The morphology of the mandibular antegonial notches and facial symmetry

Fares Al-Sehaibany* / Omar Salem ** / Brian Preston***

Thirty randomly selected pre-treatment postero-anterior cranial radiographs of adolescent patients attending the orthodontic department, School of Dental Medicine, State University of New York at Buffalo comprised the sample in this study. The aims of this study were (1) to compare the depths of the right, and the left, mandibular antegonial notches, and (2) to determine whether the morphology of the antegonial notches bears a statistical relationship to some other transverse metrical characters of the face. The frontal cranial radiographs of thirty patients were digitized to determine the linear, and surface area, measurements of the right, and the left, antegonial notches as well as some transverse dimensions of the faces. An analysis of variance showed that no statistically significant difference existed between the measurements made by the two examiners, who digitized the radiographs. The data were analyzed by means of the Student's t- test. The results showed that there were statistically significant differences (P<0.05) between the measurements of the right, and the left, mandibular antegonial notches. The data also showed that there were highly statistically significant differences between the corresponding bilateral facial dimensions (P<0.001). The results of this study suggest that facial symmetry, as measured on a frontal skull radiograph, is associated with the respective depths of the right, and the left, mandibular antegonial notches.

J Clin Pediatr Dent 26(2): 155-160, 2002

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/26/2/155/1745868/jcpd_26_2_av4179x75q3287k2.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

INTRODUCTION

The presence of prominent mandibular antegonial notches is frequently noted in subjects with disturbed, or arrested, mandibular condylar growth.[1-6] In cases of unilateral condylar hypoplasia, marked mandibular notching develops only on the affected side.[1,5-7] Björk's implant studies[2,8-12] show that in a mandible with a predominantly vertical growth pattern, apposition occurs below the mandibular symphysis, while resorption tends to take place in the region of the gonial angles.

Other workers report that a mandible that rotates backwards, and downwards, during growth, usually exhibits pronounced bone apposition beneath the gonial angles in combination with excessive resorption posterior to the bony symphysis.[2,8,9] Excessive vertical mandibular growth thus results in cranially directed curvatures, or antegonial notches, of the inferior border of the mandible anterior to the gonial angles.

There are indications that the growth potential of mandibles with pronounced antegonial notching[13] is reduced while, in general, mandibles with straight inferior borders tend to be longer than those that have deep notches. On average, mandibles with deep antegonial notches have comparatively obtuse gonial angles, relatively shorter mandibular rami and occlusal planes that form more obtuse angles with the respective anterior cranial bases. The mean total anterior facial height of subjects with straight, un-notched, mandibular inferior borders was smaller than that of subjects with deep antegonial notches, while the maxillae of the former group were more protrusive in relation to the cranial bases than were those of the latter group.[14]

Symmetry may be defined as the correspondence, in size, form, and arrangement, of parts on opposite sides of a plane, line or point. Conversely, the term asymmetry implies an imbalance in the arrangement of parts. Asymmetry of the component parts of the dentofacial complex may be unilateral or bilateral and may occur in the following directions: antero-posterior, supero-inferior, and medio-lateral.[15]

The uniqueness of individual human features can most probably be ascribed to the presence of clinically

* Fares Al-Sehaibany, BDS, PhD, FAAPD, Postgraduate Resident, Department of Orthodontics, SUNY at Buffalo, School of Dental Medicine.
** Omar Salem, DDS, MS, Clinical Assistant Professor, Department of Orthodontics, SUNY at Buffalo, School of Dental Medicine.
*** Brian Preston BDS, PhD, Professor and Chairman, Department of Orthodontics, SUNY at Buffalo, School of Dental Medicine.

Address all correspondence to Dr. Fares Al-Sehaibany, Department of Orthodontics, SUNY at Buffalo, School of Dental Medicine, 140 Squire Hall, 3435 Main St., Buffalo, NY 14214.

Figure 1. Postero-anterior cranial radiograph.

