ORIGINAL ARTICLE

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ANATOMICAL VARIATIONS OF THE VERTEBRAL ARTERY IN A ZAMBIAN INDIGENOUS ADULT POPULATION UNDERGOING COMPUTERISED TOMOGRAPHY ANGIOGRAPHY AT THE UNIVERSITY TEACHING HOSPITALS LUSAKA, ZAMBIA

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ABSTRACT

Vertebral artery is an important source of blood supply to the brain which arises from the subclavian arteries. Anatomical variations have been incidentally reported during autopsy and angiograms. These variations predispose to development of aneurysms, dissections and may lead to vertebrobasilar ischaemia and posterior circulation stroke. Knowledge of variations of the great vessels of the neck is important for endovascular interventionists and diagnostic radiologists, more so in the era of new therapeutic options for intracranial interventions. Forty-two computerised tomography angiograms at the University Teaching Hospitals, Radiology Department Lusaka were examined to investigate vertebral artery variations in a Zambian population and determine the origin of the vessels. These paired vessels were examined thoroughly individually. Eighty-four arteries were examined eighty one (96.4%) had origin from the subclavian artery while three (3.6%) left took origin from the aortic arch. Variations found were two (2.4%) right vertebral arteries had fenestrations, ten (11.9%) had dual origin and one (1.2%) left was hypoplastic. The age ranged from 18 and 81 with mean age of (42.5±) of these seven females and four males had variations. Demographic characteristic (gender and age) had no statistically significant association to variations of vertebral artery (P>0.05). Variations of the vertebral artery are common. Knowledge of these variations is important and helpful in preventing iatrogenic injuries and haemorrhage during endovascular intervention and diagnostic procedures.

Key words: Vertebral artery, duplication, fenestrations, hypoplasia

INTRODUCTION

The vertebral artery originates from the first part of the subclavian artery and unite to form the basilar artery which is the primary blood supply for infratentorial brain structures such as the mesencephalon, pons, medulla oblongata and cerebellum. Pathologies, including anomalous origin and course, duplication, fenestration, hypoplasia and aneurysm formation implicate typically in cerebrovascular events as it is a source of blood supply of posterior circulation (Polguj *et al.*, 2013). Anatomical variations of the vertebral arteries are commonly encountered in routine cadaveric dissections and during imaging procedures (Komiyama *et al.*, 1999; Polguj *et al.*, 2013). These variations increase the risks of aneurysms development, dissections and may lead to vertebrobasilar ischaemia and posterior circulation stroke. With the increase in the rate

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of cardiovascular diseases in developing countries and Sub-Saharan Africa (WHO, 2014), knowledge of the normal and possible variations of the vertebral arteries is indispensable and imperative in diagnosis, treatment and implementation of interventional measures. The findings of this study would be of help to radiologists and surgeons especially with the installation of a catheter laboratory at the University Teaching Hospitals as it would provide important clinical information to radiologists and vascular surgeons.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted to evaluate 42 Computer Tomography Angiogram with various reasons at the University Teaching Hospitals Radiology Department, Lusaka. A data collection form was used as a tool to gather data and sample selection was done through systematic sampling. The research assistants (radiographers) followed the CTA protocol as they were getting CT angiography, 50ml of highly iodinated contrast agent was administered intravenously, followed by a saline chaser of 30ml, both with a flow rate of 5ml/s. CT angiography was performed from the aortic arch to the vertex with scan parameters 120kV and 300mA tube voltage and attenuation-based tube current modulation. Axial images were reconstructed with a slice thickness ranging from 0.5- 2.0 mm. The obtained axial images from CT angiography were transferred to a workstation for analysis. In addition to the axial source data, post processed multiplanar reformatted and 3D volume-rendering images were evaluated by the radiologist. The data obtained was tabulated and analysed using the Statistical Package for Social Sciences (SPSS) version 22.0 program. For continuous variables mean and standard deviation was used where as for the categorical variables Chi-Square was employed. All statistical tests were performed at 5% significance level or 95% confidence interval with p-value of ≤ 0.05 to determine statistical significance.

RESULTS

Out of the 42 computerised tomography angiogram examined, eighty-four vertebral arteries were analysed. Three (3.6%) left vertebral arteries were found to be originating from the aortic arch while eighty-one (96.4%) took origin from the subclavian artery. The variations found one (1.2%) vessel was hypoplastic, ten (11.9%) had dual origin from the subclavian arteries, two (2.4%) had fenestrations. The study found that there are variations in the vertebral artery in our country and duplication is more prevalent.

