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Temporomandibular Joint Relations of Bone and Lateral Pterygoid Muscle : A Computerized Tomography Study

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Abstract

TEMPOROMANDIBULAR JOINT RELATIONS OF BONE AND LATERAL PTERYGOID MUSCLE: A COMPUTERIZED TOMOGRAPHY STUDY

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This study utilized the imaging technique of computerized tomography (CT). Scans taken with a GE CT/N 8800 scanner of an adult cadaver and a 12-patient group were obtained through the Loma Linda University School of Dentistry, TMJ Department, and Loma Linda University Medical Center, Department of Neuroradiology.

The lateral scout image and a lateral cephalogram of the cadaver were compared using six angular measurements for facial type from Ricketts' Cephalometric Analysis. The six measurements, Maxillary Depth, Facial Depth, Mandibular Arc, Mandibular Plane, Lower Face Height and Facial Axis, were found to be similar. This allowed the investigator to rely exclusively on CT scans to determine facial type and to image the hard and soft tissues of the TMJ.

Axial, coronal and sagittal images were used to measure axial condylar angle, transverse condylar head dimension, antero-posterior condylar head dimension, sagittal joint interval, central and medial coronal joint interval and the lateral pterygoid muscle angle and length. The mean values for these measurements were compared with respect to facial type. Although the small sample precluded statistical analysis,

a trend toward a decreased lateral pterygoid muscle angle in an axial plane was noted in the dolichofacial group.

This application of CT was limited to studies of condylar position and lateral pterygoid muscle relations in different facial types. The relative non-invasiveness of the technique lends itself to other areas of concern to orthodontists. These include condylar and muscle responses to orthodontic treatment such as functional appliances and orthopedic mechanics. Longitudinal studies of growth and development of the lateral pterygoid muscle and other hard and soft tissues which are not imaged satisfactorily with conventional radiography are now possible.

LOMA LINDA UNIVERSITY

Graduate School

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Each person whose signature appears below certifies that this thesis in his opinion is adequate, in scope and quality, as a thesis for the degree of Master of Science.

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CHAPTER 1

Introduction

Condylar position in the glenoid fossa is an everyday concern of the orthodontist. One of the traditional ways to evaluate position is by use of a laminagraphic radiograph. Research has shown that there can be a large variation in condylar position.[2-5,9,13,15,24-26,32] Increased accuracy in determining position would make diagnosis of condylar position more useful to the clinician.

Orthodontic clinicians have come to appreciate the differences in skeletal morphology by treatment response of the different facial types. Facial types have been categorized broadly in brachyfacial, mesofacial and dolichofacial patterns. There has been some indication in the literation that condylar morphology and facial type[25] are related.

The purpose of this study, therefore, is to find a more accurate way to perform measurements and find relationships between condylar position and facial type. This would give the clinical orthodontist a more accurate way to individualize treatment of a patient based on condylar position.

CHAPTER 2

Literature Review

The first study of the morphology and relation of the TMJ utilizing a cephalometric laminagraphic technique was published by Ricketts in 1950. In this article and subsequently in 1952, he showed that the use of laminagraphy gave reproducible results. Subdividing the sample into normal, Class I, Class II and Class III malocclusions, he studied the TMJ to see if it reflected changes in occlusal relations. The resting position of the condyle was determined in 55 subjects where three relations between the mandibular condyle, glenoid fossa and the articular eminence of the temporal bone were measured. The first measurement was the space between the posterior slope of the articular eminence to the anterior border of the mandibular condyle. The second was from the superior tip of the mandibular condyle to the roof of the glenoid fossa. The third measurement was referenced to a line perpendicular to the Frankfort Horizontal Plane (FHP), a plane which passes from the superior rim of the external auditory meatus to the inferior rim of the orbit. The perpendicular line was drawn through the center of the external auditory meatus and the distance from this line to the posterior border of the mandibular condyle was recorded.

Ricketts' conclusions in regard to condylar and occlusal relations are summarized below.

1. In Class I and Class II malocclusions the relation of the

mandibular condyle to the slope of the articular eminence of the temporal bone remained constant with the teeth in occlusion.

2. In Class II malocclusions the resting position of the condyle was downward and forward when compared to the normal control group.

3. Wide variation between patients was evidenced in the normal laminagraphic measurements.

4. The standards for laminagraphic analysis of the TMJ's condyle-fossa relations for fully occluded teeth were for condyle-articular eminence space, ranging from 0.5mm to 3.0mm with a mean of 1.5mm and a standard deviation of 0.5mm. The distance between the superior tip of the condyle to the roof of the fossa had a mean of 2.5mm, a standard deviation of 1.0mm and a range from 0.5mm to 5.5mm.[26]

Other reports of similar radiographic measurement studies of TMJ relations have been made. Blascke (1981) studied corrected lateral tomograms and measured the area of the joint space anterior and posterior to the mandibular condyle. In 25 normal subjects in centric occlusion, the condyles were centered, exhibited a large variation anteriorly and posteriorly and have a low correlation between the left and right condylar relation with the temporal bone.[3,4] The subjects were not subdivided according to occlusal relations or facial types.

Dumas (1983) studied 30 subjects with normal TMJs and Class I occlusal relationships. Steiner, Downs and Tweed's analyses showed the subjects to be all within the normal range for facial classification. TMJ tomograms, corrected for condylar angulation by using a submental vertex radiograph, were taken. Linear measurements of the joint space were made with the teeth in centric relation. Anterior, superior and posterior joint spaces were measured and a combined left and right side mean of 2.37mm for the anterior space, 3.47mm for the superior space and 2.72mm for the posterior space were obtained.

The cited independent studies by Ricketts, Blascke and Dumas utilized the radiographic technique of tomography. Klein, Blattenfein and Miglino (1970) dissected the TMJ on 200 cadavers and performed radiographic TMJ studies on 100 cadavers. Their conclusion was that although the images are not as sharp as those of conventional radiographs, tomography provides three-dimensional information regarding the contours of the condyle, glenoid fossa and their relationships.

Eckerdal (1973) studied TMJs which were sectioned tomographically and histologically. Under favorable circumstances the central two-thirds of the joint was accessible for clear reproduction. Both the lateral and medial portions of the joint were blurred as a result of extra-articular anatomical and geometric-morphological factors within it. The medial portions of the joint were less accessible largely due to superimposition of the base of the skull. Joints which were narrow medio-laterally tended to be less clear than joints which provided a wider more central portion. Weinberg (2973) attached wires to outline bony landmarks on a lateral TMJ radiograph. The image was essentially a profile or cross-sectional view of the lateral third of the glenoid fossa and condyle.

Radiographs of the TMJ were used by Wilkie (1974) to compare condyle-fossa relationships with different maxillo-manidbular registrations. When intercuspation, or centric occlusion methods were used, the condyles were centered in the fossa. The centric relation method tended to position the condyles slightly posteriorly in the glenoid fossa. Condylar position of normal subjects with Class I occlusal relations in centric relation and centric occlusion using transcranial lateral oblique radiographs has also been studied.[22] In centric relation, the condyles were positioned more posteriorly and superiorly than in centric occlusion. When the subjects were positioned in centric occlusion the condyles were symmetrical antero-posteriorly in their fossae, that is the anterior joint space was equal to the posterior joint space.[27]

Three groups of anatomic structures essential to any evaluation of the TMJ have been identified. First is the joint itself, second is the teeth and their supporting structures, and third, the muscles and tendons. Complicating factors in TMJ radiography are the anatomic differences among patients, the distortions caused by geometric projections of the technique and the difficulty in reorienting the patient in the same position for serial radiographs.[13] These factors must be taken into account when examining the TMJ.

Berret (1983) stated that the TMJ is the most difficult part of the body to visualize clearly by means of x-ray films due to superimposed anatomic structures on the joint. He also summarized the various tomographic techniques used to study the joint. Linear tomography isolates a selected section for study by obscuring anatomic structures above and below the level of interest. It is considered crude by diagnostic radiologists and has largely been abandoned.

Panoramic tomography is a convenient method for screening patients with suspected fractures and deformities. The inherent distortion in this technique precludes it for detailed visualization of the TMJ. He feels it is impossible to visualize the TMJ adequately with any other method with the possible exception of CT.

CT is synonymous with computerized transverse axial tomography (CTAT), computer-assisted tomography or computerized axial tomography (CAT) and computerized transaxial transmission reconstructive tomography (CTT). Computed tomography is the accepted term by Radiology and American Journal of Roentgenology.[28] CT was described by Seerum (1982) as a cross-sectional tomographic imaging which eliminates all unwanted planes or anatomic layers using mathematical techniques. Radiation that has passed through a body from multiple angles is detected and the transmission values are stored in the computer. A cross section of absorption values for that body section is then computed. The computer reconstructs an image from these data and displays it on a television screen for viewing and photographic recording.