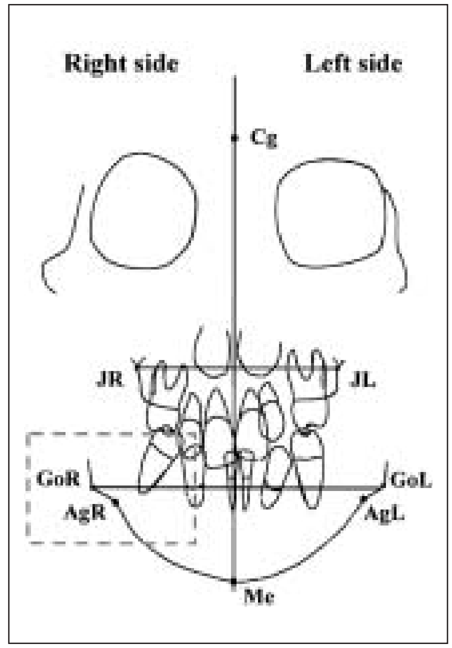

Figure 2. Digitized image of posterio-anterior cranial radiograph.

unimportant facial asymmetries that are present in all faces. Craniofacial asymmetries, however, vary in the degrees of severity and when they are significant they may interfere with occlusal function while, at the same time, presenting esthetic challenges during orthodontic treatment.

The successful orthodontic treatment of craniofacial asymmetries requires an in-depth understanding of facial growth and development as well as orthodontic treatment techniques. Facial asymmetry can usually be diagnosed radiographically by the presence of relative discrepancies in the sizes of the facial bones.

The etiology of these size discrepancies involves many factors, one of which is probably the presence of different growth rates between the right and left sides of the face.[16]

Postero-anterior radiographic cephalograms contain diagnostic information that is not readily available from other sources. This information allows orthodontists to evaluate the comparative widths, and transverse positions of the maxilla and mandible. Specifically to diagnose the presence, and the severity of facial asymmetries relative to the midline sagittal plane.[17] Frontal facial photographs and postero-anterior cephalographs provide important diagnostic clues and they should therefore be included in those records that are used to evaluate facial form.[18]

Postero-anterior radiographs have been used in studies of craniofacial asymmetry and usually by measurements made to a vertical line constructed midway between the medial aspects of the orbits and passing through the nasal septum.[19,20] The relationship between the widths of maxillary and mandibular skeletal bases is presumable the most critical information sought from the postero-anterior cranial radiograph and in this respect the Ricketts' analysis seems to be the one most widely used.[18,21-26]

The aims of the present study were (1) to compare the depth of right, and left mandibular antegonial notches, and (2) to investigate the correlations that may exist between the depth of the mandibular antegonial notches and facial symmetry as seen in the transverse dimension.

METHODS AND MATERIALS

Thirty randomly selected pre-treatment postero-anterior cranial radiographs (Figure 1) of adolescent patients attending the Orthodontic Department, School of Dental Medicine, State University of New York at Buffalo were digitized with the JOE32™ digitizing program (RMO)®. None of the patients had a medical history that could affect craniofacial growth adversely, nor were considered to have overt facial asymmetry.

All of the radiographs were subject to the same enlargement factor, which was approximately six percent. Two examiners used a standardized technique to digitize the chosen radiographs and to identify selected craniofacial structures. On the postero-anterior radiographs a line extending through Crista galli (Cg) and Menton (Me) represented the facial midline. Crista galli was located at the most constricted point of the projection of the perpendicular lamina of the ethmoid, while the lowermost midline point of the contour of the chin represented Menton.

