments of Normal (N) Joints and Joints With Anterior Disc Position (ID)

	Lateral to Central					Central to Medial				
	Normal		ID			Normal		ID		
	Mean	(SD)	Mean	(SD)	*P*	Mean	(SD)	Mean	(SD)	P
Disc complex (inferior surface)										
Anterior attachment	−0.2	(0.3)	-0.1	(0.5)	h	0.0	(0.3)	−0.2	(0.4)	**
Disc	−0.1	(0.2)	0.0	(0.5)	h	0.1	(0.3)	−0.1	(0.3)	*
Posterior attachment	0.1	(0.3)	−0.1	(0.4)	*	0.0	(0.1)	0.0	(0.3)	h
Total	−0.1	(0.6)	−0.2	(1.1)	h	0.1	(0.6)	−0.4	(0.8)	*
Disc complex (superior surface)										
Anterior attachment	−0.1	(0.1)	−0.2	(0.3)	ns	0.0	(0.1)	0.0	(0.1)	h
Disc	−0.2	(0.1)	−0.2	(0.3)	h	0.0	(0.1)	0.0	(0.1)	h
Posterior attachment	−0.3	(0.3)	−0.5	(0.6)	h	0.0	(0.1)	0.0	(0.2)	h
Total	−0.6	(0.5)	−0.9	(1.2)	h	0.0	(0.2)	0.0	(0.3)	h

Levels of significance: h = $P > .1$, ns = $.1 \geq P > .05$, * = $.05 \geq P > .01$, ** = $.01 \geq P > .001$, *** = $.001 \geq P$.



For comparison of partial and total internal derangement, the joints of subjects with anterior disc position in the lateral and central segments (2 females, average age 34.4 years; 3 males, average age 24.8 years) were compared to nine specimens (3 females, average age 65.9 years; 6 males, average age 61.1 years) in which all three segments were affected. Average ages differed significantly.

Significant differences in absolute measurements between specimens with partial and total anterior disc position were observed regarding the condylar articular surface in the lateral segment and regarding the inferior surface of the disc complex in the medial segment (Figs 5a and 5b). In the lateral segment, the lengths of both the anterior and posterior slope, as well as of the entire articular surface of the condyle (Fig 5a), were greater; in the medial segment, the inferior surfaces of the disc and its attachments (Fig 5b) were longer in joints with total internal derangement than those with partial internal derangement. As a result, relative lengths of the anterior inferior disc attachment, the inferior surface of the disc, and the entire disc complex were significantly larger in the lateral segment of joints exhibiting partial anterior disc position (Fig 5c). In the remaining two segments (Fig 5c) and in the upper joint compartment, the relative size of the disc complex was similar in both forms of internal derangement.

Discussion

The results indicate that anterior disc position is associated primarily with deviations in the dimensions of the inferior synovial cavity. In particular, the posterior and anterior inferior disc attachments were too long relative to the size of the condylar articular surface. In terms of absolute measurements, this discrepancy seemed to be due both to comparatively large attachments and a small condylar articular surface.

Although the joints examined were collected without being selective, and although the age of the individuals from whom they were obtained

Fig 5 Absolute lengths of components of condyle (*a*) and inferior surface of disc complex (*b*), as well as relative lengths of components of inferior surface of disc complex. (P = partial anterior disc position, T = total anterior disc position. ns = $.1 \geq P > .05$; * = $.05 \geq P > .01$; ** = $.01 \geq P > .001$; *** = $.001 \geq P$.)

was similar to that of clinical samples,[3,7,8,15,16,25-27] a comparatively high frequency of anterior disc position was found in both females (47%) and males (32%). These numbers also exceed the prevalence of about 20% to 30% indicated by epidemiologic studies[25-27] of young adults. On the other hand, our frequency data are in good agreement with those of earlier autopsy studies in considerably older samples,[17,19-22,24,38] although they are higher than those found in adolescents and young adults.[34] The consistent discrepancy in estimates of prevalence obtained from clinical examination and direct postmortem observation suggests that many joints with anterior disc position need not cause symptoms and, therefore, may remain undetected upon clinical investigation. This assumption has, in fact, been confirmed by Kircos et al[12] and Westesson et al,[13] who found 32% and 15% of asymptomatic joints as having internal derangement.

