SLOPE IN THE SKULL-A TOOL IN FORENSICS

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ABSTRACT

The present study is done to assess the clivus quantitatively by CBCT by measuring the width and length of clivus in axial and sagittal section, also to determine the forensic significance in morhphometric analysis. **Material and Methods:** The CBCT images of 61 subjects obtained Planmeca Promax 3D Mid ProFace machine using Romexis software.The clivus length and clivus width were measured using Dicom software programme on sagittal images and axial images (DICOM images). **Results:** The mean of clivus length was statisticallyhighly significant (p<0.001) and higher in males compared to females however the clivus width was statistically not significant (p>0.05) in both males and females. The Pearson correlation coefficient shows that the clivus length and clivus width was directly associated with age. The clivus length was found to be statistically significant in all age groups i.e. statistically significant difference was observed between age groups (p value <0.05). The clivus width was also found to be statistically significant in all age groups i.e. statistically significant difference was observed between age groups (p value < 0.05) The Pearson Correlation between age and clivus width demonstrates a significant positive relation. **Conclusion:** The CBCT measurement of the clivus dimensions can be used to predict the age of individuals. The clivus dimensions are directly related to age and gender. So it can be concluded that clivus dimensions can be used to differentiate male from female and age determination. However it can also be used as an additional or only parameter when other parameters or measures were inconclusive in medico-legal cases.

KEYWORDS: Clivus, Foramen Magnum, Cone Beam Computed Tomography.

INTRODUCTION

Forensic experts are facing great problem in identifying the persons in mass disaster from the skeletal remnants (bones). They have been used as a tool for sexual dimorphism as bones of the body are last to disintegrate after death next to enamel.[1] Forensic doctors don't always receive a complete skeleton, they generally receive only a part of the bone. That's why it is important for alternate areas of the skeleton to be researched for sex determination.[2] Traditionally skull is most studied bone for gender determination in forensics followed by mandible and pelvis.[3] Clivus being a denser part of bony skull can be recovered intact from a damaged or incinerated skull. Therefore it can alternatively be used as an anthropometric measurement for gender determination to some extent medicolegally.[2]

Clivus is a unique central area of the skull base. The clivus is the part of the skull base situated between the foramen magnum and the dorsum sellae. It results from the fusion of the synchondrosis between the basioccipital and exoccipital bones, with growth and ossify from the 3 to the 25 year of age to form the basisphenoid and the basiocciput. The anterior margin of the clivus abuts the sphenoidal sinus, whereas the posterior surface is the anterior limit of the prepontine and premedullary cisterns. The inferior margin represents the posterior nasopharyngeal surface. The clivus is bounded laterally by the petrooccipital fissure, which begins near the cavernous sinus and extends inferiorly to the jugular foramen.

Normal CT appearance: Clivus is best seen in the axial and sagittal view. Traditional studies by non-metrical methods were not reliable. So morphometry and statistical methods were introduced. In this study we quantitatively analyse the data with the help of cone beam computed tomography to determine the forensic and medicolegal significance more than the clinical significance by measuring the clivus width and length in axial and sagittal section respectively.

MATERIALS AND METHODS

CBCT images of 61 subjects (31 males and 30 females) in the age group of 14 yrs to 66 years was taken. This age group was chosen because the final length and width are achieved before this age of an individual. The CBCT images of subjects having no history of trauma, pathology diagnosed as normal have been included in study. Any CBCT with obvious pathology, trauma and facial asymmetry were excluded from this study. All the patients were

examined on Planmeca Promax 3D Mid ProFace machine using Romexis software. The greatest measurement were taken after going through different slices in sagittal sections of CBCT images. The measurements are done as follows-

1. The clivus width was measured on axial reconstructed image and was defined as the longest distance from left to right side near the anterior peripheral margin of foramen magnum inferiorly.(**Fig. 1**)

Fig 1: Showing clivus length measured in sagittal section.

