Mandibular Posterior Displacement: Its Relationship to Orthodontic Diagnosis and Treatment

CHARLES G. SLEICHTER,* D.D.S., M.S.
Iowa City, Iowa

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The relationship of the mandibular condyle to the glenoid fossa as associated with various mandibular positions is a subject of considerable debate (1, 15, 17, 23, 24).

Functional anterior movement of the mandible from centric position** varies considerably and is not normally limited by bony parts of the skull.

Posterior movements of the mandible are restricted by definite calcified structures: the post glenoid process and the tympanic part of the temporal bone. The space available posterior to the condyles, when the mandible is in centric position with the condyles in a normal location in their fossae, is the determining factor in posterior displacement of the mandible.

If the mandible can be displaced posteriorly from a position where the condyles are well centered in the glenoid fossae to a new position in which the teeth occlude one cusp distal to centric occlusion, this distal displacement becomes significant in the diagnosis and treatment of deformities of the face and malocclusion of the teeth. A glenoid fossa large enough to permit this amount of distal displacement would allow a normal occlusion to be transformed into an undesirable malocclusion by environmental factors. This would be accomplished by movement of the lower jaw and teeth backward from a functionally and esthetically desirable centric position to an undesirable retrusion of the mandible. Assuming that such a hypothetical malocclusion has been produced, the treatment would consist simply of removing the causative agents affecting the displacement. The main factor in any consideration of posterior mandibular movement, from a functional condylar location, is the anatomical structure of the temporomandibular joint.

The purpose of this paper is to present measurements and data concerning:

1. Condylar location as related to centric position of the mandible.
2. Space available for posterior condylar movement from a centric position of the mandible.
3. Condylar location associated with an anterior movement of the mandible from centric position.

MATERIALS AND METHODS

The material used in this study consisted of 71 dry human skulls, 33 clinical subjects and 40 laminagraphic X-rays of the right and left temporomandibular joints of living humans.

The skulls were obtained from:

* National Institute of Dental Research, National Institutes of Health, Public Health Service, U. S. Department of Health, Education and Welfare, Bethesda, Maryland.

** Centric occlusion when used in this paper refers to a functional interdigitation of the teeth. In this position the condyles of the mandible are not necessarily in the most retruded location in the glenoid fossa.
Centric position refers to the location of the mandible when the teeth are in centric occlusion.

A. The Smithsonian Institution, Division of Physical Anthropology. This group was comprised of skulls of Indians, Chinese, Eskimos, Tibetans and Germans as listed in Table I.
B. Howard University, Department of Anatomy. Twenty-six modern adult negro skulls were examined.
C. University of Alabama, Department of Anatomy. Two child skulls were examined.

Selection of the above material was made on the basis of integrity of the skull, temporomandibular joint fossa and mandibular condyle and the presence of sufficient teeth to determine centric occlusion.

All joint relationships were evaluated in the same manner. The teeth were first brought into centric occlusion without reference to the condylar area. After mandibular relationship to the skull was thus established, the temporomandibular joint was inspected and the position of the condyle was noted. Following this, the mandible was forced backward until impeded by the osseous structures posterior to the condyle. At this time, the occlusal position was again noted and the amount of posterior mandibular movement from centric occlusion was recorded in fourths of a cusp.*

The subjects for laminagraphic examination and clinical observation were individuals reporting for screening and treatment at the Dental Clinic of the National Institute of Dental Research. None of the subjects examined or radiographed had received previous orthodontic treatment. Twenty-eight children and five adults were examined for a potential posterior movement of the mandible from a position determined by centric occlusion of the teeth. This movement was accomplished by patient effort, forceful manipulation by the examiner, postural position (head of subject tipped back as far as possible so as to tense the supra- and infra-hyoid muscles) or a combination of these methods. Posterior movement was measured in fractions of a cusp.

Forty laminagraphic roentgenograms were made of the left and right temporomandibular joint of twenty additional children and adults. These subjects were positioned in a device similar to the one described by Ricketts.[16] Positioned laminagraphy was used in preference to other roentgenographic methods since it is the only technique providing a reproducible cross section of the condyle and fossa. Dental casts were made of each case and the distance required for a mandibular movement from a position of centric occlusion to a posterior position, the width of one cusp, was measured. This distance was compared with the space available for distal condylar movement as measured in the laminagraphs from the head of the condyle to the post glenoid process of the tympanic part of the temporal bone.

