

**SCREENING FOR ANOMALIES IN OCCIPITO-CERVICAL JUNCTION USING CRANIOMETRY IN COMPUTED TOMOGRAPHY****MR. MADHAVAN T.S¹ AND MS. WINNIECIA DKHAR^{2*}**

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ABSTRACT

The aim of this study is screening for anomalies in Occipito-Cervical Junction using craniometry in Computed Tomography. In this study 170 patients undergo CT of cervical spine on MDCT Brilliance 64 slice Phillips with normal routine protocol and later post processed into Multiplanar imaging where Craniometry was performed in the mid sagittal plane and Wackenheim-clivus baseline, clivus-canal angle, McRae line, Chamberlain line, McGregor line were calculated using the measurement tools. The present study brings in the significant role of Chamberlain's line and McGregor's line as the deviation of the measured values from standard values which confirms the abnormality within the anatomical structure and hence helpful for the physicians especially for the ortho-surgeons to diagnose and provide appropriate management either clinically or surgically in the early stage.

KEYWORDS: Occipito-Cervical Junction, craniometry, computed tomography.



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INTRODUCTION

Occipito-cervical craniometry is an important step towards evaluation of CVJ related anomalies. Occipito-cervical junction is the highly specialized area of the spine.¹ Understanding the unique anatomy, its imaging and craniometry of this area helps in evaluating and managing the devastating effect of that pathologies has on it.¹ Craniometry of this region helps in determination, treatment and surgical management of the abnormalities related to it.² In early decade craniometry was performed on radiographic image, though the measurements were used to diagnose the abnormality of Occipito-cervical junction but the evaluation and diagnosis was restricted to only one dimension and was not accurate. With the evolving of technology in the field of radiology, it has led to easy diagnosis of Occipito-cervical junction anomalies in the early stages. Computed Tomography imaging represents a feasible, reproducible and accurate method for the measurements of craniometry and vertebral body dimensions because of the high contrast resolution. Occipito-cervical craniometry is an important step towards evaluation of CVJ related anomalies. Occipito-cervical junction is the highly specialized area of the spine.¹ Pathologic conditions at OCJ can be diagnosed using computed radiography, computed tomography (CT), magnetic resonance imaging (MRI). Pathologic conditions involving Occipito-cervical junction compromises normal anatomy and may lead to superior migration of dens, atlanto-axial instability and neural compression. One of the most common pathology in relation to Occipito-Cervical junction is Basilar Invagination. Thus, the aim of the present study was to screen the Anomalies in Occipito-Cervical Junction using Craniometry in Computed Tomography.

MATERIALS AND METHODS

Approval was acquired from ethical committee, Kasturba Hospital and institution research committee, School of Allied Health Sciences. It was a perspective observational study, carried out at Department Of Radio-diagnosis and Imaging, Kasturba Hospital, Manipal, Karnataka, using Phillips Brilliance 64-SLICE

CT. Samples collected were 170, of age group between 20-50 years who were referred by treating doctor for CT of Cervical Spine. Patients with trauma, major injuries & fractures of cervical spine were exclude from the study. CT of cervical spine was performed with normal routine protocol. Patients was positioned on the CT couch in supine head first position, with the area coverage of tip of the mastoid to sternal notch. Scan of the required area of interest was performed on the acquired scanogram keeping in mind that scan is performed with no loss of anatomical structures, axial sections of cervical spine acquired with the slice thickness of 0.9mm with slice increment of 0.45mm with filter of detail D producing standard bone resolution. The consent form was obtained from the patient before the start of examination. The original series of cervical spine scan having thickness of 0.9mm with the slice interval of 0.45mm were selected for the study, transverse images per patient data set which was included in the study were sent to dedicated workstation Phillips Extended Brilliance workstation and the acquired axial sections were converted to coronal and sagittal orientation using MPR (Multi-planar Reconstruction) tool in Phillips CT viewer software which allows 2D post-processing. Craniometry was performed in the mid sagittal plane and Wackenheimer-clivus baseline (Tangent drawn along the superior surface of clivus), clivus-canal angle (Angle formed by Wackenheimer line and posterior vertebral body line), McRae line (from basion to opisthion), Chamberlain line (from hard palate to opisthion) McGregor line (from hard palate to most caudal point on midline occipital curve) was calculated using the measurement tools. Metric data was collected and used for the comparison with the standard values which determine the normality of the subject being studied. In order to define the normality of the subjects being studied each craniometric parameter was compared with the standard values such as wakenheimer baseline in which the dens should be below the line, similarly clivus canal angle the normal range varies from 150° in flexion and 180° in extension, in case of McRae line the dens should be below the line, whereas in chamberlains line the dens should not protrude above 4.5mm and in McGregor line the dens should be below 3mm.

