VOLUME-7, ISSUE-1, JANUARY-2018 • PRINT ISSN No 2277 - 8160

Original Research Paper

Anatomy

ASYMMETRY OF THE HUMAN SKULL AS DETERMINED BY VARIATIONS OF ANGULAR RELATIONSHIP BETWEEN THE STRUCTURES SEEN ON BASILAR VIEW OF CRANIUM

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ABSTRACT

BACKGROUND:- The human head and skull are anatomically symmetrical about the sagittal plane, but perfectly symmetrical face would have an unpleasant mask like appearance. A minor degree of asymmetry has been observed in the normal skull .The degree of asymmetry is measured in the form of variations of the angular relationship between the structures seen lying on the lateral planes on the basilar view of the cranium.

MATERIAL AND METHOD- the present study was done in 60 skulls from collection in the department of Anatomy, SMS Medical College, Jaipur(Rajasthan). For the diagnosis of neuro-cranial asymmetric skulls which are grouped into 3 categories(I,II,III) on basis of normal value of 90^0 as derived by Farkes (1981).

RESULT- Angular variations between anterior and posterior parts of skull base was less than 5^0 in normal skull (category I) below $5\text{-}7^0$ in asymmetric skull (category II) and more than 7^0 in malformed skull(category III)

Conclusion-Out of 60 skulls, 57 skull fall in normal,2 skull in asymmetric group, 1 fall in malformed group.

KEYWORDS : Skull, Symmetry, Asymmetry, Malformed, Anterior, Posterior, Anatomical, Angular relationship, Neurocranial

INTRODUCTION

In recent years neurocranial morphology has been determined by various neurotechniques such as Computed tomography (CT), Magnetic Resonance Imaging (MRI), Ultrasound and stereoscopic mapping. Although all these techniques are highly accurate but only a limited group of population is benefited.

The human head and skull are anatomically symmetrical with reference to the sagittal plane as a consequence the lateral image is asymmetrical, been produced by bilateral overlap of symmetrical features superimposed as midline structures. Both frontal and basal views present symmetrical images .

In the frontal view, anterior structures overlap posterior ones and in the basal view the inferior ones overlap the superior ones. In both cases the denser bones of face overlap the cranium which in consequences in partially obscured. (M. J. Trenouth 1985)

While the skull is symmetrical in frontal and basal view, the minor degree of asymmetry has been recognized in the normal adult skull.

The anatomical survey of the external aspect of skull base to find out the angular relationship between the structures seen on basilar view of cranium and to co-relate these findings with radiological images.

In this method, observations distance similar to the distance between X-ray source and film for radiological imaging is employed so that the parallel remain the same and the readings are interchangeable.

This method should be useful in diagnostic screening survey of normal subjects or in the follow-up of craniofacial surgery.

The form of neuro-cranium is well observed in norma verticalis (Olivier, 1969). When the skull is viewed from the above but it has been shown (Kadanoff & Joudanocv 1978) that asymmetry becomes more evident as the plane of observations is lowered towards the basal plane. It has also been stressed by many authors that a basilar midline datum once constructed can be used to assess asymmetry (Berger 1964, Marmary et.al 1979 and Grason et.al 1985).

An angular measurement is preferred over simple linear measurement because it focuses on the inter-relationships between the components rather than single variables .

MATERIAL AND METHOS-

60 samples of skull from collection in the Department of Anatomy, SMS Medical College, Jaipur (Rajasthan). Only those skulls are considered for the study where all reference points of study on base of skull are intact.

Cubic Craniophore, Plane glass sheet, Glass marking pencil, backlite sheet with pin hole (standard diameter 0.1mm), backlite sheet with pin hole stand, Protactor and Parallelogram.

Skull under study is cleaned and reference points are marked on the base of skull by using a marking pen. The anatomical landmarks were defined as follows:-

AK- Akanthion
ZYM- Zygomatic Maxillary point
Fo- Foramen ovale – Midpoint of the largest transverse diameter of the foramen ovale.
CC- Carotid canal – Middle of the largest tranverse diameter of the carotid canal.
STY- Mid point of styloid process
Ba- Basion
OP- Opisthion
I- Inion.

The skull is fixed in cubic craniophore in such a way that auriculo-orbital plane of Virchow/ Frankfurt horizontal plane is parallel to the floor. A backilite sheet with pin hole is fixed on a stand at a distance of 1 meter per perpendicular to the plane of measurements. The reference points are marked over a glass using a glass marking pencil by viewing perpendicularly to the chosen reference points through a fixed pin hole placed at a distance of 1 meter.

The right and left side of skull are marked over the glass and a midline , anterior and posterior transverse lines are drawn by joining the reference points. The posterior transverse reference line, connects both carotid canal points(Cc-Cc). The anterior transverse reference line connects both zygomatic maxillary points"Zym-Zym".

Anterior Angle- Cc-Cc/ Ak Ba Op I
Posterior Angle- Zym-Zym / Ak Ba Op I

Anterior and Posterior Angles on both the sides and Acute angle either Anterior or Posterior on Both sides of Skull is recorded.