A line extending from the right to the left Jugale (J),[22,23] a cephalometric point located on the buccal out-

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/26/2/155/1745868/jcpd_26_2_av4179x75q3287k2.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

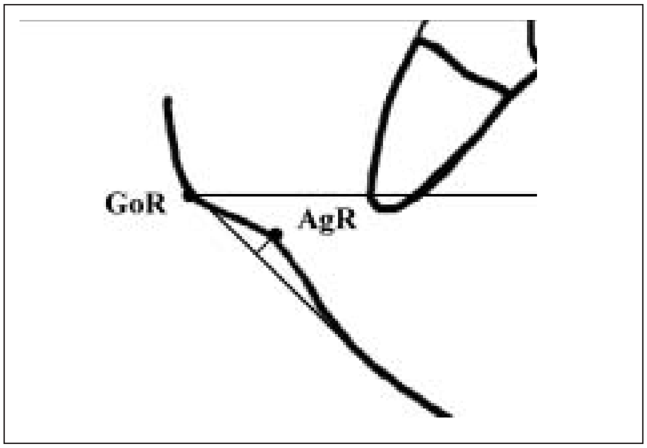

Figure 3. Enlarged image of the right manibular antegonial notch (AgR).

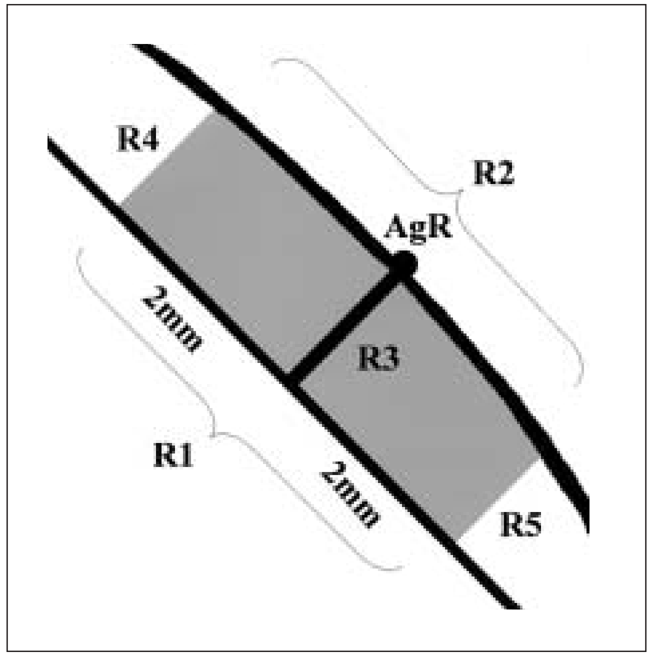

Figure 4. Linear and surface area outline of the right mandibular antegonial notch (AgR).

line of the maxillary tuberosity, was used to measure the maxillary transverse dimension. Likewise, a line joining the bilateral cephalometric landmarks, Gonion (Go), located at the corresponding mandibular gonial angles represented the mandibular transverse dimension. The inferior border of the mandible was traced on each cephalometric radiograph and particular care was taken in outlining the mandibular antegonial notches.

All of the measurements were performed by both of the investigators. The results obtained by the two examiners were subjected to statistical evaluation to test for inter-operator error. Each examiner repeated the measurements on ten randomly selected radiographs after a period of at least two days had lapsed. The data obtained in this manner were used to test for intra-operator error. The deepest points, by inspection, on the curvatures of the right, and left antegonial notches were identified on the radiographs and digitized as AgR and AgL respectively (Figures 2 and 3).

The points of intersection between perpendiculars drawn from points AgR and AgL to the right, and left tangential lines to the inferior borders of the mandibles were designated R1 and L1 respectively. Subsequently on each radiograph the right, and left dimensions between the points AgR and R1, and AgL and L1 were recorded as R3 and L3 respectively (Figure 4). The lengths of the outlines of the right, and left antegonial notches between the limiting lines, was termed R2 and L2 respectively.