Findings

In the material examined it was found that posterior positioning of the mandible from centric occlusion is possible, but only to a relatively small degree (fig. 1 & 2). Of the 71 skulls examined, 37 exhibited one-fourth cusp or less potential posterior mandibular movement and 31 could be displaced posteriorly more than one-quarter but less than one-half cusp from centric position (Table I).

In only one child skull was it possible to position the mandible more than one-half cusp posteriorly from centric occlusion. In two of the child specimens, sufficient posterior movement was per-

* One cusp refers to the approximate width of a premolar tooth.

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mitted to produce an approximate Class II occlusion from the normal end-to-end cuspal permanent molar relationship in the mixed dentition although the distance was slightly less than one-half cusp. It should be noted that the temporal joint fossa in the child is not as well delimited as that of the adult.

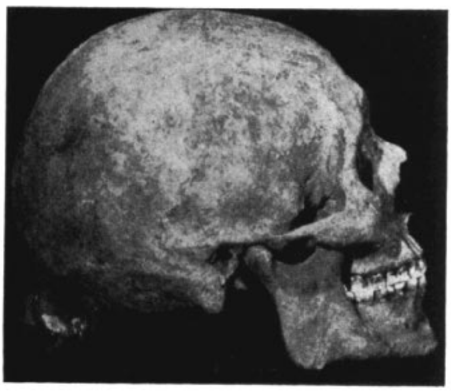

Fig. 1. Normal temporomandibular joint associated with an acceptable occlusion (skull courtesy of the Smithsonian Institution, Department of Physical Anthropology).

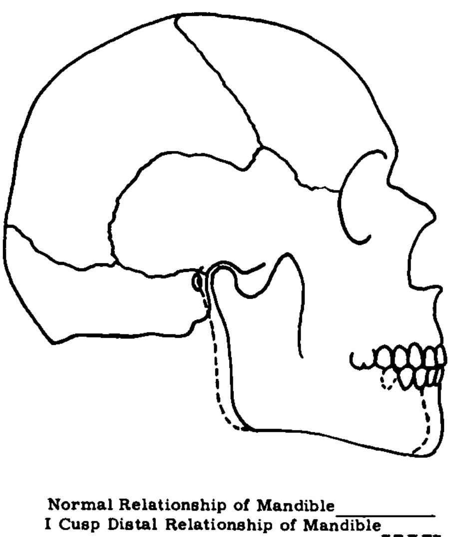

Fig. 2. Usual position that will be occupied by the average mandible associated with a Class I occlusion: 1. Normal centric occlusion; 2. Body of the mandible placed posteriorly one cusp.

Some additional skulls, in which there was gross erosion of the condylar process or articular fossa, were also examined. There appeared to be considerably more space available for posterior, superior and anterior movements of the condyle in these skulls than in those with non-pathologic joints.

None of the laminagraphs of living material evidenced sufficient space back of the condylar head for more than one-half cusp posterior mandibular movement from centric occlusion. Most

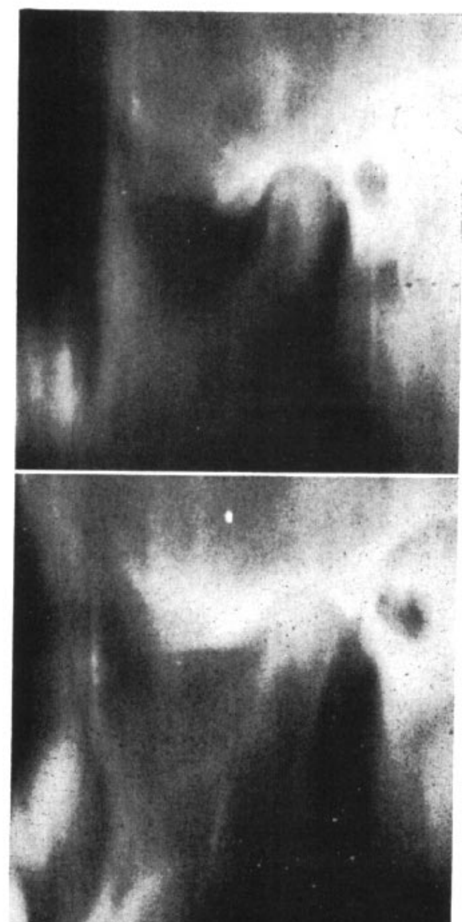

Fig. 3. Laminagraphs of the right (above) and left (below) temporomandibular joints of a patient possessing a Class I dentition (centric occlusion).