McCullough (1975) noted that radiography and tomography fail to demonsrrate slight differences in contrast characteristics of soft tissues. CT images tissue constrast with excellent discrimination. This is in agreement with Marshall who stated that a radiograph "does not distinguish between a homogeneous object of non-uniform thickness and a uniformly thick object of varying composition."[17]

Since the first CT brain scanner was installed in the United States[11] only 10 years ago, it is not surprising that there is only one published CT study of the TMJ.[33] CT-assisted arthrography is useful in patients who show clinical evidence of internal derangement and normal radiographic findings.[12] Wilkinson and Maryniuk (1983), using eight cadaver joints, compared CT images against sequentially dissected soft tissue slices of the same cadavers. They reported that CT was valuable in imaging the morphology of the TMJ without the invasiveness of arthrography. The image gave excellent bone definition, permitted visualization of the contour and amount of cortical bone and the condylar position within the glenoid fossa.

CHAPTER 3

Materials and Methods

A 47-year-old dentulous female cadaver was obtained through the TMJ Department of Loma Linda University School of Dentistry. Prior to rigor mortis the mandible was manipulated into a position where the teeth were fully occluded. The maxilla and mandible were wired together in the fully occluded relation. After the head was sectioned from the body at spinal level C-3 it was drained, shaved and stored frozen for later radiographic and CT studies.

A lateral cephalogram was taken of the frozen head and an acetate tracing made of the cephalogram. This was analyzed using six of Ricketts' cephalometric measurements for facial type (Figure 1). The head was then scanned using a GE CT/N 8800 scanner. A lateral scout image (Figure 2), a lateral head projection similar in appearance to a lateral radiograph of the head, was magnified 1.75 times and analyzed using the same angular measurements as the lateral cephalogram. This procedure concluded the cadaver portion of the study.

The patient group consisted of 12 dentulous non-growing adults, 8 females and 4 males, ranging in age from 20 to 82 years (both females). The subjects were selected from the computer tape records of the Department of Neuroradiology, Loma Linda University Medical Center, based on scans through the TMJ. The tape files contained 27 patients who had been scanned through the TMJ. Of these, two were edentulous and not

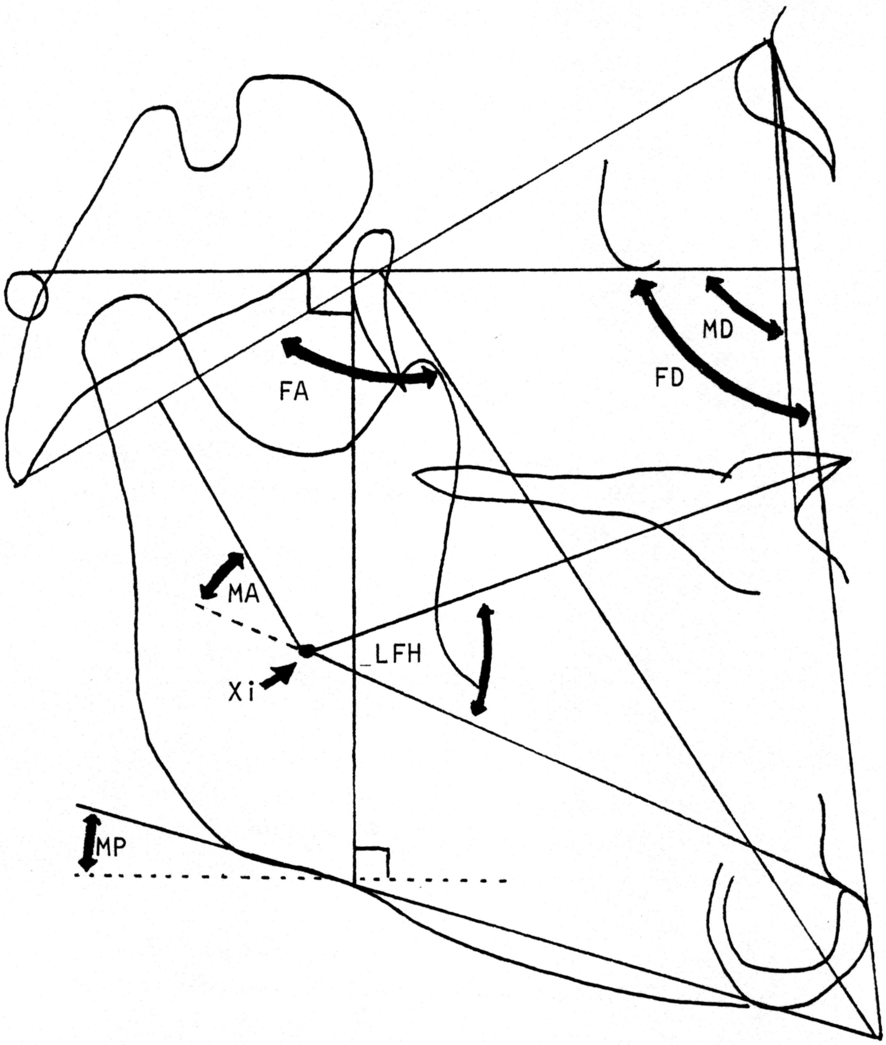

Figure 1.   LATERAL CEPHALOMETRIC TRACING OF FROZEN HEAD

The six angular measurements used to determine facial type were Maxillary Depth (MD), Facial Depth (FD), Mandibular Plane (MP), Mandibular Arc (MA), Lower Face Height (LFH) and Facial Axis (FA).

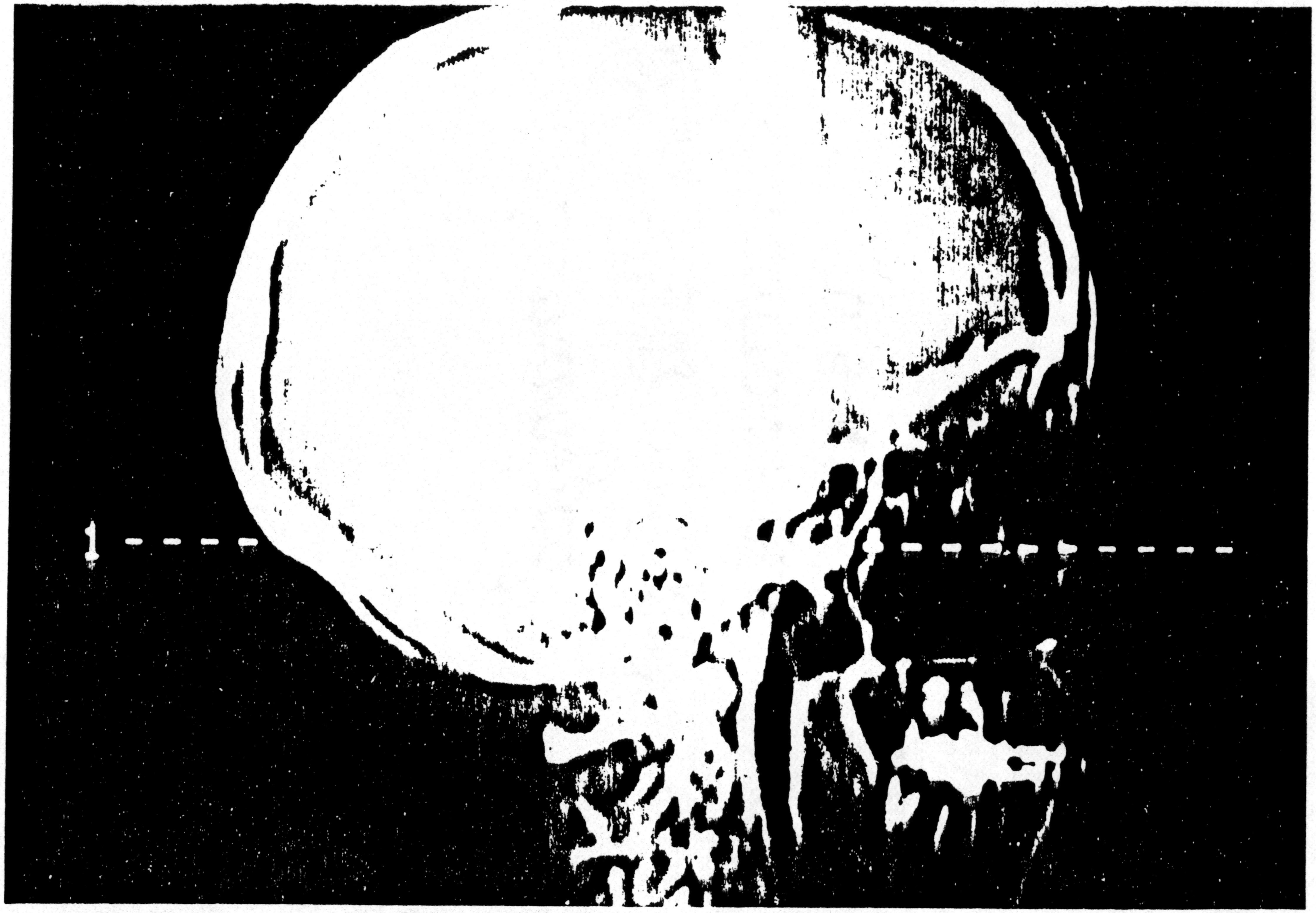

Figure 2. LATERAL SCOUT IMAGE

The dotted line (1) is the baseline to which scans are oriented. It passes from the superior rim of the external auditory meatus to the inferior rim of the orbit (Frankfort Horizontal Plane).