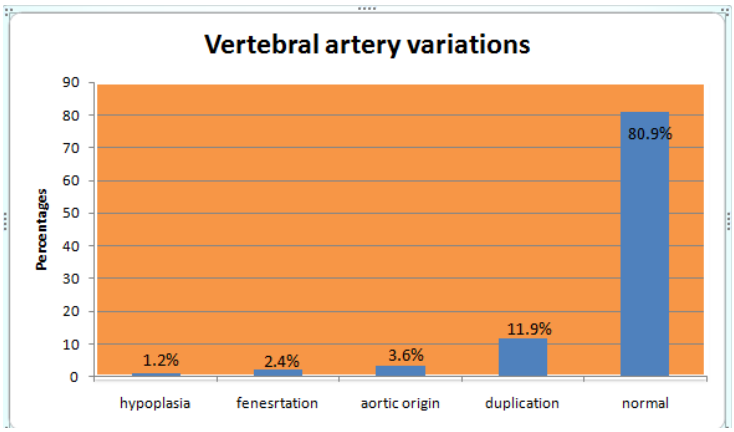

Figure 1: Variations of the vertebral artery

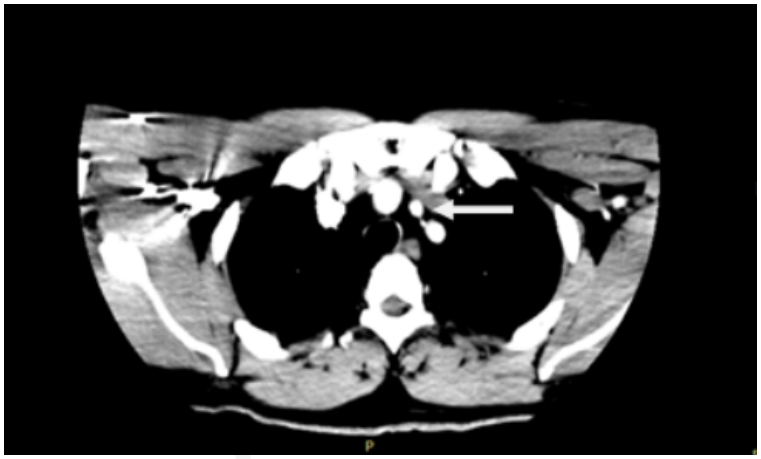

Figure 2a: Aortic origin of left vertebral

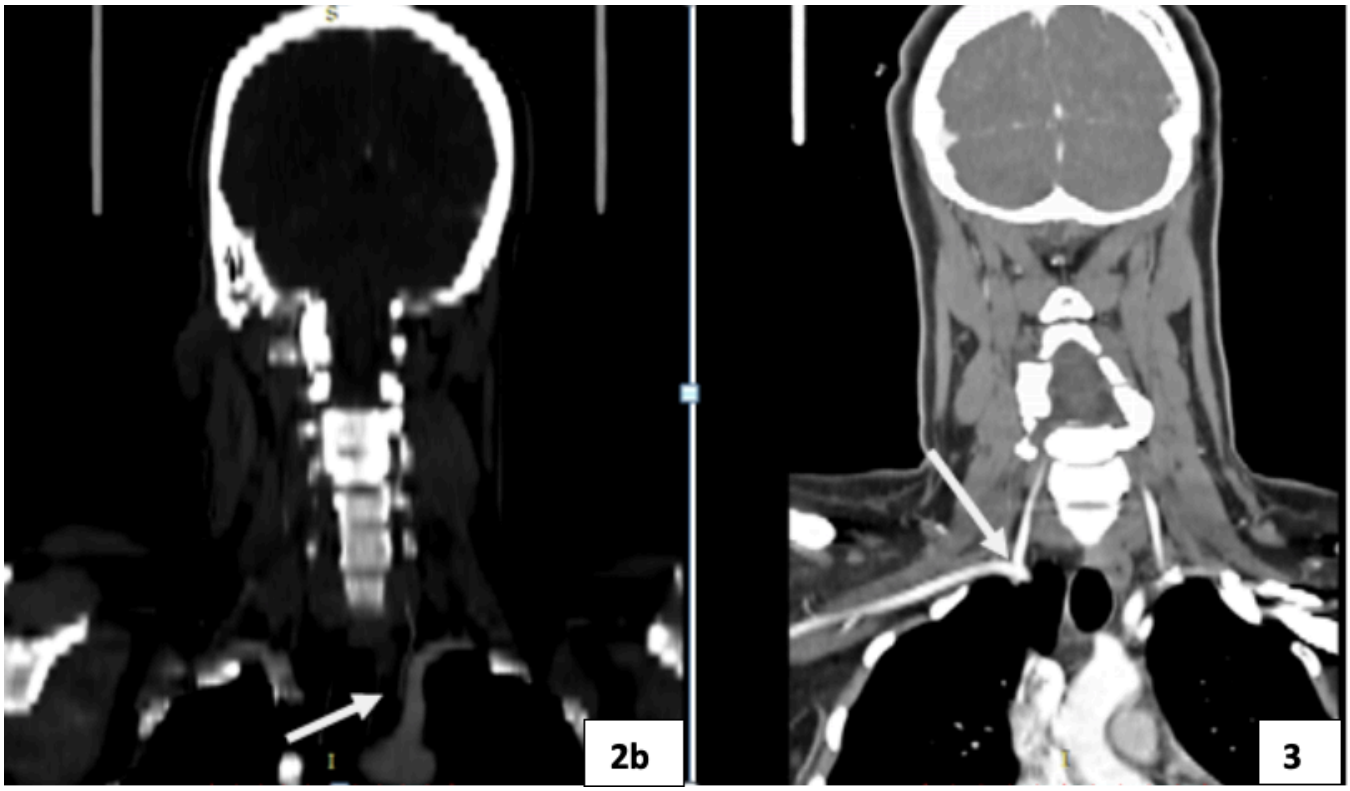

Figure 2b: Aortic origin

Figure 3: Subclavian origin of vertebral arter

DISCUSSION

In the current study it has been noted that the vertebral artery took origin from the subclavian artery in eighty-one (96.4%) vessels. The vessel can also arise from the aortic arch, brachiocephalic trunk and thyrocervical trunk. The variation examined in this study, reported three (3.6%) left vertebral artery originating from the aortic arch (*figure 2a & b*), with most studies reporting prevalence between 3% and 8% (Kubikova et al., 2008). In comparison with other reports, Yamaki et al examined the branch of the vertebral artery in 515 Japanese adult cadavers, in thirty (5.8%) left vertebral artery originated directly from the aortic arch and one right vertebral artery from brachiocephalic trunk (Yamaki et al., 2006). In another study done in

Korean adults two (8%) of 25 examined arch of the aorta revealed that the left vertebral artery was directly originated from the arch of aorta (Shin et al., 2008) while Tetiker et al reported that among 76 cases, three (7.9%) of the left vertebral artery originated directly from the aortic arch.

Duplication t is defined as the vertebral artery with two origins which fuse at a variable level of the neck which is as a result of abnormality of embryologic development of aortic arch and persistence of the intersegmental artery (Polguj et al., 2013). Ten (11.9%) vessels had a dual origin from the subclavian artery. From literature it has been suggested that failure of the primitive dorsal aorta to regress together with the two intersegmental arteries may give rise to duplication of the vertebral artery (Rameshbabu et al., 2014).

Vertebral artery fenestration occurs when the vessel lumen is divided into two separate channels that eventually fuse, forming the primary vessel. Autopsy and angiographic studies suggest that the incidence of vertebral artery fenestration is 0.23%-1.95% (Drapkin, 2000) these findings are actually incidental. However, in this study two (2.4%) right vessels had fenestration. Vertebral artery fenestration has