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TABLE I

Source	Physical Develop. Stage (1)	Angle Classif. of Occlusion (2)	Distal Move. Possible from Centric —¼	—½	+½ Cusp	Location of Head of Condyle in Articular Fossa	Pathology of Joint (3)	Degree of Dental Abrasion (4)
S. Dak. Ind.								
315,533	Adult	I	x			Average	None	I.
315,535	Adult	I*	x			Average	L	A.
315,541	Adult	I		x		Average	N	M.
315,536	Adult	I(**) (*)		x		Average	N	A.
315,542	Adult	I		x		Average	L	M.
315,538	Adult	I(*) (**)	x			Average	N	A.
315,539	Adult	I		x		Average	N	M.
315,544	Adult	I		x		Average	N	M.
Chinese								
3,078	Adult	II Sub.	x			Average	N	M.
780	Adult	II Sub.		x		Average	N	M.
3,079	Adult	I		x		Average	N	
263,130	Adult	II		x		Average	N	M.
225,299	Adult	I	x			Average	N	I.
Tibetan								
326,321	Adult	II Sub.	x			Average	N	I.
363,714	Adult	I	x			Average	N	
363,717	Adult	III	x			Average	N	I.
363,716	Adult	I	x			Average	R	M.
363,719	Adult	II	x			Average	N	M.
Zuni Ind.	Dec. Dent.	I		x		Average	N	I.
Alaska Eskimo								
363,544	Mixed Dent.	I			x	Average	N	I.
363,542	Mixed Dent.	I	x			Average	N	I.
363,548	Adult	I	x			Average	N	
363,658	Mixed.	I	x	x		Average	N	I.
346,193	Mixed.	I	x			Average	N	I.
346,031	Mixed.	I	x			Average	N	I.
Oregon Ind.								
243,598	Adult	I(**)	x			Average	N	A.
243,600	Adult	I	x			Average	N	A.
243,605	Adult	II Sub.	x			Average	N	A.

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Table I (Continued)

Source	Physical Develop. Stage (1)	Angle Classif. of Occlusion (2)	Distal Move. Possible from Centric —¼	—½	+½ Cusp	Location of Head of Condyle in Articular Fossa	Pathology of Joint (3)	Degree of Dental Abrasion (4)
243,603	Adult	II	x			Average	N	A.
243,922	Adult	I	x			Average	N	M.
347,002	Adult*	I	x			Average	N	A.
374,010	Adult	I		x		Average	L	M.
Penna. Ind.								
288,368	Adult	I		x		Average	N	I.
306,989	Adult	I		x		Average	R	M.
Patagonian Ind.								
279,995	Adult	I		x		Average	N	M.
Bolivian Ind.								
262,486	Adult*	II Sub.	x			Average	N	I.
311,212	Adult*	I	x			Average	N	I.
Modern German								
272,473	Adult	I	x	x		Average	N	M.
272,466	Adult	II Sub. (***)	x			Average	N	I.
270,998	Adult	II Sub.	x			Average	N	I.
272,453	Adult	I	x			Average	N	I.
270,994	Adult	I(**)	x			Average	N	M.
258,859	Adult	I(**)	x			Average	N	I.
Howard U. Negro								
7	Adult	I****	x	x		Average	N	M.
8	Adult	I****	x			Average	N	M.
13	Adult	I	x	x		Average	N	M.
15	Adult	I unilateral cross bite (**)		x		Average	N	M.
17	Adult	I(***)	x			Average	N	I.
18	Adult	I						A.
20	Adult	I(**) (***)	x			Average	N	
21	Adult	II Sup| (**) (***)	x			Average	N	
24	Adult	I(**) Mal.	x			Average	N	
26	Adult	II Sub. (**)	x			Average	N	M.
30	Adult	I(***)	x			Average	N	
31	Adult	I	x			Average	N	I.
54	Adult	I(**)	x			Average	N	I.
68	Adult	I		x		Average	N	

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Table I (Continued)