2. The clivus length was measured on sagittal reconstructed image and was defined as the longest distance superio-inferiorly from the upper point of dorsum sellae to the lowest point on anterior margin of foramen magnum.(**Fig. 2**)
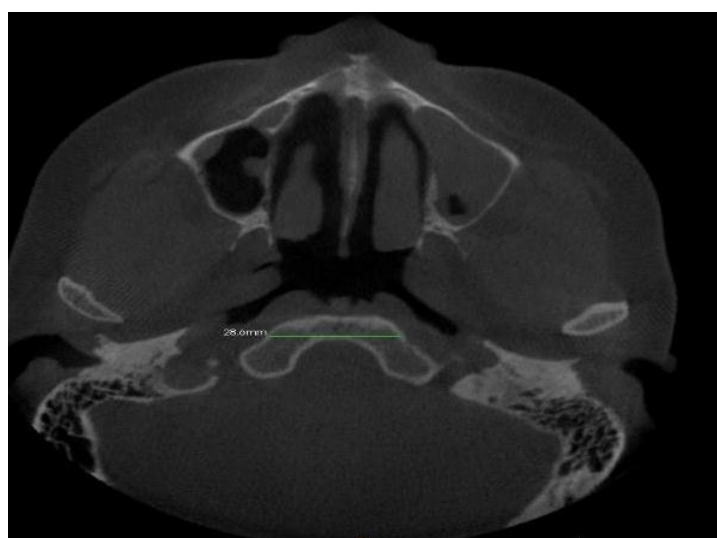
Fig 2: Clivus width measured in axial section.

RESULTS

Statistical Analysis: The categorical variables is presented in number and percentage (%) and continuous variables is presented as mean and SD. Quantitative variables is compared using Unpaired ttest between two groups and ANOVA test between three groups. Pearson correlation coefficient is used to determine the relationship between two scale parameters while correlation was defined as a measure of the strength of a linear relationship between two variables. A p value of <0.05 is considered statistically significant. The data was be entered in MS EXCEL spreadsheet and analysis will be done using Statistical Package for Social Sciences (SPSS) version 21.0.

The study samples consists of 61 subjects aged between 14 and 66 years. study subjects were divided into 3 groups; group 1 being 14-30 years (n=24); group 2 being 31to 50 years (n=20); group 3 being 151-66 years (n=17)**Table 1**).

Table 1: Showing study samples in groups.

Age groups	Frequency	Percent
14-30 years	24	39
31-50	20	33
51-66	17	28
Total	61	100

The sex ratio in our study population showed that males subjects were almost equal to the female subjects (**Table 2**).

Table 2: Showing gender distribution of study samples.

Gender	Frequency	Percent
Male	31	50.8
Female	30	49.2
Total	61	100

Using unpaired t-test, the association of clivus length and clivus width was estimated in relation to gender, It was found that mean of clivus length was statistically highly significant (p<0.001) and higher in males compared to females however the clivus width was statistically not significant (p>0.05) in both males and females.(**Table 3**)
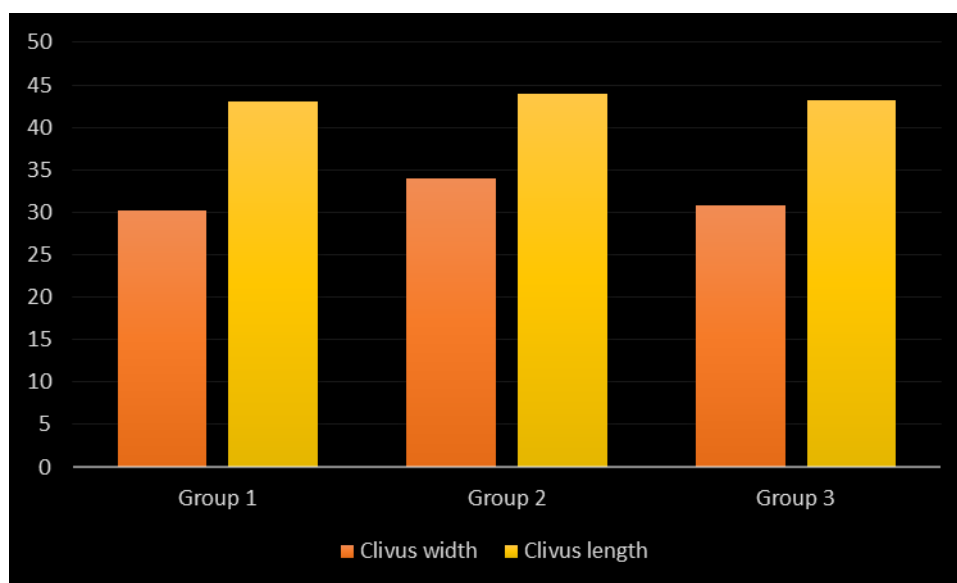
Table 3: Showing clivus dimensions among the gender.