Digital optical images of the right and left antegonial notches were produced with a Nikon® stereomicroscope at 2x magnification. The depth (R3 and L3) of the right, and left notches were measured and the surface area of each notch was also determined with the Image-Pro program®. The surface area of each antegonial notch was limited mesially and distally by the lines R4 and R5, and L4 and L5 for the right and left sides respectively. The mesial and distal limiting lines were on either side of, 2mm away from and parallel to, the AgR-R1 and AgL-L1 lines. The surface area measured is the shaded area shown in Figure 4.

The transverse facial measurements that were recorded on the digitized postero-anterior radiographs included the transverse width of the maxilla, the linear measurements from the right and left Jugale to the facial midline, the transverse mandibular width and the linear distances from the right and left Gonion to the facial midline. Linear and surface area measurements of the right, and left mandibular antegonial notches (Ag), and the facial linear measurements of the right and left sides were compared to each other. Descriptive statistics were obtained and statistical comparisons were performed by the mean of Student's t-test.

RESULTS

An analysis of variance did not disclose statistically significant ($p<0.01$) intra-, or inter-operator, differences in the measurements made by the two examiners. The intraclass correlation coefficient indicated that the reliability of the measurements made in this study were high ($r=0.99$). Statistical examination of the results of this study pointed to the presence of an asymmetry between the right and left mandibular antegonial notches ($p<0.05$) in this sample.

Accordingly, the mean dimensions of the right mandibular antegonial notches were greater than the corresponding mean dimensions recorded for the left antegonial notches. This statement is true for both the linear as well as the surface area measurements (Tables 1 A, B and Figure 5).

Statistical analysis of the data disclosed the presence of an association between the mean values of the dimen-

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/26/2/155/1745868/jcpd_26_2_av4179x75q3287k2.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

Tables 1 A, B. Linear and surface area measurements in mm. of right and left mandibular antegonial notches (AgR and AgL). A, linear measurements of AgR, and AgL, B, surface area measurements of AgR, and AgL.

Table 1 A.

	mean ± sd	p-value
Linear measurements of AgR	1.37 ± 0.58	0.006
Linear measurements of AgL	1.07 ± 0.61	

Table 1 B.

	mean ± sd	p-value
Surface area measurements of AgR	5.25 ± 2.26	0.006
Surface area measurements of AgL	4.12 ± 2.35	

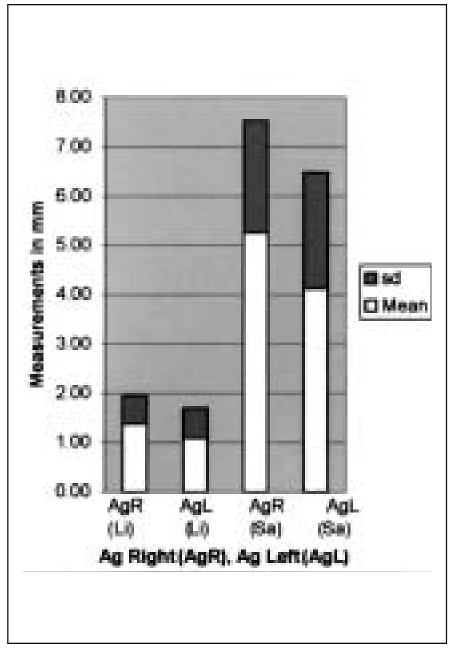

Figure 5. Linear (Li) and surface area (Sa) measurements in mm. of the right and left mandibualr antegonial notches (AgR and AgL).

sions of the antegonial notches and the mean values of the metrical characters used to study facial symmetry relative to the facial midline. The mean values of the left linear facial measurements, J and Go to the facial midline, were greater than the mean values recorded for the same respective measurements on the right side of the faces in this sample. Statistical analysis showed that there were a highly significant negative association ($P<0.001$) between the dimensions of antegonial notches and those dimensions used in this study to measure facial symmetry (Tables 2 A, B and Figure 6).