Source	*Physical Develop. Stage (1)*	*Angle Classif. of Occlusion (2)*	*Distal Move. Possible from Centric* —¼	—½	+½ *Cusp*	*Location of Head of Condyle in Articular Fossa*	*Pathology of Joint (3)*	*Degree of Dental Abrasion (4)*
70	Adult	I(**)	x	x		Average		
71	Adult	I(**) (***)		x		Average	N	
76	Adult	I(**)						
77	Adult	III(**)	x			Average	N	
81	Adult	I(***)		x		Average	N	
98	Adult	I(**)		x		Average	R	A.
114	Adult	I(**)	x			Average	N	
119	Adult	I(**)		x		Average	N	I.
121	Adult	I(**)	x			Average	N	A.
189	Adult	I**		x		Average	N	A.
125	Adult	I**		x		Average	N	A.
159	Adult	I		x		Average	N	A.
Univ. of Alabama								
1	Mixed Dent.	I		x		Average	N	I.
2	Mixed Dent.	III		x		Average	N	I.

Footnotes:

(1) Physical development *Bound skull

(2) Angle Classification *End to end incisor relationship

**Mutilated (one or more teeth within the arch have been extracted)

***Extreme malocclusion

****Excellent occlusion

(3) Pathology of Joint — Noted as erosion or resorption of condyle or fossae:

N—No Pathology

R or L—Denotes same pathologic changes in either the right or left joint

(4) Degree of Dental Abrasion: I—Insignificant

M—Moderate

A—Advanced

(5) No. 363,717—A degree of warping of this mandible made bilateral seating of the condyles impossible due to interference at the medial surfaces of the condylar heads.

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of the laminagraphs indicated the possibility of approximately one-fourth to one-half cusp posterior mandibular movement from centric position (Fig. 3).

All the condyles in the study skulls and laminagraphs were in a nearly central position anteroposteriorly in the fossa with a tendency to be slightly nearer the posterior slope of the articular eminence. Exact linear measurements of the articulated joint were not included due to the difficulty of making accurate reproducible recordings of these inaccessible areas.

A grossly well centered position of the condyle was found in all the material examined, regardless of occlusion, mutilation of the dental arch and/or loss of one or several posterior teeth, extreme premature contacts or any other dental or skeletal condition encountered (Fig. 4). Anterior positioning of the mandible the width of one cusp invariably placed the condyle well down upon the articular eminence (Fig. 5). In the dry skulls examined, the articulating surface of the head of the condyle conformed remarkably well to the functioning surface of the temporal joint. Although not measured in degrees, the slope of the articular eminence did not appear to be consistently flattened in cases presenting marked abrasion of all teeth (Figs. 6 and 7).

Pathosis of the joint did not appear to be directly related to gross malocclusion. This observation was made on the basis of the lack of morphologic changes of the joint in many skulls afflicted with severe malocclusion.

Thirty-three subjects were examined clinically. In twenty-three of these cases the mandibles could be positioned posteriorly from centric occlusion one-fourth cusp or less and in the remaining