included in the study. A four-year-old, because of age, and 12 patients whose lateral scout images were incomplete, were also excluded, leaving only 12 subjects.

The study group had been scanned using either an internal auditory canal (IAC) or a temporal bone examination. The IAC examination, usually indicated to rule out acoustic neuromas, is taken in the axial plane at 1.5mm intervals through the entire temporal bone. When coronal examination is not possible, axial images are reformatted for a coronal reconstruction. The usual indications for this examination are facial nerve, ossicles and other structures in the temporal region. In both of these examinations the head is positioned so the CT cut is parallel to the FHP and perpendicular to the midsagittal plane.

The lateral scout of each patient was analyzed for facial type using the six angular measurements of Ricketts. Using axial, coronal, sagittal (Figure 3) and coronal reformatted images, relations of the TMJ were recorded in relation to an X-Y grid superimposed on the head with the X axis corresponding to the FHP (Figure 4). All axial sections measured were taken from a scan passing through the tip of the articular eminence in the axial plane. Sagittal and coronal scans were taken through this reference to achieve reproducible values. One operator performed all measurements to preclude interoperator error. Each measurement was recorded to the outermost edge or between lines best describing a long axis at a magnification of 1.2.

The axial images of the right and left TMJ were examined for hard and soft tissue relations. An axis was drawn through the observed long

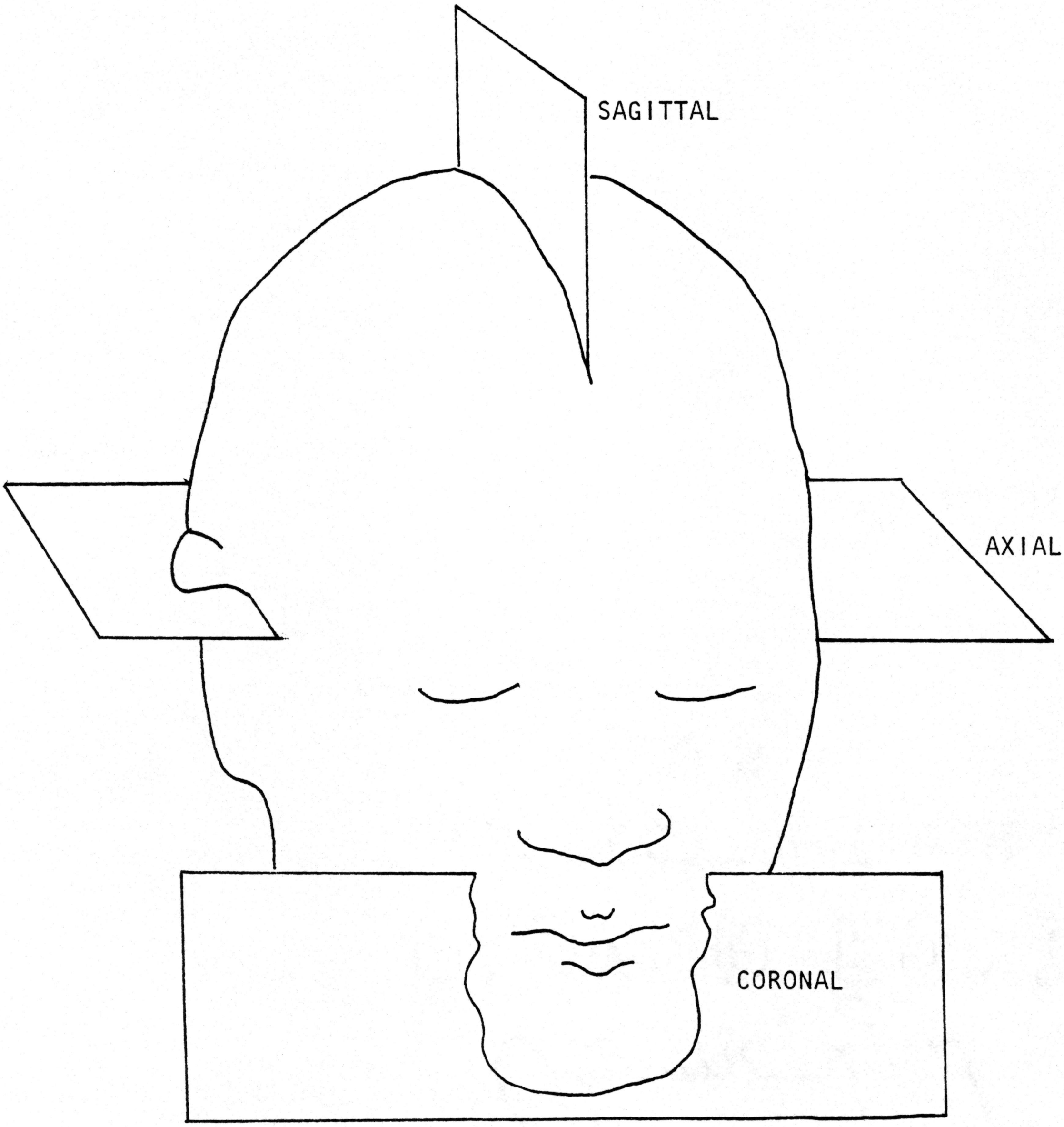

FIGURE 3. THREE PLANES IN TOMOGRAPHY

The axial plane is oriented from the superior rim of the external auditory meatus to the inferior rim of the orbit. The sagittal and coronal planes are then oriented at right angles to this baseline.

