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Study of Head Types of Stroke Patients: A Retrospective Hospital-Based Imaging Study using Brain CT Scans

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Abstract
Stroke has been linked with various anthropometric parameters. Many researchers studied anthropometric parameters such as height, weight and BMI in relation to stroke. Cephalometry is used to estimate the dimensions of skull with which different head types could be determined. This study was aimed at determining the different head types of stroke patients. This is a descriptive retrospective imaging study that used brain CT scans of stroke patients. Vitrea® 2.0 software was used for the image analysis. The software has an in-built caliper which was used for measurement of Fronto-Occipital Diameter (FOD) and Bi-Parietal Diameter (BPD). Data were analyzed using SPSS version 26.0. The overall mean age and standard deviation of the study subjects was 58±15yrs. The mean age and standard deviation for males and females were 58 ± 14 years and 59 ± 15 years respectively. The mean and standard deviation of FOD, BPD and Cranial Index (CI) were found to be 170 ± 11 mm, 122 ± 8 mm and 72 ± 6 respectively. Majority of the patients were observed to have Dolichocephalic head type (302, 73%). This study established that the predominant head type found amongst the stroke patients is Dolichocephalic.

Keywords: Dolichocephalic, Dimorphism, Hyperbrachycephalic, Stroke

INTRODUCTION
Stroke is clinically defined as a transient episode of neurological dysfunction caused by focal brain, spinal cord or retinal ischaemia, without acute infarction (Easton et al., 2009). It is one of the major global disease of public health importance and requires huge investment in health care delivery and rehabilitation (Feigin et al., 2017). Various anthropometric parameters have

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been studied in stroke patients. Several studies were conducted by various researchers where anthropometric parameters such as height, weight, BMI, skinfold thickness and midarm circumference (MAC) were studied (Holanda et al., 2006; Owolabi & Agunloye, 2013; Dhandapani et al., 2015; Kim & Nam, 2020). In addition, researchers had studied FOD, BPD and Bregma Occiput Diameter (BOD) and linked them with medical disease such as moyamoya (Qureshi et al., 2014; Faheem et al., 2019). Similarly, parameters such as BMI, WC, WHR, were used by another team of researchers to predict functional recovery in patients with stroke (Winter et al., 2016; Kang et al., 2017; Nishioka et al., 2021). Furthermore, cephalometry is a method used to estimate the dimensions of skull with which different head types could be determined (Phuntsho *et al*., 2018). Using Cranial Index (CI), the head is internationally categorized into; Dolichocephalic head (CI of less than 74.9%) described as long head type with narrow cranial width, a long narrow shape head and high mandibular plane angle, Mesocephalic head (CI of 75-79.9%) described as medium head type with an average cranial width; brachycephalic head (CI of 80-84.9%) described as short broad head with an average cranial width and broad, square head, and low mandibular plane angle, and Hyperbrachycephalic head **(**CI of above 85%**)** described as a very short broad head (Franco *et al*., 2013; Shah *et al*., 2015). This study aimed at studying the different head types of stroke patients in a Tertiary Health Center in Kano, Nigeria.

METHODOLOGY

This is a descriptive retrospective hospital-based imaging study that employed the use of brain CT images and, was conducted at Muhammadu Sunusi II Radio-diagnostic Center Aminu Kano Teaching Hospital, Kano State, Nigeria. Ethical clearance was obtained from the ethical commitee of Kano State Ministry of Health. Brain CT images of stroke patients were obtained from the local database of the CT suite and back up external drives from the CT archives of the Department of Radiology, over a period of five years (2014 – 2019). Computed Tomography (CT) machine – 164 slice CT scanner Aquillion prime Model TSX-303A and Vitrea® 2.0 software were used in the study. Brain CT scans with image quality, which have been reported and confirmed by a Consultant Radiologist within the period of study were included. Similarly, we excluded images with craniofacial deformities. The Vitrea® software uses an in-built caliper used for linear measurements of Fronto-Occipital Diameter (FOD), a distance between the extreme points of the frontal and occipital bones (Fig 1A), and Bi-Parietal Diameter (BPD) the distance between the parietal bones (Fig 1B). Two researchers did measurements of the skull diameters to address inter and intra-observer errors. The CI was obtained using [(BP/FOD) × 100]. Data were collected and summarized using frequencies, percentages, means and standard deviations, and analyzed using IBM SPSS version 26.0. P-value of less than 0.05 was considered statistically significant.