	Gender	N	Mean=std.dev	pvalue
Clivus length	Male	31	45.33 ± 3.58	<0.001***
	female	30	41.33 ± 4.90	>0.01
Clivus width	Male	31	31.14 ± 2.79	>0.01
	female	30	30.37 ± 2.14	>0.01
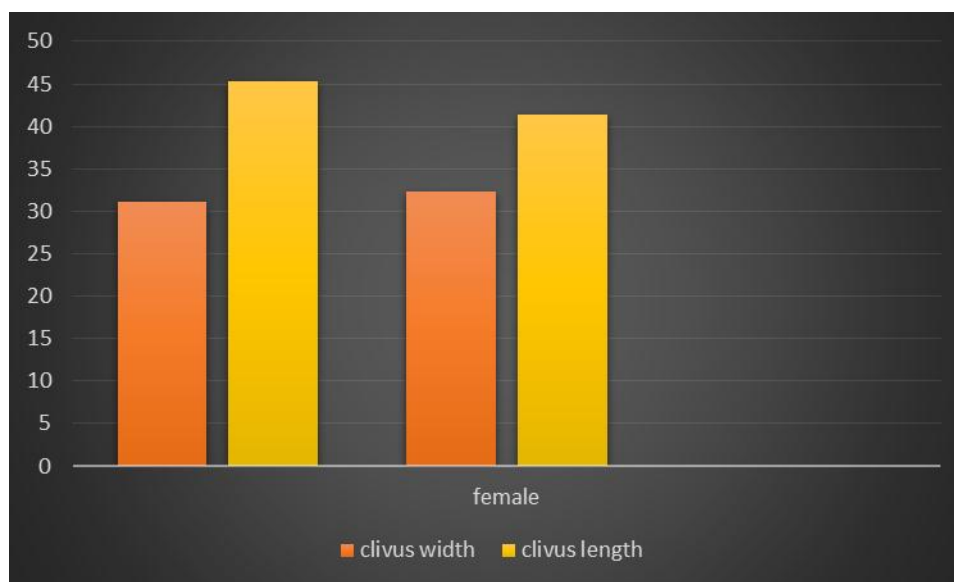
The one way ANOVA is applied to determine association of clivus length and clivus width in age groups of subjects. The clivus length and width was more in group 2 patients and clivus width was found to be statistically significant in all age groups with P value 0.001 for clivus width(table 4).

Table 4: Showing clivus dimensions among the three groups.

Groups	Clivus width	Clivus length
1	30.23	42.98
2	34.40	44.01
3	30.76	43.14

The mean value of clivus length was higher in age group 31 to 50 years (44.01mm) than other age groups. The clivus width was also found to be statistically significant in all age groups i.e. statistically significant difference was observed between age groups (p value < 0.05). The mean value of clivus width was higher in age group 31 to 50 years (34.4mm) than other age groups.

The 2 tailed t-test is used to know the association between clivus length, clivus width and Age. It was found that the clivus width was directly associated with age. The Pearson Correlation between age and clivus width demonstrates a significant positive relation (i.e. r=0.050, p=0.050.(**Table 5**).

Table 5: Showing correlation between age and clivus dimensions among the gender.