RESULT-

For the diagnosis of Neuro-Cranial asymmetries the skull are grouped into 3 categories (I,II,III) on the basis of normal value of 90^0 as derived by Frakas (1981)

Category I- constitute normal skull
Category II- constitute Asymmetric skull
Category III- malformed Skull

(in degree)	Right angular measurement				Left angular measurement			
	Anterior		Posterior		Anterior		Posterior	
	Total	%	total	%	Total	%	total	%
75-79	1	1.7	x	X	X	x	x	x
80-84	1	1.7	x	X	1	1.7	2	3.3
85-89	33	55	21	35	9	15	23	38.3
90-94	24	40	36	60	48	80	35	58.3
95-99	1	1.7	3	5	2	3.3	X	X
100-104	X	X	x	x	1	1.7	x	x

TABLE -1-distribution of anterior & posterior angles according to their position

Sr. no	Angular measurement groups	Range (in degree)
1	Right Anterior	79 – 96
2	Left Anterior	84 – 101
3	Right Posterior	86 – 97
4	Left Posterior	83 – 94

TABLE 2- Range of Angles in all angular measurements groups

Angles / Position	Anterior	Posterior	P Value	Significance
	Mean ± S.D N= 60	Mean ± S.D N= 60		
Right	89.22 ± 2.25	90.62 ± 2.12	<.001	Significant
Left	90.78 ± 2.25	89.38 ± 2.17	<.001	Significant
P Value	< .001	<.001		
Significance	Significant	Significant		

TABLE -3- Mean ± S.D of Anterior & Posterior angles according to their position

Cate gory	Group	Total No of Skulls							
		Right Anterior		Right Posterior		Left Anterior		Left Posterior	
		Total	%	Total	%	Total	%	Total	%
I	Normal	50 7±50	83.3 95	48 10±48	80 96.7	50 7±50	8.33 96.7	52 6±52	86.7 97.7
II	Asymmetric	2	3.3	2	3.3	2	3.3	2	3.3
III	Malformed	1	1.7	x	0	1	0	x	0

Thus in present study the necessity was felt to determine criteria to define symmetry and asymmetry and co-relation of any angular variations in anterior and posterior as well as right and left side of skull base.

Rabet Gozil et al (1996) and Farkas (1981) define the limit of symmetry and asymmetry by giving definite limit of angular variation in anterior and posterior parts of the skull base but they do not explain the relationship between angular variations of right and left side of skull base.

Alphonse R Burdi showed close similarity of prenatal and postnatal craniofacial growth. A comparison of the anterior and posterior cranial base lengths by Burdi indicated that regression coefficient (b-0.513) for anterior cranial base was significantly greater than regression coefficient (b=0.295) for posterior base length. This leads to the fact that length of anterior cranial base exceed that posterior base.

Different timing of growth cessation in the anterior and posterior parts of skull base (Scott, 1988) may also give rise to different angular variations on the 2 sides in anterior and posterior parts in occasional skulls, consistent with our finding which shows only 3.3% skull to be asymmetric. These values are also approximately similar to values (3.7% asymmetric skull of Rabit Gozil 1996)

A small change in single plane or angle may produce significant change in shape of skull (M.J. Trenouth,1984) and is the major cause of asymmetry of the skull demonstrated as flattening out in basal part of cranium along with anterior displacement of naso maxillary segment to left side asymmetrical development of temporal lobe of cerebrum was responsible. The accurate measurement of these angles can help in determination of normal and abnormal skull.

So that in the present study accurate measurements of angles on the skull base are carried out to differentiate skull into 95-96% normal, 3.3% asymmetric and 1.66% malformed skull group. These finding are almost similar to the normal (94.9%), Asymmetric (3.7%) and malformed (1.2%) skulls of turkey, observed by Rabet Gozil et.al (1996).

Our findings are consistent with Ford (1956) that is an angular increase observed in two asymmetric and one malformed skull (i.e right posterior angle 97^0) and left anterior angle (101^0) respectively (Table II)

Interpretation of mean angular variables suggested that there is significant difference existing between the mean of right anterior and right posterior angles (i.e P < .001) left anterior and left posterior angles (i.e P < .001), as well as between anterior and posterior angles of both sides (i.e P < .001). (Table III)

The mean left anterior angle (90.78) and left posterior angle (89.38) of skulls in the present series in close to the mean left anterior (90.21) and left posterior angle (89.34) of skull of Turkey which is observed by Rabit Gozil (1996).

According to Rabit Gozil (1996) right sided angles of the skull base are not considered for skull base angular measurement because 64% right angles are acute but he could not explain any reason. In contrast to above study in our study it is observed that there is significant bilateral difference (x^2- right P < .01, left P<.01) between acute, obtuse or right angles (<or>, 90^0) of right anterior and posterior angles as well as left anterior or posterior angles. The mean value of all these angles also shows significant differences (Table V & VI).

SUMMARY AND CONCLUSION-

The degree of asymmetry is measured in the form of variations of the angular relationship between the structures seen lying on the lateral planes on the basilar view of the cranium. The present study in 60 skulls concluded that the angular variations between the anterior and posterior part of skull base was less than 5^0 in the normal skulls between 5^0-7^0 in asymmetric skulls more than 7^0 in malformed skull.

Inference of present study supports the hypothesis that an appreciable difference does exist between the craniofacial structures on left & right side. It may be of practical relevance in that it help to define what may be regarded as limit of symmetry, so that pathological condition can be easily distinguished. Two skulls falling in asymmetric category (>±2SD ; <± 3SD) & one malformed skull (>±3SD) were associated with cranial synostosis that might have necessitated correlative neurocranial surgery.

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