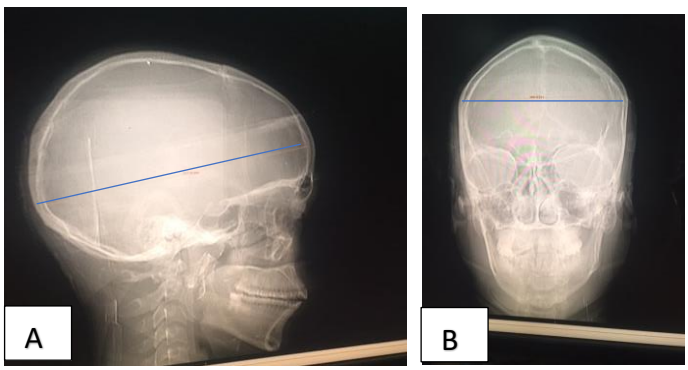

Fig 1 A & B: Measurement of FOD and BPD on Scanograms

RESULTS

A total of 414 brain CT images of stroke patients, certified and signed by a Consultant Radiologist, were used for this study. The study comprised of CT images of 251 males (61%) stroke patients with mean age of 58.15 ± 14.1 years and 163 females (39%) with mean age of 58.87 ± 15.5 years. Overall mean age for all the stroke patients was found to be 58 ± 15 years. The minimum and maximum estimates, the mean and standard deviation of Fronto-Occiptal Diameter, Biparietal Diameter, Cranial Index, were respectively found to be, 170 ± 10.69 mm, 122 ± 7.47 mm, and 72 ± 5.67 mm (Table 1).

Table 2 shows the distribution of stroke patients based on various head types with the predominant head type having being found to be dolichocephalic (73%), while the Mesocephalic, Brachicephalic and Hyperbrachycephalic account for 21%, 5% and 1% respectively.

Statistically significant sexual difference in FOD and BPD was observed between the sexes. However, no significant difference between males and females was observed with respect to the Cranial Index. Most of the measured parameters that were found to be statistically significant had values higher in males than in females (Table 3).

Table 1: Descriptive Statistics of Computerized Generated Anthropometric Parameters

Parameter	Minimum	Maximum	Mean	SD
FOD (mm)	103	201.9	169.9	10.69
BPD (mm)	83.5	164.8	121.8	7.47
CI	54.6	110.7	71.9	5.67

FOD: Fronto-Occiptal Diameter, BPD: Biparietal Diameter, CI: Cranial Index

Table 2: Distribution of Stroke Patients Based on Head Types

Head Type	Frequency (n)	Percent (%)
Dolichocephalic	302	73
Mesocephalic	86	21
Brachycephalic	21	5
Hyperbrachycephalic	5	1

Table 3: Sexual Difference in Computer Generated Anthropometric Parameters

	Male	Female		
Variable	Mean ± SD	Mean ± SD	t	P-value
FOD (mm)	172.3 ± 11.4	165±8.1	6.295	0.000
BPD (mm)	123.1 ± 7.1	119.9 ± 7.8	4.244	0.000
CI	71.7 ± 6.3	72.4 ± 5.1	-1.213	0.226

FOD: Fronto-Occiptal Diameter, BPD: Biparietal Diameter, CI: Cranial Index

DISCUSSION

With its widespread availability, CT imaging has for years became the best technique for developing a database for anthropometric measurements in both healthy and diseased

subjects. CT imaging has been extensively used in evaluating craniofacial and brain anatomy in adults and children (Pool *et al*., 2016). In the present study, our team embarked on studying the head types of stroke patients in order to generate a database that could be used as baseline in managing patients with stroke. Moreover, the different head dimensions such as FOD and BPD could also be used to estimates the risk of developing stroke.

In this study, the predominant head type was found to be the Dolichocephal (73%), an observation that is in keeping with many studies conducted across various ethnicities in the globe and Nigeria in particular (Golalipour et al., 2005; Azouz et al., 2006; Fawehinmi et al., 2009; Hossain et al., 2013; Oladipo et al., 2014; Jervas et al., 2016; Bernhardt et al., 2017; Madadi et al., 2018;). Additionally, for the remaining head types of stroke patients, Mesocephalic, Brachi-cephalic and Hyper-brachycephalic account for 21%, 5% and 1% respectively.
Similarly, the mean and SD values of FOD, BPD and CI were respectively found to be 170 ± 10.69, 122 ± 7.47 and 72 ± 5.67. This also agrees with many studies conducted in our locality (Omotoso *et al*., 2019; Udo-Affah *et al*., 2021) and across the globe at large, however, among healthy subjects (Omotoso *et al*., 2019; Paulinus *et al*., 2019). Unlike in many studies (Golalipour *et al*., 2005; Fawehinmi *et al*., 2009; Bernhardt *et al*., 2017), which were conducted on healthy subjects, the present study was among stroke patients and there was no similar study found or done in this locality, where stroke patients' head types were assessed, however, the findings of the present study agree with the studies mentioned above (Omotoso *et al*., 2019; Udo-Affah *et al*., 2021). Like in many other studies (Ilayperuma, 2011; Maina *et al*., 2011; Terkula *et al*., 2019), conducted on healthy individuals, sexual dimorphisms were observed in FOD and BPD.

CONCLUSION

This study established that the predominant head type amongst the stroke patients is Dolichocephalic. Other head types determined were Mesocephalic, Brachi-cephalic and Hyperbrachycephalic. Furthermore, the anthropometric parameters measured should be added to the database of stroke patients for future use especially in the area of diagnosis and prognosis.

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