In accordance with indications from previous autopsy studies,[17,19,22,24,38] about half of the joints examined exhibited partial anterior disc position, and in a majority of these joints the discs appeared anteriorly and medially rotated. However, partial anterior disc position in the present sample occurred at significantly younger ages than did complete internal derangement. Furthermore, severe disc deformations were seen only in specimens obtained from individuals over 40 years of age. In the absence of dental history, the observations and associations found by Westesson et al[17] between joint function and configuration of the disc would allow speculation that a considerable number of anterior disc positions in younger individuals was of the reducing type, while most of the specimens obtained from older subjects represented cases of long-lasting internal derangement.

Histologic processing inevitably results in some degree of tissue shrinkage and, thus, may affect histometric measurements. In histologic preparations of the TMJ, the occurrence of spaces between the condyle or temporal component and the disc has been attributed to shrinking of the disc attachments.[39,40] Such spaces have, in fact, been observed in most of our specimens, and we cannot rule out the possibility that they are artifacts. However, tissue shrinking due to histologic processing can be assumed to similarly affect normal and internally deranged joints, although alterations in collagen fiber composition and glycosaminoglycan content of the disc attachments as a result of anterior disc position have been recorded.[28-33,41] In addition, the disadvantages of histologic processing are probably fully compensated for by the advantage of microscopic examination, which allows proper distinction between the articular disc and its attachments.[31,32] Therefore, while absolute dimensions of the synovial cavities may have been somewhat overestimated in this study, we consider the comparisons between various disc attachments, as well as between joints with normal and anterior disc position, to be reliable.

The results of our histometric evaluation can hardly be contrasted with previous data on TMJ dimensions, as these were all derived from straight linear measurements in arthrograms or macroscopic and microscopic preparations.[17,18,23,35,42,43] We can, however, confirm the finding of Öberg et al[42] that sagittal joint dimensions do not vary between females and males and are unaffected by age above 20 years. Furthermore, our data support the observation in arthrograms that the anterior recess of the inferior joint cavity is longer than normal in association with anterior disc position.[17,18] In contrast to suggested measurements of the size of the posterior recess,[18] our results indicate that the length of the posterior inferior disc attachment also, and even more than the anterior one, is affected by internal derangement. Thus, the entire cap constituted by the disc and its attachments appeared to be abnormally large in relation to the condylar head on which it sits. The discrepancy in size of the two components was due not only to the cap being too large, but also to the head being too small. This applied equally to internally deranged as compared to normal joints, and to joints exhibiting partial as compared to total anterior disc position. Hence, effects on the cap and the head seem to exist not only in cases of presumed long-lasting internal derangement, but also in specimens where anterior disc position might have been present for a comparatively short time. With regard to the present method of measurement, a deviation in condylar size does not necessarily indicate a difference in overall condylar volume. As the boundary length of the articular surface was recorded, a deviation in condylar size could also point to diverging sites of insertion of the anterior and/or posterior disc attachments.

In contrast to the dimensions of the lower synovial cavity, the size of the upper cavity seemed little affected by internal derangement. This does not agree with the finding of excessive condylar mobility in patients suffering from anterior disc position,[14,16,43] as translation of the condyle seems to be restrained primarily by the wall of the upper joint compartment.[37]

Discrepancies in size of the condyle and disc complex, such as described above, conceivably could be primary or secondary. A primary discrep-

ancy would exist if during prenatal development the disc was built too large and/or the condyle was built too small, or if the disc attachments were inserted at aberrant sites on the condylar surface. As a result, the disc could be formed primarily in an anterior position, which consequently could be considered a normal anatomic variation as suggested by Hellsing and Holmlund.[11] On the other hand, a primary discrepancy in size of the condyle and disc complex could also be associated with a primarily normal disc position but constitute a predisposing factor for later development of disc displacement. Support for the concept of a primary, constitutional discrepancy is lent by the observation of systemic joint laxity in patients with clinical signs of internal derangement.[3,27] Furthermore, joint sounds pointing to a disturbed articular function have been recorded already in infants, although these symptoms seem to be rare and usually transient.[44]