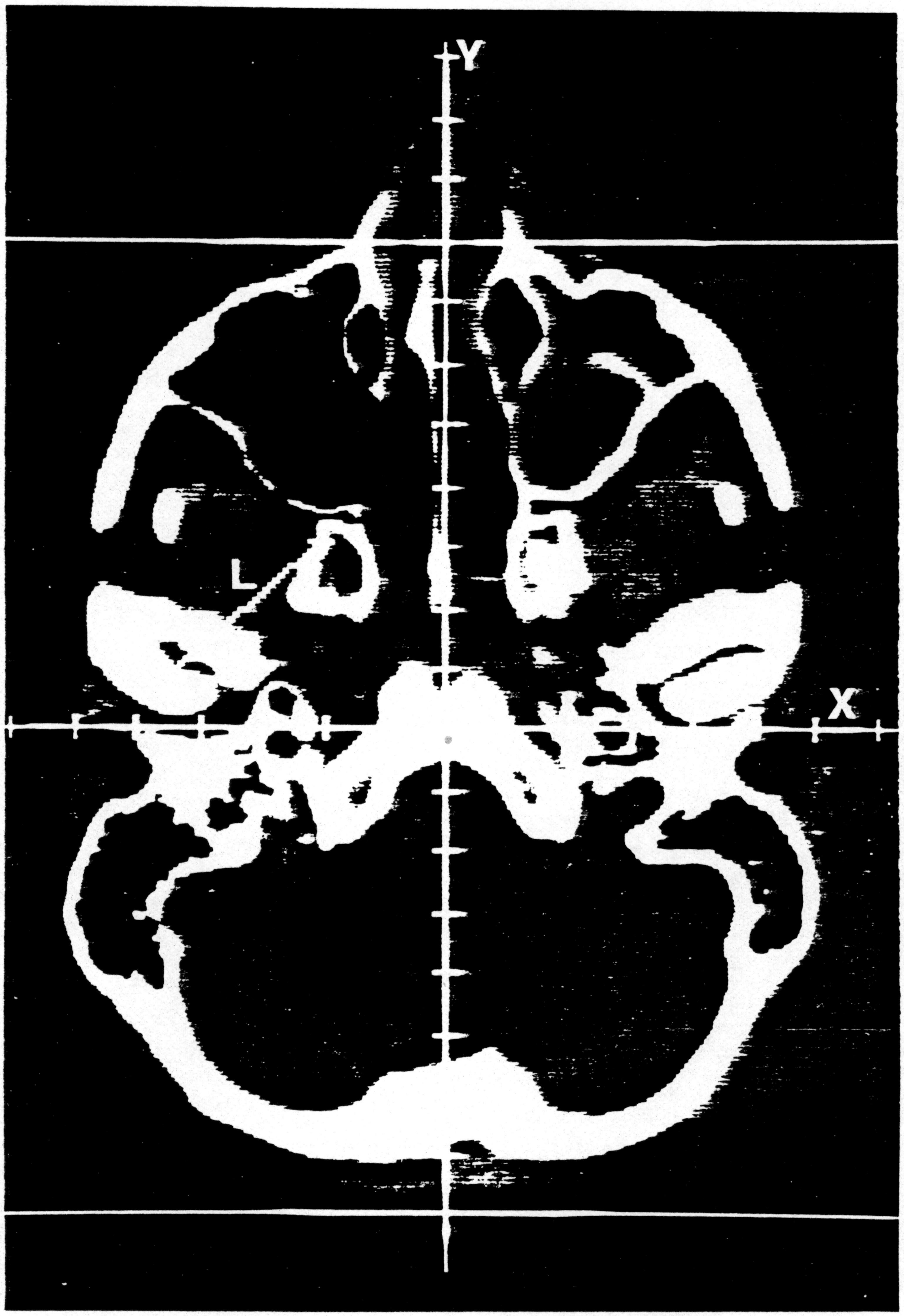

FIGURE 4. AXIAL SCAN THROUGH CONDYLES AND TEMPORAL BONE WITH SUPERIMPOSED GRID

Each division on an axis represents 1.0cm. Angular measurements such as the angle of lateral pterygoid muscle (L) were in relation to the X-axis.

axis of the right and left condyle and the angle measured against the X-axis (Figure 5). The transverse dimension of the right and left condylar head was measured as the distance from medial to lateral poles. The antero-posterior dimension was recorded as the greatest distance from anterior to posterior edges on the axial view of the condyle (Figure 6). The long axis of the lateral pterygoid was measured as an angle to the X-axis and their length measured from the lateral surface of the lateral pterygoid plate to the anterior of the mandibular condyle (Figure 7).

Sagittal images were studied to measure the interval between the outermost bone surfaces of the mandibular condyle and the posterior slope of the articular eminence of the temporal bone at their closest distance. This measurement was noted for right and left sides (Figure 8).

The interval between the outermost bone surfaces of the right and left mandibular condyle and temporal bone was obtained from coronal images of the TMJ. This interval was divided into the central joint interval, at the center of the coronal section, and the medial joint interval, measured from the medial pole of the mandibular condyle (Figures 9 and 10).

Figure 5. AXIAL SCAN THROUGH CONDYLE AND BASE OF SPHENOID

Condylar angle between the long axis (A) of the condyle (C) and the horizontal plane on an axial CT scan.

Figure 6. AXIAL SCAN THROUGH RIGHT CONDYLE AND TEMPORAL BONE

Transverse (T) and antero-posterior (A) dimension of the condyle (C) on an axial CT scan.

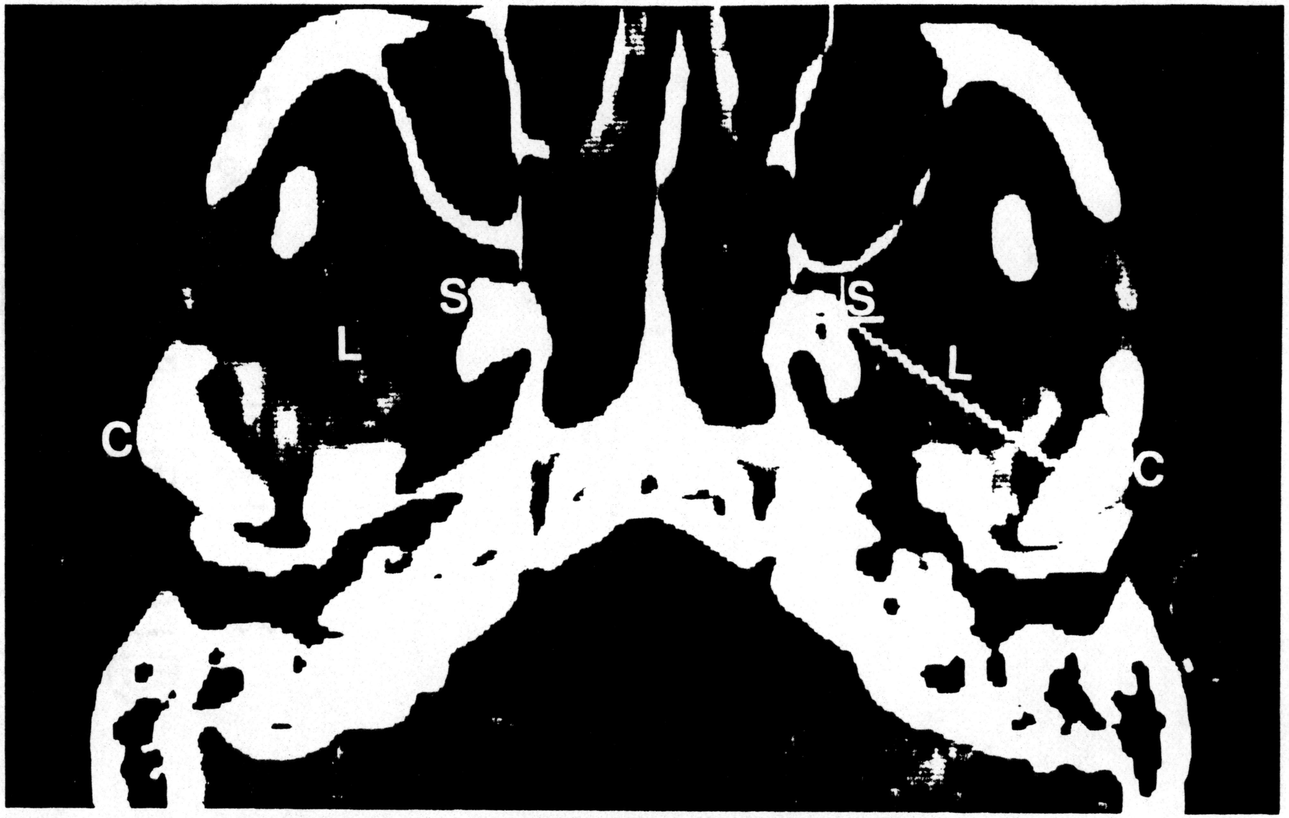

Figure 7. AXIAL SCAN OPTIMIZING SOFT TISSUE THROUGH TEMPORAL, SPHENOID AND CONDYLE

Lateral pterygoid muscle angle and length measured from its long axis (L) between the condyle (C) and lateral surface of the lateral pterygoid plate of the sphenoid (S) on an axial CT scan.