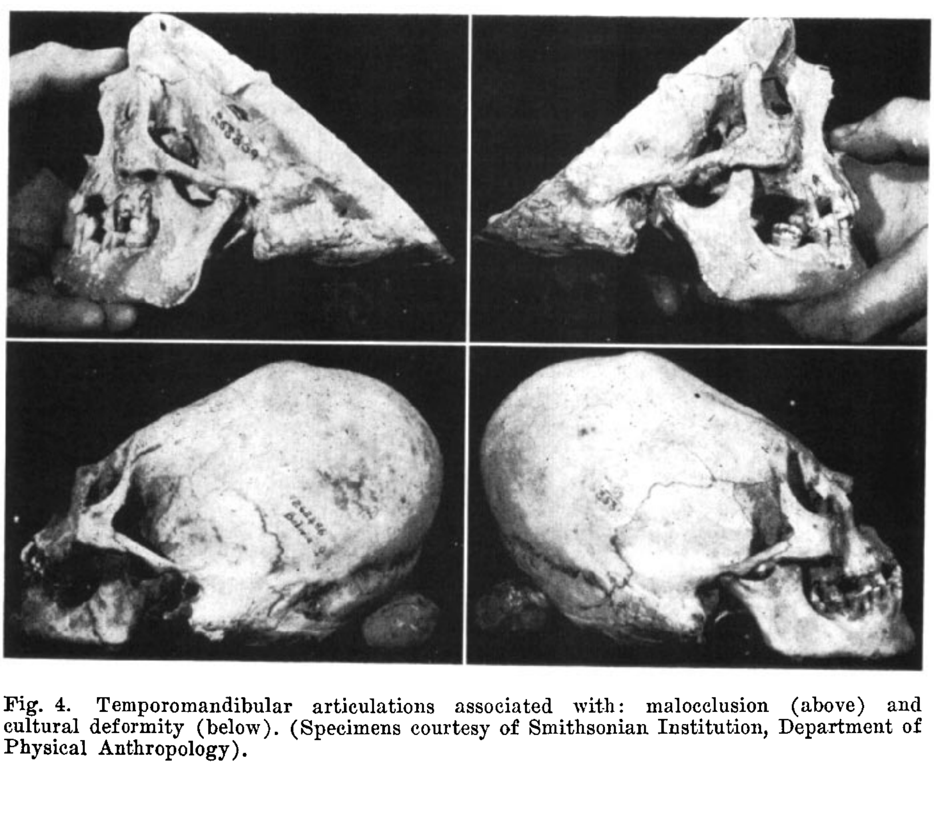

Fig. 4. Temporomandibular articulations associated with: malocclusion (above) and cultural deformity (below). (Specimens courtesy of Smithsonian Institution, Department of Physical Anthropology).

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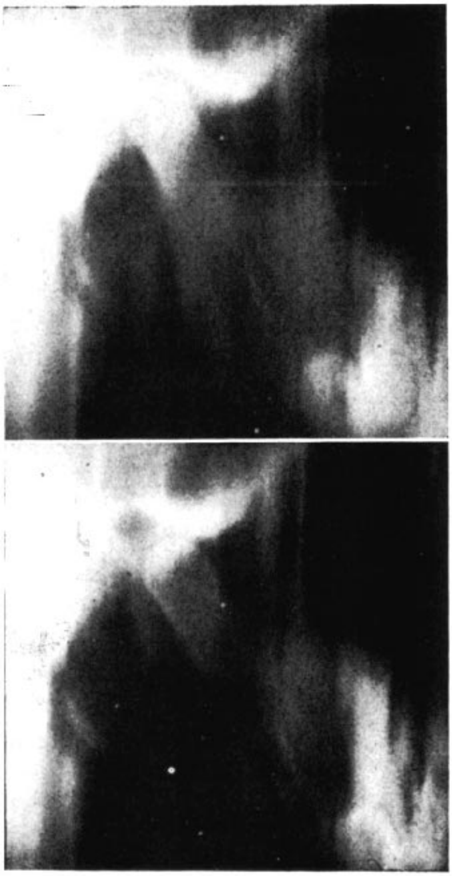

Fig. 5. Laminagraphs of temporomandibular joint (acceptable occlusion): in centric occlusion (above) and with mandibular teeth occluded approximately one cusp anterior to centric occlusion (below).

ten less than one-half cusp.

The limiting factor in posterior movement of the condyle in dry skulls was primarily the posterior lip of the temporal fossa (post glenoid process). However, in many cases the tympanic part of the temporal bone also limited posterior condylar movement.

Discussion

Several investigators [2,4,12,14] have mentioned that certain apparent Class II occlusions are in reality Class I occlusions in which the mandible is being forced distally into a Class II occlusion by environmental factors (Fig. 8). It has also been suggested that these Class II occlusions can often be treated with the use of flat maxillary bite plane or occlusal bite blocks. These appliances prevent full closure of the mandible and decrease overlapping of the anterior teeth. The assumption then is that by relieving interference, the condyle will move forward from a distal, strained position to a more normal position in the fossa. The result would be a change from distal occlusion of the lower teeth to a more desirable neutral occlusion. There is some evidence which tends to indicate that this type of anterior shift of the mandible does not occur.[21, 22]

The limited posterior movement of the mandible noted in this study, from centric position, in both the living specimens and the dry skulls, does not support the contention that it is possible to thrust the mandible backward from a normal condylar position a sufficient distance to result in a new occlusion one cusp distal to normal occlusion. In fact, in the living subjects observed, less than one-fourth cusp possible distal positioning was the rule. In a few cases the mandible could be forced very slightly more than one-fourth cusp dorsally. The dry skulls, although not entirely representative of the American population, were from morphologically modern races. In the latter material, the jaws could be positioned distally a maximum of one-half cusp and usually approximately one-fourth cusp. The presence of soft tissues in the living would definitely decrease the available space posterior to the condyle.[28-31]

The work of Ricketts[23] and Wylie[24], noting that the position of the condyle and fossa can be determined from the location of the posterior surface of the condyle but only when the teeth are in centric occlusion, is supported.