DISCUSSION

Mandibular morphology is closely associated with the prognosis of a successful outcome to orthodontic treatment. In growing orthodontic patients, the shape of the mandible has a direct bearing on the specific treatment modality chosen, and also on the resultant facial aesthetic appearance. The seemingly infinite variation in human facial form can most likely be attributed to a subtle interplay between three linear dimensions. Even though the face is three-dimensional, most orthodontic diagnoses are still performed in only two dimensions as visualized on a lateral cephalometric radiograph.

Systems that provide volumetric assessments of cranial form are becoming more practical, but the costs involved, and the lack of ready availability, require orthodontists to look elsewhere for information to augment the insight gained solely from lateral cephalometric radiographs.

Radiographs showing the transverse features of the skull give additional insight into cranial morphology over that gained from a lateral skull radiograph. Despite the fact that frontal cephalometric radiographs have an important role to play in orthodontic diagnosis they are not held to be inherent to the standard of care in orthodontics. The antegonial notch is considered an important mandibular feature and it is frequently mentioned in lateral cephalometric radiographic studies of the face.[14] The present study looks at the mandibular antegonial notches as seen in postero-anterior radiographs.

Certainly, orthodontists are frequently called upon to treat dentitions that display decided dental, skeletal or dentoskeletal asymmetry.[16] Cranio-facial asymmetries exist in all degrees of severity and other than in the mildest forms. They may interfere with normal cranial function, while at the same time presenting some challenging esthetic problems. Ideally a craniofacial complex should have identical right, and left halves that would include perfectly symmetrical dental arches. The results of this study showed that in this sample there were dimensional differences between the right, and the left, mean measurements that describe the basic shapes of the mandibular antegonial notches. The findings of this study revealed that the right mandibular antegonial notches were on average deeper than the counterparts on the left sides. The observed differences were not confined to the depths of the notches, but also to the surface areas and to the other metrical characters used to define these structures.

The ultimate shape of a fully-grown mandible is the result of genetic determinants that express themselves under the influence of the functional environment. The relatively complex shape of the mandible reflects

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/26/2/155/1745868/jcpd_26_2_av4179x75q3287k2.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

Tables 2 A, B. Linear measurements in mm. of A, Right, and left Jugale (JR and JL) to the facial midline. B, Right and Left Gonion (GoR and GoL) to the facial midline.

Table 2 A.

	mean ± sd	p-value
JR – Facial midline	30.43 (2.36	0.0002
JL - Facial midline	32.38 (2.02	

Table 2 B.

	mean ± sd	p-value
GoR - Facial midline	44.62 (3.39	0.0001
GoL - Facial midline	46.83 (3.58	

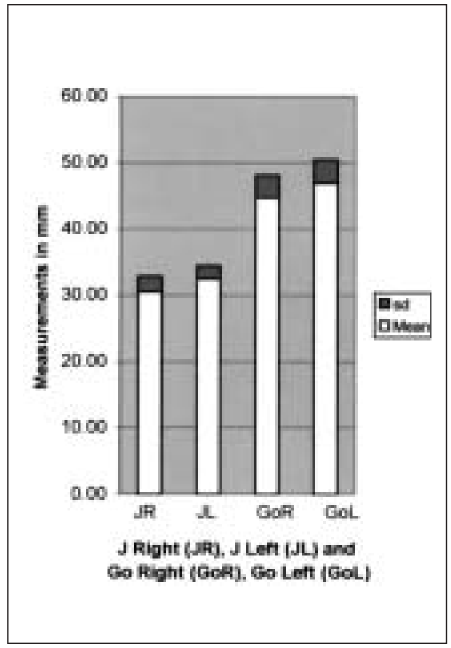

Figure 6. Linear measurements of right, left Jugale (JR and JL) to facial midline, and right, left Gonion (GoR and GoL) to facial midline.