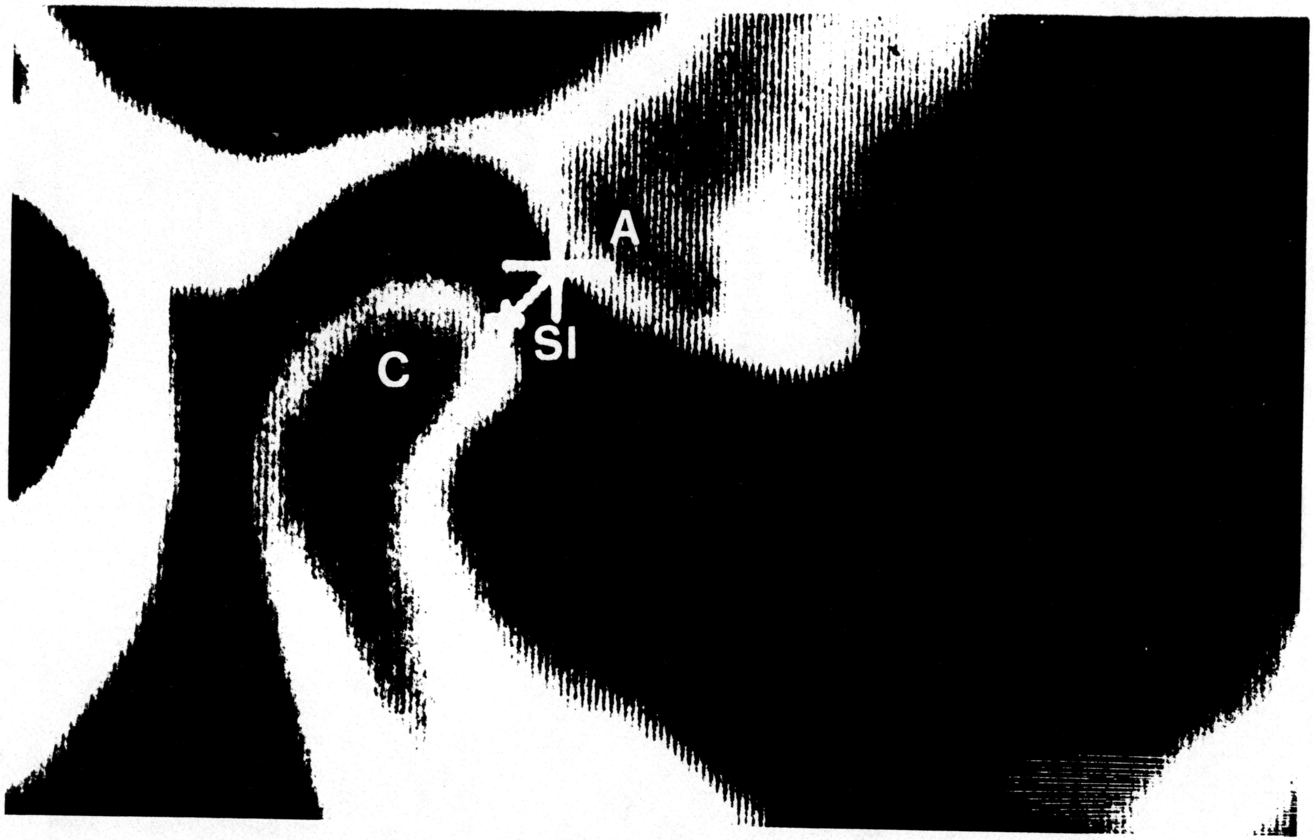

Figure 8. SAGITTAL SCAN THROUGH GLENOID FOSSA AND CONDYLE

Sagittal joint interval (SI) was the closest distance between the articular eminence (A) and the condyle (C) on a sagittal CT scan.

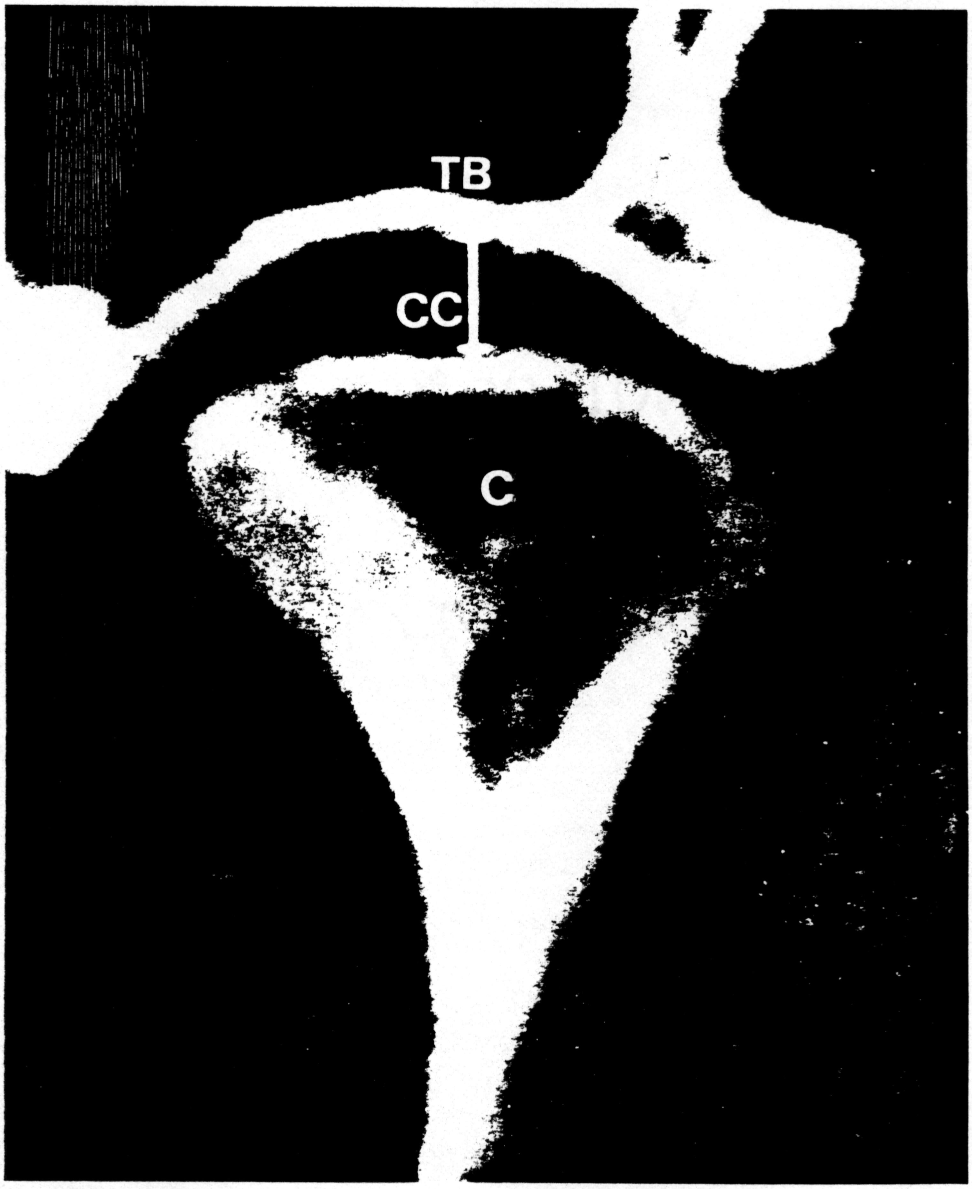

Figure 9. CORONAL SCAN THROUGH GLENOID FOSSA AND CONDYLE

Central coronal joint interval (CC) between the condyle (C) and roof of the glenoid fossa of the temporal bone (TB) on a coronal CT scan.