True anterior disc displacement, as distinct from anterior disc position, would also have to be assumed if it resulted from an altered relationship in size of joint components that previously had been normal. Such a secondary discrepancy could be due to articular remodeling that, in turn, could be related to normal biologic adaptation or degeneration. Remodeling of the TMJ associated with normal adaptation to altered functional demands seems to be particularly prominent during late growth and early maturity, which is when the condyle undergoes considerable changes in overall shape.[34,42] This observation is compatible with the relatively frequent occurrence of signs and symptoms of internal derangement in adolescents and young adults, signs and symptoms which are commonly transient.[25-27] However, articular remodeling is not confined to the growth period, but apparently continues throughout life and at more advanced ages may merge gradually and imperceptibly in osteoarthritis, ie, degeneration.[42,45,46] Osteoarthritis is always associated with marked remodeling of articular cartilage, subchondral bone, capsule, and ligaments[22,45,47] and could well account for the discrepancies in size of the joint components found in this study. In fact, internal derangement is significantly associated with osteoarthritis,[11,22,32,38] and Stegenga et al[48] have proposed recently that osteoarthritis might be the main basic disorder underlying craniomandibular dysfunction.

Finally, effects of trauma[2-4] and overstretching conceivably could account for the development of true disc displacement. It should be emphasized, however, that we did not detect any sign for immediate antecedence of such an acute event, as none of the disc attachments in the internally deranged specimens appeared mechanically torn. This finding strongly indicates that whatever the primary cause of the disc displacement, it has elicited considerable adaptive remodeling of the joint wall. Such adaptive remodeling, particularly of the posterior disc attachments, has also been suggested by several other investigations.[29-31,33,41,49] On the other hand, the absence of signs for mechanical stretching of the joint wall is also compatible with the concept of a primary anterior disc position.

Conclusion

Our findings suggest that a discrepancy in size of the disc complex and the condyle or an aberrant insertion of the disc attachments at the condyle, either constitutional or as a consequence of remodeling, may result in primary anterior disc position or constitute a predisposing factor for development of anterior disc displacement.

Acknowledgments

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Resumen

Estudio Histométrico de la Cavidad Sinovial de las Articulaciones Temporomandibulares en Humanos cuyos Discos Están en Posiciones Normales y Anteriores

Se midieron las longitudes sagitales de las superficies condilares, temporales y del disco articular, lo mismo que aquellas correspondientes a las inserciones del disco; por medio de cortes histológicos de articulaciones temporomandibulares de humanos para evaluar los efectos del malfuncionamiento interno. Los especímenes fueron obtenidos en el momento de realizar la autopsia principalmente de adolescentes, adultos jóvenes y personas de edad madura. Mientras que el compartimiento superior de la articulación aparecia un poco afectado, la posición anterior del disco estaba significativamente asociada con las inserciones de los discos compartivamente inferiores y largas y con una superficie articular condilar corta, lo cual indicaba posiblemente que existían inserciones aberrantes. Tales discrepancias en el tamaño o la alineación entre el complejo del cóndilo y del disco, podrían reflejar una desviación constitucional primaria o haber resultado secundariamente de la remodelación.

Zusammenfassung

Histometrische Studie der Synovialraum-Dimensionen menschlicher Kiefergelenke mit normaler und anteriorer Diskusposition.

In der Absicht, Effekte von abnormaler Diskusposition abzuschätzen, wurden die Synovialräume menschlicher Kiefergelenke in histologischen Sagittalschnitten ausgemessen. Die Gelenke wurden bei Autopsien von mehrheitlich Adoleszenten, jungen Erwachsenen und Individuen mittleren Alters entnommen. Histometrisch wurden die Längen der Gelenkflächen von Kondylus, temporaler Komponente und Diskus sowie der Diskusbefestigungen gemessen. Während die Dimensionen des oberen Gelenkkompartimentes von der Anordnung des Diskus nur wenig beeinflusst schienen, war anteriore Diskusposition signifikant verbunden mit vergleichsweise langen Diskusbefestigungen am Kondylus und einer kurzen kondylären Gelenkoberfläche, das heisst einem möglicherweise abnormalen Ansatz der Befestigungen. Solche Diskrepanzen in Grösse oder Anordnung von Kondylus und Diskuskomplex könnten sowohl Ausdruck einer primären, konstitutionellen Abweichung sein als auch von Umbauprozessen herrühren.