been reported to show some association with multiple co-morbid vascular malformations such as aneurysm and dissections. Kubo and others demonstrated increased risk of saccular aneurysm formation (Kubo et al., 2005). A study done by Uchino and others demonstrated a 7% prevalence of vertebral artery fenestration in 51 cases with known arteriovenous malformation (Uchino et al., 2002).

The published prevalence of vertebral artery hypoplasia varies substantially roughly estimated to range from 1.9% to 11.6% (Katsanos et al., 2013). The current study observed one (1.19%) vessel was hypoplastic. A study done in Kenya revealed a 28.9% of 346 prevalence of vertebral artery hypoplasia (Ogeng'o et al., 2014) higher than prevalence reported in other populations. Vertebral artery hypoplasia is associated to increase the risk of posterior circulation ischemia, particularly in the territory of the posterior inferior cerebellar artery often due to a relative hypoperfusion to the region. Characteristics of this condition are also important in selection and moulding of catheters during interventional neuroradiological procedures as well as mitigating complications of endovascular treatment and prognostication of cerebrovascular disease.

Table 1: Comparison of origin vertebral artery with other studies

Studies	**No of VA studied**	**Origin of the VA**						
		Subclavian		**Aortic arch**		**Others**		**%**
		Rt	**Lt**	**Rt**	**Lt**	**Rt**	**Lt**	
Current study	84	42	39		3			
Tetiker	76	38	35		3			
Melia et al	102	102	96		6			
Satti et al	Case report			1				

Table 2: Comparison of VA variations with other studies

Studies	No of VA studied	Variations of VA						
		Duplication		Fenestration		Hypoplasia		%
		Rt	Lt	Rt	Lt	Rt	Lt	
Current study	84	5	5	2			1	15.5
Ogeng'o et al	346					60	40	28.9
Uchino et al	51			4				7
Kim	3386	7	3					0.3

In conclusion, vertebral artery anomalies are common. Radiologists should be wary of these anomalies and distinguish them from pathological conditions. A detailed knowledge of the exact position of vertebral arteries is important in endovascular and surgical interventions available today and the constantly evolving imaging techniques to avoid iatrogenic injuries and haemorrhage during surgical procedures.

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