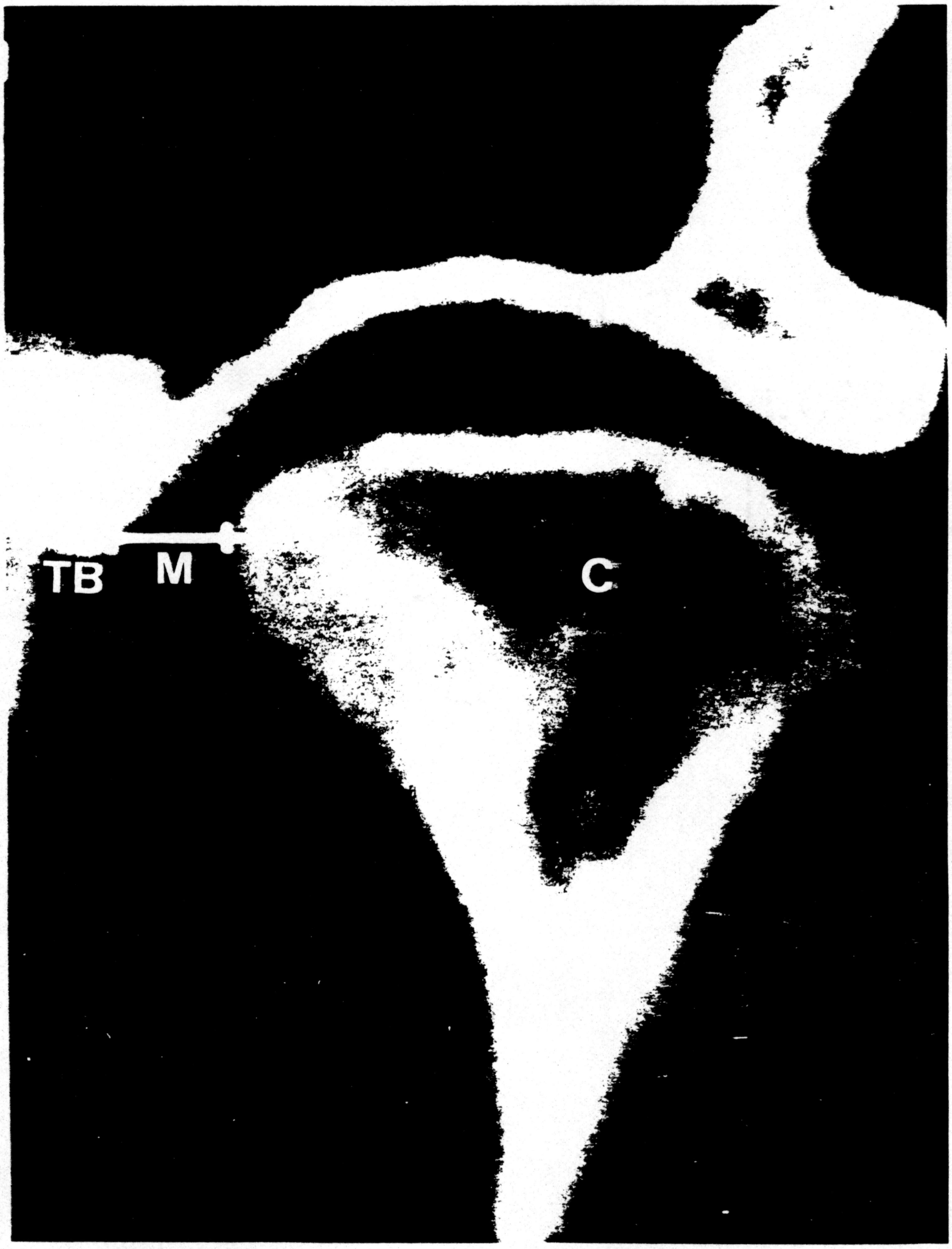

Figure 10. CORONAL SCAN THROUGH GLENOID FOSSA AND CONDYLE

Medial coronal joint interval (M) from the medial pole of the condyle (C) to the medial surface of the glenoid fossa (TB) of the temporal bone.

CHAPTER 4

Results

Values obtained from the analysis of the lateral cephalogram of the frozen head were compared to those of the lateral scout. Five of the six angeles were the same. The value for Mandibular Arc on the tracing from the cephalogram was 36 degrees compared to 32 degrees from the lateral scout (Table 1).

The mesofacial group had a mean condylar angle of 24.8 ± 12.0 degrees for the right and 21.8 ± 7.7 degrees for the left side (Table 2). Transverse condylar head values showed little left-right differences; the mean values for both sides of 2.1cm had a standard deviation of 0.3 for the left and 0.5 for the right side (Table 3). There was no difference between sides in the A-P condylar head dimension and sagittal joint interval. These values were 0.7 ± 0.2cm and 0.2 ± 0.1cm respectively (Tables 4 and 5). The mean left-right values were 0.2 ± 0.13cm and 0.2 ± 0.07cm for the central coronal joint interval (Table 6). Left-right differences of the medial joint interval were very slight. Values of 0.4 ± 0.12cm and 0.4 ± 0.13cm for left and right show little difference (Table 7). Left-right differences were greater in lateral pterygoid muscle angle. The left was 39.5 ± 1.2 degrees compared to 37.0 ± 8.7 degrees on the right (Table 8). The muscle length showed less variability with values of 3.8 ± 0.59cm and 3.7 ± 0.42cm (Table 9).

Table 1

Analysis of Frozen Head
(Ricketts' Cephalometric Analysis)

Measurement	Mean and S.D.* (Age=9 yrs.)	Change **	Mean and S.D.* (Age=47 yrs.)	Lateral Cephalogram (degrees)	Lateral Scout Image (degrees)
Maxillary Depth	90±3.0	No change with age	90±3.0	93	93
Facial Depth	86±3.0	Increases 1/yr.	88±3.0	95	95
Mandibular Plane	26±4.5	Decreases 1/yr.	28±4.5	15	15
Mandibular Arc	26±4.0	Increases .5/yr.	27.5±4	36	38
Lower Face Height	47±4.0	No change with age	47±4.0	45	45
Faxial Axis	90±3.5	No change with age	90±3.5	93	93

*S.D. = Standard Deviation
**Growth is estimated in females to stop at 13 years of age.

The brachyfacial group had a condylar angle mean value of 21.8 ± 7.7 degrees on the left and 24.8 ± 12 degrees on the right (Table 2). Transverse condylar head means were 2.1cm for both sides with a standard deviation of 0.5 and 0.3 right and left (Table 3). The right A-P condylar dimension was 0.7 ± 0.2cm and the left 0.8 ± 0.2cm (Table 4). Sagittal joint interval left-right values were 0.2 ± 0.01 cm and 0.2 ± 0.1cm respectively (Table 5). Central and medial coronal joint intervals showed little left-right differences (Tables 6 and 7). Mean central interval was 0.2cm with a left-right standard deviation of 0.2 and 0.21. Right medial value was 0.5 ± 0.12cm and left was 0.5 ± 0.01cm. The lateral pterygoid muscle angles were 40.2 ± 9.8 degrees and 39.3 ± 4.29 degrees, right and left (Table 8). Muscle lengths showed no side differences in mean values and a left value of 0.37 and right of 0.31 for standard deviation (Table 9).

In the dolichofacial group the left-right condylar angle values were 22.1 ± 18.8 degrees and 21.7 ± 19.6 degrees (Table 2). Transverse condylar head mean values were 1.9 ±-.5cm for the right and 1.8 ± 0.5cm on the left (Table 3). The A-P condylar head mean values of 0.8cm showed no difference for sides and a standard deviation of 0.1 on the left and 0.3 on the right (Table 4). Mean left and right values for sagittal joint interval were 0.2cm with a standard deviation on the left of 0.05 and 0.1 on the right (Table 5). The left-right coronal and medial joint intervals were 0.2 ± 0.08cm and 0.2 ± 0.04cm for the coronal and 0.4 ± 0.23cm and 0.3 ± 0.20cm for the medial (Tables 6 and 7). Lateral pterygoid muscle angles were 33.6 ± 10.45 degrees on the left and 34.0 ± 9.1 degrees on the right (Table 8). The muscle lengths were 3.5 ± 0.53cm and 3.7 ± 0.61cm, left and right (Table 9).

Table 2

Condylar Angle
(degrees)

Facial Type	N	Right $\bar{x}$	Right s	Left $\bar{x}$	Left s
Brachyfacial	3	21.4	4.3	20.8	6.2
Mesofacial	5	24.8	12.0	21.8	7.7
Dolichofacial	4	21.7	19.6	22.1	18.8

Table 3

Transverse Condylar Head
(cm)

Facial Type	N	Right $\bar{x}$	Right s	Left $\bar{x}$	Left s
Brachyfacial	3	1.9	0.5	1.9	0.4
Mesofacial	5	2.1	0.5	2.1	0.3
Dolichofacial	4	1.9	0.5	1.8	0.5

Table 4

A-P Condylar Head
(cm)

		Right		Left	
Facial Type	N	$\bar{x}$	s	$\bar{x}$	s
Brachyfacial	3	0.7	0.2	0.8	0.2
Mesofacial	5	0.7	0.2	0.7	0.2
Dolichofacial	4	0.8	0.3	0.8	0.1

Table 5

Sagittal Joint Interval
(cm)

		Right		Left	
Facial Type	N	$\bar{x}$	s	$\bar{x}$	s
Brachyfacial	3	0.2	0.01	0.2	0.1
Mesofacial	5	0.2	0.1	0.2	0.1
Dolichofacial	4	0.2	0.1	0.2	0.05

Table 6

Central Coronal Joint Interval
(cm)

		Right		Left	
Facial Type	N	$\bar{x}$	s	$\bar{x}$	s
Brachyfacial	3	0.3	0.21	0.3	0.2
Mesofacial	5	0.2	0.07	0.2	0.13
Dolichofacial	4	0.2	0.04	0.2	0.08

Table 7

Medial Coronal Joint Interval
(cm)

		Right		Left	
Facial Type	N	$\bar{x}$	s	$\bar{x}$	s
Brachyfacial	5	0.5	0.15	0.5	0.01
Mesofacial	3	0.4	0.13	0.4	0.12
Dolichofacial	4	0.3	0.2	0.4	0.23

Table 8

Lateral Pterygoid Muscle Angle
(degrees)

		Right		Left	
Facial Type	N	$\bar{x}$	s	$\bar{x}$	s
Brachyfacial	3	40.2	9.8	39.3	4.29
Mesofacial	5	37.0	8.7	39.5	1.2
Dolichofacial	4	34.0	9.1	33.6	10.45

Table 9

Lateral Pterygoid Muscle Length
(cm)

		Right		Left	
Facial Type	N	$\bar{x}$	s	$\bar{x}$	s
Brachyfacial	3	3.6	0.31	3.6	0.37
Mesofacial	5	3.8	0.59	3.7	0.42
Dolichofacial	4	3.7	0.61	3.5	0.53

CHAPTER 5

Discussion

The practicality of utilizing CT scans in studying hard and soft tissue relations of the TMJ and its relation to facial type is dependent on its adaptability to an existing orthodontic analytical method for determining facial type. The Ricketts' Analysis, based on cephalometric radiographs, provides measurements necessary to determine the facial type. When angular measurements of the lateral cephalogram and lateral scout are compared, only Mandibular Arc varies. This can be explained by the change in magnification factor which would affect linear, but not angular measurements as evidenced in the five angles that matched. The 2-degree difference between cephalogram and lateral scout was due to the poor visibility on lateral head images of the anterior border of the ramus and coronoid notch, both essential landmarks in locating Xi (Figure 1). The close correlation of angular measurements enabled the investigator to rely on CT images alone to determine the facial type.

