Variant termination of basilar artery in a black kenyan population

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Abstract

Variant termination of basilar artery influences occurrence of atherosclerosis and aneurysms, and is also important during cerebrovascular surgery and interventional neuroradiology at the basilar bifurcation, interpeduncular fossa and clivus. There are, however, hardly any reports on these patterns. The purpose of this study was to describe the pattern of termination of the basilar artery in a black Kenyan population. One hundred and seventy three (99 male; 74 female) adult cadaveric and autopsy brains of black Kenyans (age range 20-79) were examined. The basilar artery was exposed in its entire length, terminal branches identified and termination pattern recorded. Representative patterns of variations were photographed with a high resolution digital camera. Data were analyzed for frequency and are represented in a pie chart and macrographs. Bifurcation occurred in 142 (82.1%) of cases. In some of these cases, the superior cerebellar and posterior cerebral arteries had a common trunk of origin. Variant terminations included trifurcation (18, 10.4%), quadrifurcation (10, 5.8%) and pentafircation (3, 1.7%). All the variants were related to duplication and/or point of origin of the superior cerebellar artery and occurrence of common trunk of origin for superior cerebellar and posterior cerebral artery. Variant termination of the basilar artery occurs in 17.9% of cases. These variations are related to the pattern of origin of superior cerebellar artery. Anticipation of these variations is important during neuroradiology, cerebrovascular surgery and interpretation of posterior circulatory stroke.

Keywords: basilar artery, variations, termination, Kenyans.

1 Introduction

The basilar artery (BA), which forms the spine of posterior cerebral circulation, usually terminates by dividing into two posterior cerebral arteries (PCA) (YASARGIL, 1987; RHOTON JUNIOR, 2000). Variant terminations described include double posterior cerebral arteries and common trunks for posterior cerebral and superior cerebellar arteries (PADMAVATHI, 2005). Variant branching patterns of arteries subjects them to abnormal flow patterns predisposing them to atherosclerosis and aneurysms (INGEBRIGTSEN, MORGAN, FAULDER et al., 2004; GESSAGHI, RASCHI, LARRETEGUY et al., 2007), and may complicate surgery at basilar bifurcation angle and clivus (DAGCINAR, KAYA, AYDIN et al., 2007). Basilar termination is the most frequent site of aneurysm (VASOVIC, JOVANOVIC, UGRENOVIC et al., 2008). The abnormalities may also alter the relationships with and compress occulomotor nerve (UCHINO, SAWADA, TAKASE et al., 2003). There are, however, few reports on variant termination of the basilar artery. This study therefore investigated the pattern of termination of the basilar artery in a black Kenyan population.

2 Material and methods

Two hundred and seventeen formalin fixed brains from black adult Kenyans obtained during autopsy and from cadavers at the Department of Human Anatomy, University of Nairobi, Kenya were available for the study. Ethical approval was granted by the Kenyatta National Hospital/ University of Nairobi Ethics and Research Committee. Forty four brains in whom the vessels were damaged were excluded. One seventy three (173) brains were examined. The arachnoid matter was gently peeled off to expose the basilar artery in its entire length. The termination was examined further for origin of SCA and PCA. Pia matter, veins and small perforating arteries were sacrificed to clarify the pattern of termination. The arteries given off just before terminal bifurcation, which coursed laterally to ramify over the superior surface of cerebellar hemispheres, were identified as SCA. The terminal branches which were joined to internal carotid by posterior communicating were identified as PCA. The patterns of termination were categorized into four, namely:

- Bifurcation if the basilar artery gave rise to two unequivocal branches;
- Trifurcation if the basilar artery gave rise to three branches from a common point;
- Quadrifurcation of the BA gave rise to four branches; and
- Pentafircation where BA gave five branches.

The patterns were entered in a data sheet and analyzed for frequency. Images of variant patterns were taken with a high resolution digital camera. The data are presented in a pie chart and macrographs.

3 Results

Single basilar artery running in the pontine cistern was present in all cases. It terminated at the pontomedullary junction in four main patterns. Bifurcation was the most common pattern in 142 (82.1%) cases (Figure 1). In 2 (1.2%) cases of bifurcation, there was bilateral common trunk for PCA – SCA with duplication of SCA on right side (Figure 2).

Variant patterns of termination included trifurcation into SCA, and the two PCA (Figure 3, 10.4%); quadrifurcation into 2 superior cerebellar and 2 posterior cerebellar arteries (Figure 4) [10, 5.8%]. In 2 cases the right SCA branched immediately after its origin giving an impression of a false pentafircation. Pentafircation was observed in 3 (1.7%) cases. The branches included left SCA, left PCA, Right PCA, and duplicated right SCA (Figure 5). One of the SCA arose from the dorsal aspect.