the multiplicity of functions. The antegonial notch lies at the junction of the body, and the ramus, of the mandible and in this strategic position the shape is probably a good indicator of how the mandible grew, or perhaps more importantly, will grow. Thus, it has been said that if the inferior border of the mandible is relatively flat it grows forwards and, that when the antegonial notches are deep the mandible grows downwards.[8,9]

On the basis of present knowledge, it is difficult to make definite correlations between specific mandibular shapes and any particular deviations in oral function. At least some studies indicate that when the growth of the mandibular condyle fails to contribute to the lowering of the mandible, the masseter and medial pterygoid, by the continued growth, cause, the bone in the region of the angle to grow downward, producing antegonial notching. In other words, resorption that normally occurs below the gonial angle does not occur. Rather, a relative tension is generated between the angle and the muscle sling, in which it is suspended, such that bone deposition occurs in the area under the angle posterior to the notch.[1-6] When the underdevelopment of the mandible and the soft tissue environment are equal in degree, the antegonial notch does not form.[6] Animal studies show that the presence of the superficial masseter and, or the medial pterygoid muscle are necessary for the development of the angular process of the mandible.[1,27]

It is not clear how asymmetric growth of the mandible may relate to the growth of the face in general.[20] There are some indications that if the antegonial notches, in any one mandible, are of different sizes, then the mandible will develop some degree of asymmetry.[1,5] The present pilot study was undertaken to gain some basic insight into the relationship, if any exists, between mandibular, and facial, asymmetry.

The study indicates that in a group of orthodontic patients who, by visual inspection, have acceptable facial symmetry there were in most of the subjects some variation in the sizes and shapes of the bilateral antegonial notches. The study also indicates that in this group of individuals there was a statistically significant ($p<0.001$) relationship between the sizes of the antegonial notches and the basic symmetry of the respective faces. Although growth in maxillary width is probably completed prior to the completion in the growth of the mandible,[18] it was decided to use bilateral maxillary and mandibular measurements to determine facial symmetry in this study. Future studies will use more sophisticated measures of facial symmetry to explore the existence of possible relationships between the transverse dimensions of the mandible and the maxilla.

The results of this study suggest that right, and left facial symmetry are associated with the depth of the right, and left mandibular antegonial notches. Many reasons have been put forward for the shapes of individual antegonial notches.[14,28] It remains to be seen if these possible factors can operate on the individual sides of the mandible. If so, it could be useful to know if there is a relationship between the bilateral shapes of the mandible and the shapes of the corresponding sides of the rest of the face.

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/26/2/155/1745868/jcpd_26_2_av4179x75q3287k2.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022

CONCLUSIONS

The present study revealed the presence of an asymmetry in the shapes, and sizes of the right and left mandibular antegonial notches. In this sample the mean depth and surface area of the right mandibular antegonial notches were shown to be greater than those recorded on the left side. The results of this study further suggest that on the side were the mandibular antegonial notches are greater the face appeared to be narrower.

ACKNOWLEDGMENTS

The authors would like to thank Mr. Peter Bush for his assistance during the development of this project, and Mr. Alex Ho for assistance in statistical analysis of this study.