Correlations			Clivuswidth	Clivuslength	Age
Gender			**Clivuswidth**	**Clivuslength**	**Age**
F	Clivuswidth	Pearson Correlation	1	-.061	-.076
		Sig. (2-tailed)		.748	.689
		N	30	30	30
	Clivuslength	Pearson Correlation	-.061	1	.006
		Sig. (2-tailed)	.748		.974
		N	30	30	30
	Age	Pearson Correlation	-.076	.006	1
		Sig. (2-tailed)	.689	.974	
		N	30	30	30
M	Clivuswidth	Pearson Correlation	1	-.144	.341
		Sig. (2-tailed)		.441	.050
		N	31	31	31
	Clivuslength	Pearson Correlation	-.144	1	.089

			.441		.633
		N	31	31	31
	Age	Pearson Correlation	.341	.089	1
		Sig. (2-tailed)	.050	.633	
		N	31	31	31

DISCUSSION

O'Higgins P et al., and Richtsmeier JT et al., performed many morphometric studies to study the sexual dimorphism in different primate species however, the morphometric studies involving human skull is sparse and based on relatively small sample sizes.[5,6] Jehan M et al[7] stated that final length of the clivus was reached by 11 years of life in both men and women, and then remained constant throughout life. It seems that the postnatal age up to 11 years of life is the crucial time of the development of the clivus, when the final adult width of the clivus is first reached. The mean Clivus length and width of male was larger than females and this difference was statistically significant.

Krogman et al[8] stated that the shape of the cranial base as seen in the sellar angle was influenced by clefting whereas the size i.e., the clivus length and the anterior cranial base length were affected by sex therefore, we tried to make out dimensional analysis of the size of clivus and its sexual dimorphism in MP region.

Apart from these, other studies emphasize on clivus length that were correlated clinically with the soft tissue pathology of the related area. For example, Clivus length in Chiari malformation Type-I (CM-I) was measured and correlated with different parameters by Dufton et al.[9] Clivus length was shorter (P= 0.0009) in CM-I patients (4.02cm ± 0.45) than comparison patients (4.23cm ± 0.42). A negative correlation was found between tonsillar herniation and clivus length (r = -0.30, P<0.001) greater degree of cerebellar tonsillar herniation is associated with a shorter clivus length. Similar results by Heiss et al,[10] CM-I is characterized by hindbrain deformity and clivus and basiocciput lengths were significantly shorter than the values obtained in the control group. As clivus legth is influenced in CM1 group of patients and similar groups so we excluded from our study. Whereas in our study we done our study on CBCT in contrast to other studies that were done on CT scan and it is the only study which emphasize on gender determination and age determination.

It was found that mean of clivus length was statistically highly significant (p<0.001) and higher in males compared to females however the clivus width was statistically not

significant (p>0.05) in both males and females. The mean value of clivus length was higher in age group 31 to 50 years (44.01mm) than other age groups. The clivus width was also found to be statistically significant in all age groups i.e. statistically significant difference was observed between age groups (p value < 0.05). The mean value of clivus width was higher in age group 31 to 50 years (34.4mm) than other age groups.

The 2 tailed t-test is used to know the association between clivus length, clivus width and Age. It was found that the clivus width was directly associated with age. The Pearson Correlation between age and clivus width demonstrates a significant positive relation (i.e. r=0.050, p=0.050 that there is strong positive correlation between clivus width, and age. If furthermore research studies with larger sample size is done, a better positive correlation between clivus width, length and age can be accomplished which will help us to derive a mathematical formula for deriving the age of the study population using clivus width and length.

CONCLUSION

The CBCT measurement of the clivus dimensions can be used to predict the gender of individuals. So it can be concluded that clivus dimensions can be used to differentiate male from female and age determination. However it can also be used as an additional or only parameter when other parameters or measures were inconclusive in medico-legal cases. It may also be helpful to the radiologist in radiological diagnosis of some clivus pathology and may act as a guide to the surgeons for the surgery of clivus and related region.

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