4 Discussion

Pattern of basilar artery termination influences occurrence of aneurysms and atherosclerosis (INGEBRITSEN, MORGAN, OULDER et al., 2004; VASOVIC, JOVANOVIC, UGRENOVIC et al., 2008), and may complicate surgery at basilar tip and clivus (DAGCINAR, KAYA, AYDIN et al., 2007). Observations of the current study reveal that the classical bifurcation of basilar artery into two 2 PCA (GABELLA, 1999) occurs in only about 80% of cases. The remainder of cases display variant patterns. These patterns are also important during surgery and interventional radiology in order to avoid inadvertent ligation/section and misinterpretation (UCHINO, SAWADA, TAKASE et al., 2003).

A remarkable observation of the present study was that in many cases of bifurcation, there was a common PCA – SCA trunk. This variation per se occurs in 2 – 22% (OKAHARA,

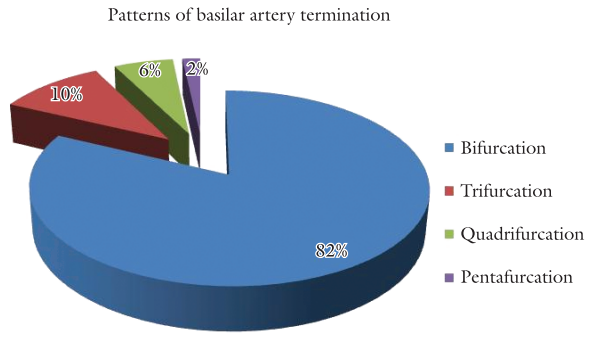

Figure 1. Patterns of Basilar Artery Termination.

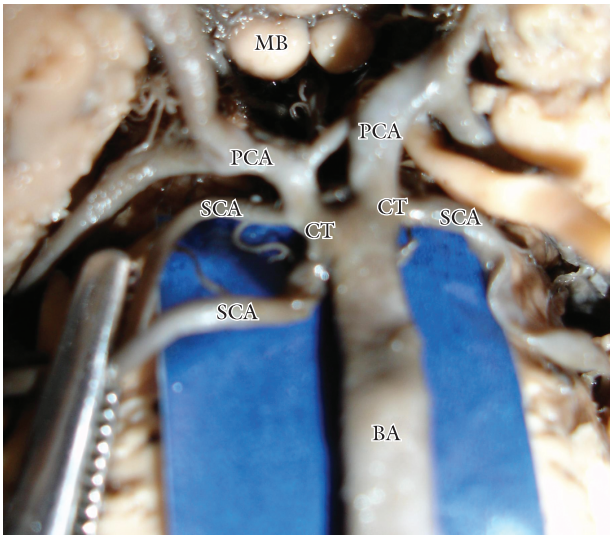

Figure 2. Bifurcation of BA into common PCA – SCA trunk. Note duplication of SCA on the right side (arrow heads).

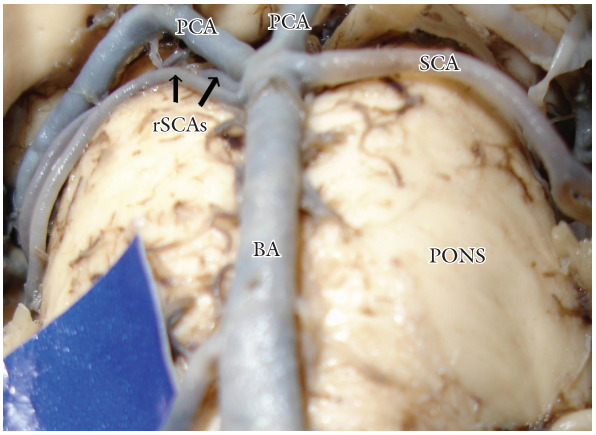

Figure 3. Trifurcation of BA into left SCA, two PCA. Note the apparent continuity of BA into left PCA, and relative hypoplasia of right SCA (arrow).

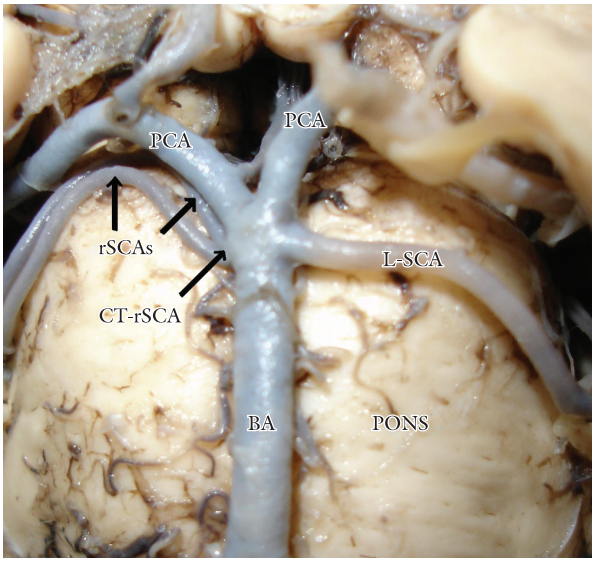

Figure 4. Quadrifurcation of BA into left SCA, two PCAs and right SCA (arrow) which immediately bifurcates.