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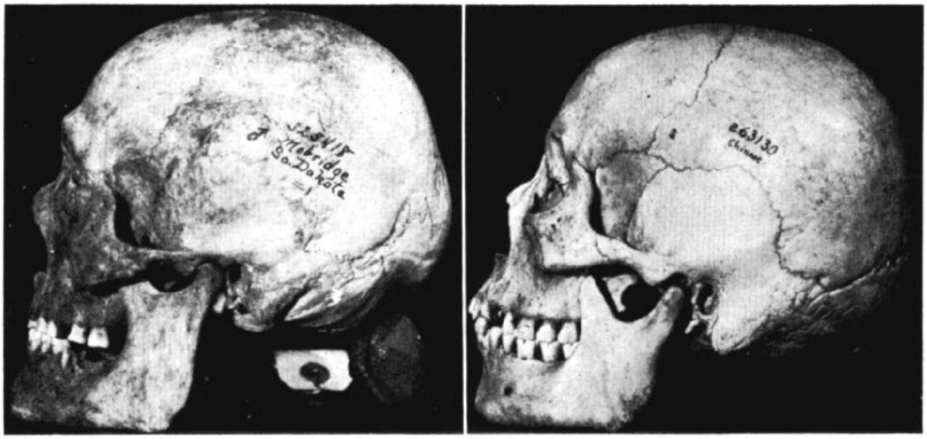

Fig. 6. Abraded dentitions associated with steep inclination of the articular eminence. (Specimens courtesy of Smithsonian Institution, Department of Physical Anthropology).

Fig. 7. Abraded dentition associated with average inclination of the articular eminence. (Specimens courtesy of Smithsonian Institution, Department of Physical Anthropology).

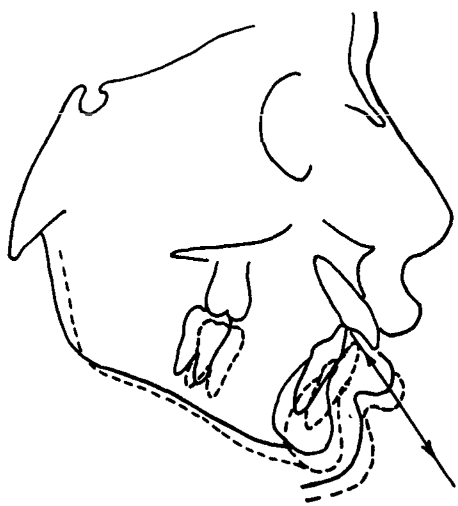

Fig. 8. Path of mandibular closure from rest position (broken line) to position of maximum cuspal interdigitation (solid line) in many Class II malocclusions.

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Ricketts has also contended that the post glenoid process does not play a role in preventing posterior condylar displacement. However, this does not seem to be invariably true. In many of the dry skulls the post glenoid process was definitely the limiting factor in posterior movement of the condyle.

It is conceivable that dental interference or chronic habits, or both, can effect a Class II dental relationship in a face which normally would be expected to contain a Class I denture. However, it appears that the condyle will still be found in the average normal relationship to the glenoid fossa. This probably represents a movement of the teeth and not a bodily movement of the mandible.

Summary

Seventy-one skulls, thirty-three clinical patients and forty laminagraphs were examined. The data accumulated indicates that:

1. Centric occlusion is closely related to a central location of the mandibular condyle in the glenoid fossa.
2. There is normally insufficient space between the posterior parts of the temporomandibular joint for significant distal movement of the mandible from a position in which the teeth are in centric occlusion. This space in the cases examined was invaribly less than one half the width of a premolar tooth.
3. Anterior movement of the mandible from centric occlusion the width of a premolar tooth places the head of the condyle out of the normal position in its fossa and well up on the slope of the articular eminence.
4. The possibility of forcing the mandible dorsally from a normal condylar relation a distance equivalent to the width of a premolar tooth is exceptional, if not the result of a morphologic abnormality.

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