REFERENCES

1. Becker MH, Coccaro PJ, Converse MD. Antegonial notching of the mandible: An often overlooked mandibular deformity in congenital and acquired disorders. Radiology 121: 149-51, 1976.
2. Björk A, Skeiller V. Normal and abnormal growth of the mandible: A synthesis of longitudinal cephalometric implant studies over a period of 25 years. Eur J Orhod 5: 1-46, 1983.
3. Brodie AG. Behavior of normal and abnormal facial growth patterns. Am J Orthod 27: 633-47, 1941.
4. Dibbets JM, Vanderweele LT, Boering G. Craniofacial morphology and temporomandibular joint dysfunction in children. In: Carlson DS, McNamara JA Jr, Ribbens KA. Developmental aspects of temporomandibular joint disorders. Monograph 16, Craniofacial Growth Series. Ann Arbor, Center for Human Growth and Development, University of Michigan, 1985.
5. Engel MB, Brodie AG. Condylar growth and mandibular deformities. Surgery 22: 976-92, 1947.
6. Hovell JH. Variations in mandibular form. Ann R Coll Surg Engl 37: 1-18, 1965.
7. Lasken DM. Pathological conditions involving the TMJ. In: Solber WK, Clkark GT. Surgery of the temporomandibular joint: biological diagnosis and treatment. Chicago, Quintessence Publishing Co., Inc, pp110-1, 1980.
8. Björk A. Variations in the growth pattern of the human mandible. Longitudinal radiographic study by the implant method. J Dent Res 42: 400-11, 1963.
9. Björk A. Prediction of mandibular growth rotation. Am J Orthod 55: 585-99, 1969.
10. Björk A. The role of genetic and local environmental factors in normal and abnormal morhpogenesis. Acta Morphol Neerl Scand 10: 49-58, 1972.
11. Björk A, Skieller V. Facial development and tooth eruption: An implant study at the age of puberty. Am J Orthod 62: 339-83, 1972.
12. Skieller V, Bjork A, Linde-Hansen T. Predication of mandibular growth rotation evaluated from a longitudinal implant sample. Am J Orthod 86: 359-70, 1984.
13. Singer CP, Manandras AH, Hunter WS. The depth of the antegonial notch as an indicator of mandibular growth potential. Am J Orthod Dentofac Orthop 92: 117-124, 1987.
14. Lambrechts AH, Harris AM, Rossouw PE, Stander I. Dimensional differences in the craniofacial morphologies of groups with deep and shallow mandibular antegonial notching. Angle Orthod 4: 265-272, 1996.
15. Fischer B. Asymmetries of the dentofacial complex. Angle Orthod 24: 179-192, 1954.
16. Mulick J. An investigation of craniofacial asymmetry using the serial twin-study method. Am. J Orthod 51: 112-129, 1965.
17. Major P, Johnson D, Hesse K, Glover K. Landmark identification error in posterior anterior cephalometrics. Angle Orhod 6: 447-454, 1994.
18. Cortella S, Shofer F, Ghafari J. Transverse development of the jaws: normal's for the postero-anterior cephalometric analysis. Am J Orthod Dent Orthoped 112: 519-522, 1997.
19. Letzer G, Kronman J. A posteroanterior cephalometric evaluation of craniofacial asymmetry. Angle Orthod 37: 205-211, 1967.
20. Thompson JR. Asymmetry of the face. JADA 30: 1859-1871, 1943.
21. Grummons DC, Kappeyne van de Coppelo MA. A frontal asymmetry analysis. J Clin Orthod 21: 448-65, 1987.
22. Ricketts R. Perspectives in the clinical application of cephalometrics: the first fifty years. Angle Orthod 51: 115-50, 1981
23. Ricketts RM, Roth RH, Chaconas SJ, Schulhof RJ, Engel GA. Orthodontic diagnosis and planning. Denver: Rocky Mountain Data Systems, 1982.
24. Sassouni V. The face in five dimensions. Philadelphia, Growth Center Publication, 1955.
25. Bergman R. Practical application of the PA cephalometric head film. Orthod Rev 2: 20-6, 1988.
26. Betts NJ, Lisenby WC. Normal adult transverse jaw values obtained using standardized postero-anterior cephalometrics. (Abstract.) J Dent Res 73: 298, 1994.
27. Avis V. The significance of the angle of the mandible: an experimental and comparative study. Am J Phys Antrop 19: 55-61, 1961.
28. Talents R, Guay J, Katzberg R, Murphy W, Proskin H. Angular and linear comparisons with unilateral mandibular asymmetry. J Craniomandib Disord Facial Oral Pain 5: 135-142, 1991.

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/26/2/155/1745868/jcpd_26_2_av4179x75q3287k2.pdf by Bharati Vidyapeeth Dental College & Hospital user on 25 June 2022