Unlike conventional radiography, CT is not affected by overlying anatomic structures and geometric morphologic factors. Thus is provides a more accurate image of the position of the condyle in the glenoid fossa. Another advantage is CT's ability to image soft tissue. This allows the determination of the lateral pterygoid relationship.

CT values for bone relations tended to be in agreement with Dumas (1983). Conventional tomographic values of 2.461mm for the right sagittal anterior joint space and 2.288mm for the left and left-right condylar angulations of 20.31 degrees and 21.66 degrees were similar to those of CT (Table 2). The observation of an extremely low angle in patient 31-12-74 with otherwise normal measurements is unexplainable (Appendix 1.4). Ricketts reported an anterior joint space of 1.5mm[25] in a control group of Class I, II and III malocclusion. The radiographic material was from a sagittal view uncorrected for condylar angulation so the superimposition of medial and lateral poles probably accounts for the different value noted by Dumas.[8]

The transverse width of the mandibular condyle based on 10 skulls and 10 patients without regard to facial type, was found to be from 1.5cm to 2.0cm.[25] Results of our CT values for all three facial types lie within this range (Table 3).

The close agreement between these three hard tissue measurements using conventional radiographic imaging and CT values suggests that hard tissued measurements previously unreported may be useful in describing the joint. Measurements of the antero-posterior condylar head and the coronal joint intervals support the observation that mean bone relations noted in this study are not determinant variables for facial type.

Initially the human subject portion of the study was designed as prospective. The daily schedules for CT studies that would pass through the TMJ were to be reviewed for potential subjects, screened to insure that their condyles were seated in the glenoid fossa and that they had normal occlusion. After two months it was determined that this design would necessitate a longer time period than currently available in a Master's degree program in Orthodontics. Two subjects were scanned through the TMJ and had intact lateral scout images. Two months of interviewing and examining occlusions of potential subjects at Loma Linda University Medical Center, Department of Neuroradiology, and reviewing CT images, revealed the need for a protracted period of time to complete a prospective study. The study design was modified and an addendum approved by the Human Studies Committee. The change allowed a retrospective evaluation of patient records on the computer tape files of the Neuroradiology Department. This provided access to patients scanned over the period covering 1982 to the Spring of 1984.

In consultation with a biostatistician, it was determined that discriminant variance would be necessary to show statistically valid relationships between facial type and the variables. This meant that statistically meaningful results using this method would necessitate having 20 subjects per variable. Sixteen variables with a subject to variable ratio of 20:1 amounts to a minimum of 320 subjects, a number far exceeding the scope of this study. Trends, however, were noted and have been reported as such.[29]

The findings of a decreased pterygoid muscle angle may have clinical significance in predicting the immediate side shift potential in mandibular lateral excursions of dolichofacial patients. The treatment goals would have to be modified to harmonize with the underlying anatomy to insure adequate anterior guidance.

CHAPTER 6

Summary

This study presents CT data from a cadaver and a patient group. The TMJ was examined from axial, coronal and sagittal images. In addition to bone and lateral pterygoid measurements of the TMJ, the facial type of each subject was determined by applying Ricketts' Cephalometric Analysis to a CT image. The advantages of this application are severalfold:

1. Access to the Neuroradiology CT computer tape files can supply the data for future studies of hard and soft tissue variations in facial types.

2. A single imaging technique suffices in the determination of facial type as well as soft and hard tissue imaging.

3. A lateral scout image of the head, used to determine facial type, is already part of the protocol for the temporal bone and internal auditory canal examinations.

4. Soft tissue images are possible with a relatively non-invasive technique.

5. CT allows the possibility of longitudinal soft tissue growth and development studies, especially muscle relationships in the head and neck structures.

The trend noted in condylar position suggests that there is little difference among mesofacial, brachyfacial and dolichofacial types. The trend for lateral pterygoid muscle suggests that in the dolichofacial group there exists a decreased muscle angle when measured in the axial plane. The clinical significance of this proposed trend must be further evaluated in light of these questions.

1. Will discriminant variance support the proposed trend in an adequate study group?

2. Can the proposed trend in a decreased lateral pterygoid muscle angle be a factor in facial type determination?

3. Is there any influence on growth and development of the mandibular condyle by the lateral pterygoid muscles?

One area for future investigation is to develop protocols for evaluating relations of other muscles in the TMJ and the face. To accomplish this it would be necessary to establish an ongoing relationship between the TMJ Department and Neuroradiology Department to insure continued access to CT files of the present study group. The present scanning protocol must be modified to meet the requirements for statistical analysis. The alternative would be to wait for 300 months given the present rate of acceptable patients, to get an adequate sample size. The only modification recommended is to include all of the mandible in the lateral scout images for temporal bone and internal auditory canal examinations.

A non-invasive method of studying condylar position, muscle orientation and facial type is valuable in orthodontic diagnosis and treatment planning. Information provided by such a method can provide answers to mandibular responses in patients during growth and treatment. Treatment planned to harmonize with the underlying anatomy would be highly desirable and beneficial to the patient.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Atkinson, W.B., Bates, R.E., Jr.: The effects of the angle of the eminence on anterior disk displacement, J. Prosth. Dent., 49(4): 554-555, April 1983

2. Berret, A. Radiology of the temporomandibular joint, Dental Clinics of North America, Philadelphia, W.B. Saunders, pp. 527-537, July 1983

3. Blaschke, D.D., Blaschke, T.J.: A method for quantitatively determining temporomandibular joint bony relationships, J. Dent. Res., 60(1):35-43, January 1981

4. Blaschke, D.D., Blaschke, T.J.: Normal TMJ bony relationships in centric occlusion, J. Dent. Res., 60(2):98-104, February 1981

5. Carlsson, G.E., Lundberg, M., Obert, T., Welander, U.: The temporomandibular joint, Odont. Rev., 19:171-185, 1968

6. Coin, C.G.: Tomography of the temporomandibular joint, Med. Radiogr. Photogr., 50(2):26-36, 1974

7. Council on Dental Materials and Devices: Advantages and disadvantages of the use of dental tomographic radiography, Reports of Councils and Bureaus, J.A.D.A., 94:147, January 1977

8. Dumas, A.L.: A combined tomographic-cephalometric analysis of the TMJ, The Journal of Craniomandibular Practice, 1(3):23-36, June-August 1983

9. Eckerdal, O.: Tomography of the temporomandibular joint, correlation between tomographic image and histologic sections in a three-dimensional system, Acta Radiologica, Supplementum 320, 1973

10. Hansson, T., Oberg, T., Carlsson, G.E., Kipp, S.: Thickness of the soft tissue layers and the articular disk in the temporomandibular joint, Acta Odontal. Scand., 35(2):77-83, May 1977

11. Hounsfield, G.N.: Historical notes on computerized axial tomography, J. Can. Assoc. Radiol. 27:1976

12. Katzberg, R.W., Dolwick, M.F., Keith, D.A., Helms, C.A., Guralnick, W.C.: New observations with routine and CT-assisted arthrography in suspected internal derangements of the temporomandibular joint, Oral Surgery, Oral Medicine, Oral Pathology, 51(6):569-574, June 1981

13. Kinne, B.H.: Laminagraphic x-ray procedures in the diagnosis and treatment of the TMJ syndrome, Dent. Radiogr. Photogr., 54(4): 65-79, 1981

14. Klein, I.E., Blattenfein, L., Miglino, J.C.: Comparison of the fidelity of radiographs of mandibular condyles made by different techniques, J. Prosth. Dent., 249(4):49-451, October 1970

15. Lewis, G.R.: Temporomandibular joint radiographic techniques. Comparison and evaluation of results, Dent. Radiogr. Photogr. 37:8, 1974