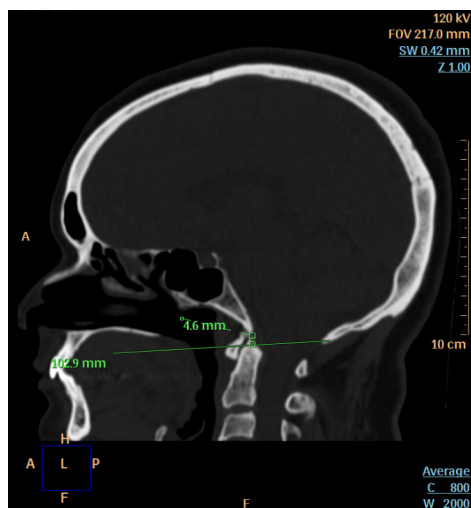


Figure 1
Craniometric measurement of Chamberlain's line with abnormal Occipito-cervical junction

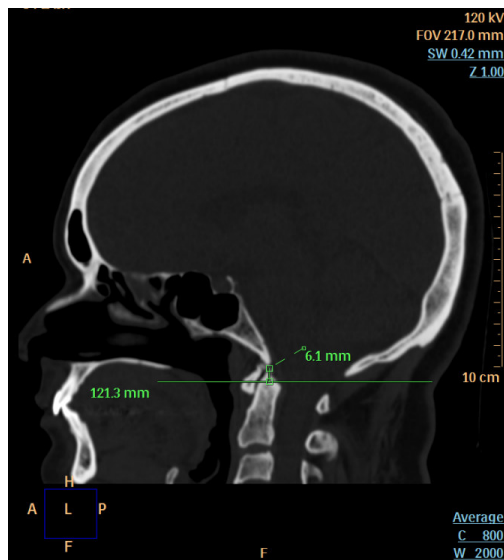


Figure 2
Craniometric measurement of McGregor's line with abnormal Occipito-cervical junction

RESULTS

Data collected from this study was used to evaluate the evidence of basilar invagination among the total of 170 individuals. A total of 109 males and 61 females were present in this study. Based on the study performed, craniometric evaluation of chamberlain's line indicates that 37 out of 170 (21.8%) individuals were found to be

normal with no evidence of basilar invagination and 133 out of 170 (78.2%) individuals were found to be abnormal with positive evidence of basilar invagination. Craniometric evaluation of McGregor's line shows that 63 out 170 (37.1%) individuals who fall under category of normal depicting no evidence of basilar invagination and 107 (62.9%) who are abnormal depicting the presence of basilar invagination.

Table 1
Percentage Frequency of Normal and Abnormal Patients with Respect to Chamberlain's Line

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Normal	37	21.8	21.8	21.8
	Not normal	133	78.2	78.2	100.0
	Total	170	100.0	100.0	-

Table 2
Percentage Frequency of Normal and Abnormal Patients with Respect to McGregor Line

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Normal	63	37.1	37.1	37.1
	Not normal	107	62.9	62.9	100.0
	Total	170	100.0	100.0	-

Considering the craniometric measurements of Chamberlain's line among males, it was found that 23 (21.1%) were normal showing no presence of basilar invagination and 86 (78.9%) were abnormal. Whereas, among females, 14 (23%) were normal and 47(77%) were abnormal. It was seen that the percentage of

abnormality was more among males and females. Chi-square test was performed to find the association of chamberlain's line among males & females and it was found that there was no significant difference in the chamberlain's line between males and females (p=0.079).

Table 3
Chi-Square table for Chamberlain's Line among males and females

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.079 ^a	1	.779	-	-
Continuity Correction ^b	.008	1	.931	-	-
Likelihood Ratio	.078	1	.780	-	-
Fisher's Exact Test			-	.847	.461
Linear-by-Linear Association	.078	1	.780	-	-
N of Valid Cases ^b	170		-	-	-

Similarly, the craniometric evaluation of McGregor's line shows that 37 (33.9%) males were normal and 72 (66.1%) was abnormal. In case of females, 26 (42.6%) were with normal Occipito-cervical junction and

35(57.4%) were found to be with abnormal Occipito-cervical junction. There was no significant association in craniometric evaluation of McGregor's between males and females ($p=1.263$) based on the chi-square test.

Table 4
Chi-square table for mcgregor's line among males and females

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.263 ^a	1	.261	-	-
Continuity Correction ^b	.918	1	.338	-	-
Likelihood Ratio	1.254	1	.263	-	-
Fisher's Exact Test	-	-	-	.321	.169
Linear-by-Linear Association	1.255	1	.263	-	-
N of Valid Cases ^b	170	-	-	-	-