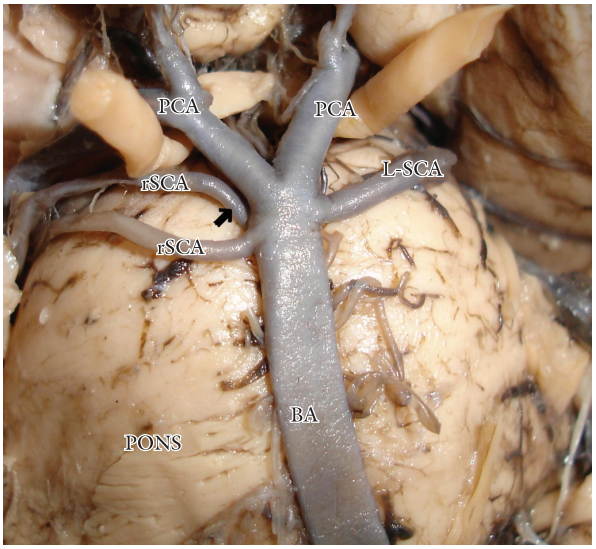

Figure 5. Pentafircation of BA into single left SCA, two PCA and duplicated right SCA (arrows). Note duplication of right SCA with one branch arising from the dorsal aspect.

KIYOSUE, MORI et al., 2002). It constitutes an additional branching point in the system. Such branching patterns are potential sites for development of atheromatous lesions because of complex flow patterns such as recirculation and secondary flow causing abnormal haemodynamic events refered to as "disturbed flow" (BUCHANAN, KLEINSTREUER, HYUN et al., 2003; GESSAGHI, RASCHI, LARRETEGUY et al., 2007). The variant patterns namely trifurcation, quadrifurcation and pentafircation are hardly reported in literature. They are probably due to variations in fusion of the primitive neural arteries at the level of the basilar rostral limit during early embryonic stage (UCHINO, SAWADA, TAKASE et al., 2003). Literature is silent on the significance of these variations. Nonetheless, trifurcations of other arteries in the brain, say of middle cerebral arteries are favourable lodging sites for cerebral emboli with consequent ischaemia of the affected region (FUTRELL, 1998). Accordingly, the high prevalence of trifurcation (10.4%) observed in the present study implies that in case of basilar artery thrombosis, embolic occlusion of the branches is most likely to occur.

The most common cause of the variant patterns is duplication of SCA. On its own, this variation occurs in 0.4 – 28% of cases (HARDY, PEACE, RHOTON JUNIOR et al., 1980; PADMAVATHI, 2005). It is thought to be due to origin of branches of SCA, such as marginal artery, directly from BA (DAGCINAR, KAYA, AYDIN et al., 2007). Duplication of SCA is important in several respects. First, that the additional artery may sustain circulation when the main one is occluded. Secondly, that perforators from it are vulnerable to inadvertent injury during surgery (DAGCINAR, KAYA, AYDIN et al., 2007). Thirdly, the additional artery or lateral deviation of the usual artery may compress the oculomotor nerve. Indeed, in the present study there were cases where the bifurcation angle appeared so wide that PCA appeared so close as to compress the occulomotor nerve. A notable observation was that in many cases of duplication of SCA, the artery appeared hypoplastic. This may increase vulnerability to occlusion, and also predispose to BA atherosclerosis and aneurysm formation. Pertinent to this suggestion are reports that disturbed flow patterns such as occur at branching points, and geometric features such as bifurcation angle and limited branch diameter predispose to atherosclerosis and aneurysm formation (KLEINSTREUER, HYUN, BUCHANAN et al., 2001; INGEBRIGTSEN, MORGAN, FAULDER et al., 2004). This implies that the population studied is more vulnerable to stroke and aneurysm formation than is usually appreciated.

5 Conclusion

Variant termination of the basilar artery occurs in 17.9% of cases. These variations are related to the pattern of origin of superior cerebellar artery. Anticipation of these variations is important during neuroradiology, cerebrovascular surgery and interpretation of posterior circulatory stroke.

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