16. Lundberg, M.: Rontgendiagnostik vid kaklebesvar (Sweden), Odont. Foren T., 29:209, 1965, cited in Eckerdal, L.: Tomography of the temporomandibular joint, Acta Radiologica, Supplementum 329, 1973

17. Marshall, C.H.: Principles of computed tomography, Postgrad. Med., 59:105-109, 1976

18. Mazione, J.V., Seltzer, S.E., Katzberg, R.W., Hammerschlag, S.B., Chiango, B.F.: Direct sagittal computed tomography of the temporomandibular joint, A.J.R., 140:165-167, January 1983

19. McCullough, E.C.: Photon attenuation in C.T., Med. Phys. 2:307-320, 1975

20. McCullough, E.C., Payne, J.T.: Patient dose in computed tomography, Radiology, 129:457-463, 1978

21. Porter, V.R.: The attachment of the lateral pterygoid muscle to the meniscus, J. Prosth. Dent., 24(5):555-562, November 1970

22. Potter, G.D.: Sectional anatomy and tomography of the head, New York: Grune and Stratton, 1979

23. Ricketts, R.M.: Variations of the temporomandibular joint as revealed by cephalometric laminagraphy, A.J.O., 36(12):877-898, December 1950

24. Ricketts, R.M.: Various conditions of the temporomandibular joint as revealed by cephalometric laminagraphy, Angle Orthodontist, 22 (2):98-115, April 1952

25. Ricketts, R.M.: Facial and denture changes during orthodontic treatment as analyzed from the temporomandibular joint, A.J.O., 41(3):163-179, March 1955

26. Ricketts, R.M., Bench, R.W., Gugino, C.F., Hilgers, J.J., Schulhof, R.J.: Bioprogressive therapy, Book 1, Rocky Mountain Orthodontics, pp. 55-60, 1980

27. Rokni, A., Ismail, Y.H.: Radiographic comparative study of condylar position in centric relation and centric occlusion, IADR Progr. and Abst., 57:No. 1070, 1978

28. Seerum, E.: Computerized Tomography Technology, Philadelphia, W. B. Saunders, 11:1-169, 1982

29. Shavlik, Gerald: Personal communication

30. Smith, R.J.: Mandibular biomechanics and temporomandibular joint function in primates, Am. J. Phys. Anthrop., 48(3):341-349, September 1978

31. Weinberg, H.: Findings in CT: A clinical and economic analysis of computed tomography, Pfizer, Inc., New York, pp. 5-58, 1979

32. Wilkie, N.O., Hurst, T.L., Mitchell, D.L.: Radiographic comparisons of condyle-fossa relations during maxillomandibular registrations made by different methods, J. Prosth. Dent., 32(5):529-533, November 1974

33. Wilkinson, T., Maryniuk, G.: The correlation between sagittal anatomic sections and computerized tomography of the TMJ, The Journal of Craniomandibular Practice, 1(3):37-45, June-August 1983

APPENDIXES

APPENDIX 1.1

Patient Data

Patient Number	Tape Number*	Run Number*	Type of Examination	Sex	Age
49-66-07	900	5426	Temporal Bone	F	20
56-61-61	907	5462	Temporal Bone	F	52
56-96-90	1006	6135	Axial	M	73
55-96-24	11029	7023	Temporal Bone	M	44
31-12-74	1172	7355	IAC	F	60
26-16-65	673	3903	Temporal Bone	M	82
17-53-45	624	3612	Temporal Bone	F	36
55-78-68	663	3838	Temporal Bone	F	76
49-36-32	618	3578	Temporal Bone	M	36
56-27-48	800	4765	Temporal Bone	F	22
29-15-80	817	4874	Temporal Bone	M	61
29-04-67	999,1001	6083	Temporal Bone	M	43

*These are identifying numbers of the study group in the Neuroradiology tape files.

APPENDIX 1.2

Patient Data

Patient Number	Facial Type	Condylar Angle Right (degrees)	Condylar Angle Left (degrees)	Transverse Condylar Head Right (cm)	Transverse Condylar Head Left (cm)	A-P Condylar Head Right (cm)	A-P Condylar Head Left (cm)
49-66-07	Brachyfacial	24.90	24.80	1.55	0.61	0.59	0.68
56-61-61	Mesofacial	33.70	23.20	1.99	19.1	0.60	0.58
56-96-90	Mesofacial	27.20	24.90	1.97	2.22	0.81	0.70
55-96-24	Brachyfacial	20.90	17.40	1.82	1.84	0.84	0.94
31-12-74	Dolichofacial	7.30	12.50	1.97	1.85	0.81	0.78
26-16-65	Brachyfacial	18.40	19.30	2.22	2.12	0.70	0.78
17-53-45	Dolichofacial	19.00	14.90	1.57	1.54	0.97	0.82
55-78-68	Mesofacial	16.10	15.30	2.34	2.28	0.76	0.84
49-36-32	Mesofacial	24.20	21.60	2.20	2.23	0.81	0.68
56-27-48	Dolichofacial	26.60	22.80	1.68	1.68	0.70	0.76
29-15-80	Mesofacial	22.80	24.00	2.11	2.02	0.66	0.74
29-04-67	Dolichofacial	33.70	38.20	2.22	2.15	0.58	0.66

APPENDIX 1.3

Patient Data

Patient Number	Sagittal Joint Interval Right (cm)	Sagittal Joint Interval Left (cm)	Central Coronal Joint Interval Right (cm)	Central Coronal Joint Interval Left (cm)	Medial Coronal Joint Interval Right (cm)	Medial Coronal Joint Interval Left (cm)
49-66-07	0.16	0.16	0.19	0.23	0.38	0.50
56-61-61	0.22	0.18	0.19	0.03	0.38	0.33
56-96-90	0.17	0.17	0.23	0.20	0.47	0.53
55-96-24	0.14	0.15	0.23	0.23	0.50	0.53
31-12-74	0.17	0.17	0.18	0.20	0.30	0.30
26-16-65	0.19	0.19	0.47	0.47	0.53	0.53
17-53-45	0.17	0.18	0.17	0.20	0.50	0.57
55-78-68	0.26	0.28	0.25	0.29	0.50	0.33
49-36-32	--	--	--	--	--	--
56-27-48	0.15	0.19	0.20	0.27	0.30	0.23
29-15-80	0.29	0.31	0.23	0.20	0.37	0.33
29-04-67	0.19	0.17	0.20	0.17	0.27	0.33

APPENDIX 1.4

Patient Data

Patient Number	Condylar Angle Right (degrees)	Condylar Angle Left (degrees)	Transverse Condylar Head Right (cm)	Transverse Condylar Head Left (cm)	A-P Condylar Head Right (cm)	A-P Condylar Head Left (cm)
49-66-07	24.90	25.80	1.55	0.61	0.59	0.68
56-61-61	33.70	23.20	1.99	1.91	0.60	0.58
56-96-90	27.20	24.90	1.97	2.22	0.81	0.70
55-96-24	20.90	17.40	1.82	1.84	0.84	0.94
31-12-74	7.30	12.50	1.97	1.85	0.81	0.78
26-16-65	18.40	19.30	2.22	2.12	0.70	0.78
17-53-45	19.00	14.90	1.57	1.54	0.97	0.82
55-78-68	16.10	15.30	2.34	2.28	0.76	0.84
49-36-32	24.20	21.60	2.20	2.23	0.81	0.68
56-27-48	26.60	22.80	1.68	1.68	0.70	0.76
29-15-80	22.80	24.00	2.11	2.02	0.66	0.74
29-04-67	33.70	38.20	2.22	2.15	0.58	0.66

APPENDIX 1.5

Patient Data

Patient Number	Lateral Pterygoid Muscle Angle (degrees) Right	Lateral Pterygoid Muscle Angle (degrees) Left	Lateral Pterygoid Muscle Length (cm) Right	Lateral Pterygoid Muscle Length (cm) Left
49-66-07	40.10	37.60	3.34	3.34
56-61-61	28.80	38.70	4.06	3.85
56-96-90	40.80	40.00	3.38	3.66
55-96-24	33.30	37.50	3.66	3.79
31-12-74	37.20	33.00	3.65	3.59
26-16-65	47.20	42.80	3.70	3.69
17-53-45	28.00	26.90	3.63	3.54
55-78-68	38.10	39.30	3.81	3.94
49-36-32	43.90	40.20	3.55	3.41
56-27-48	40.00	41.60	3.27	3.02
29-15-80	33.50	39.50	4.00	3.79
29-04-67	34.90	33.70	4.13	3.70