DISCUSSION

In the present study data we have acquired data from the patients who have undergone Computed tomography of cervical spine free from traumatic injury. Craniometric measurements performed in 170 adult patients to evaluate the Occipito-cervical junction. U. C. Batista et al studied the craniometric relationship of the normal cranio-cervical junction based on the CT scan measurements obtained in 100 asymptomatic adult patients with the mean age of 50.6 years (SD OF 18.80 median 51 years, range 18–82 years).⁸ The group included 52 men (52%) and 48 women (48%). A total of 85 patients (85%) had a CT scan for evaluation of head trauma.⁸ The mean distance of the tip of the odontoid process from the Chamberlain line was -1.5 mm (below the line; median of -1.8 mm, SD 2.2), ranging from -7.6 (below the line) to +5.2 mm (above the line) In 5 patients (5%), the tip of the odontoid process was more than 2 mm above the Chamberlain line, and in one of these 5 patients (1% of the overall group), the tip of the odontoid process was more than 5 mm above the Chamberlain line.⁸ The mean distance of the Dura mater from the line that passes from the inferior surface of the basion to the inferior aspect of the C-2 vertebral body was 6.7 mm (SD 1.0 mm, median 6.5 mm, range 4.2–10.2 mm). Just 1 patient (1% of the group) had a measurement above 9 mm: 10.2 mm.⁸ In the present study data collected was used to analyze the frequency of normal and abnormal Occipito-cervical junction among the total individuals whose data was used to evaluate the evidence of basilar invagination. Based on the study performed, craniometric evaluation of chamberlain's line indicates that 37 out of 170 (21.8%) individuals were found to be normal with no evidence of basilar invagination and 133 out of 170 (78.2%) individuals were found to be abnormal with positive evidence of basilar invagination. Craniometric evaluation of McGregor's line shows that 63 out 170 (37.1%) individuals who fall under category of normal depicting no evidence of basilar invagination and 107 (62.9%) who are abnormal depicting the presence of basilar invagination. Considering the craniometric measurements of Chamberlain's line among males, it was found that 23 (21.1%) were normal showing no presence of basilar invagination and 86 (78.9%) were abnormal. Whereas, among females, 14 (23%) were normal and 47(77%) were abnormal. It was also noted that the percentage of abnormality was more among males than females. Chi-square test was

performed to find the association of chamberlain's line among males & females and it was noted that there was no significant difference in the chamberlain's line between males and females ($p=0.079$) shown in table 3. Similarly, the craniometric evaluation of McGregor's line shows that 37 (33.9%) males were normal and 72 (66.1%) was abnormal. In case of females, 26 (42.6%) were with normal Occipito-cervical junction and 35(57.4%) were found to be with abnormal Occipito-cervical junction. There was no association in craniometric evaluation of McGregor's between males and females ($p=1.263$) based on the chi-square test. This is the first study evaluating intra-observer and inter-observer reliability in measurement of the Occipito-cervical angle, in history postoperative kyphosis of the cervical spine and subsequent neurologic deterioration made surgeons aware of the importance of the spinal alignment. Most reports on radiographic analysis of cervical spine were concerned with middle and lower cervical alignment; a very few reports are available on the upper cervical spine. Recently atlanto-axial or Occipito-cervical fusion has been more popular in the treatment for atlanto-axial subluxation associated with the rheumatoid arthritis. With the increase in the number of surgeries evaluating the Occipito-cervical angle has become markedly significant. Some studies have described the Occipito-cervical angle using the distance between landmarks whereas only one study reportedly compared measurement techniques to assess the Occipito-cervical distance. Although some techniques to evaluate the Occipito-cervical angle have been described, no studies have addressed the reliability of these parameters. Standards for measuring Occipito-cervical angle are not yet determined. This is the first study to compare reliability of these methodologies.³ The McRae line is drawn across the foramen magnum from the basion to the opisthion. This line is comparable to the lower endplate of the vertebral body of the spine. However, the McRae line obtained ICCs of 0.835 (intraobserver) and 0.802 (interobserver), indicating that this line is the least reliable for measuring the Occipito-cervical angle. We found that either the basion or opisthion was difficult to identify in some of the films; the Lateral bony structure of the skull base seems to make the occipital border dull and obscure.³ The Chamberlain line is drawn from the posterior- superior aspect of the hard palate to the opisthion, and the McGregor line is drawn from the posterior- superior aspect of the hard palate to the most caudal point on the midline Occipital curve. Intra-class correlation coefficients calculated from

the results using the McGregor line indicated predominance compared with that from the Chamberlain line. Though other studies were performed in the similar manner to prove the significance of these craniometric parameters which will be useful for the early diagnosis of the disease. Present study brings in the significant role of Chamberlain's line and McGregor's line as the deviation of the measured values from standard values which confirms the abnormality within the anatomical structure and hence helpful for the physicians especially for the ortho-surgeons to diagnose and provide appropriate management either clinically or surgically in the early stage.

CONCLUSION

The data are of significances in evaluating the anomalies of Occipito-cervical junction in comparison with the normal standard parameters, potentially improving the diagnostic criteria of most anomalies. When evaluating Occipito-cervical junction anomalies surgeons should take into account the normal ranges based on CT scan. Other craniometric parameters such as Wackenheim base line, Clivus canal angle and McRae's line were also measured and compared with the normal values but did not show any significance as the values obtained fall within the normal range.

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