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Intraluminal septation of the basilar artery: incidence and potential clinical significance

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Variations in the cerebrovascular tree can increase surgical or interventional morbidity. To date, only scant comments are to be found in the literature regarding intraluminal variations of the basilar artery. To further elucidate such anatomy, a cadaveric study was performed.
One hundred and fifty human brains were evaluated for the present study. The basilar artery was identified in each and sectioned longitudinally to observe for the presence of intraluminal septa.
One specimen (0.67%) was identified that harbored an intraluminal septum of the basilar artery. This wall was within the proximal basilar artery and measured 3 mm by 1.5 mm. No specimen was found to have other anomalies of the basilar artery and in the single specimen with an intraluminal septum no signs of intracranial pathology were seen.
Although seemingly rare, septation of the basilar artery can be found. Knowledge of such an intraluminal vascular variation may be important during invasive and minimally invasive procedures. (Folia Morphol 2008; 67: 193–195)

Key words: anatomy, neurosurgery, anomalies, variation, vasculature

INTRODUCTION

Both Hyrtl [5] and Sharpey et al. [13] have referred to Davy's description of the occasional intraluminal septation of the basilar artery. However, the "occasional" presence of such partitions was not defined. Lang [7] stated that such a dividing wall within the basilar artery as reported by Davy could be interpreted as evidence of the separation of cerebral arteries that have developed side by side (i.e. left and right vertebral arteries). Other variations of the basilar artery include, splitting of the basilar artery into two vessels that reunite (fenestration) [1], connection to the internal carotid via persistent fetal vessels (e.g. the trigeminal artery) [17], two parallel traveling vertebral arteries over the clivus that are united across the midline by several anastomotic vessels, and ectatic basilar arteries.

MATERIAL AND METHODS

One hundred and fifty formalin-fixed adult cadaveric brains were used for this study. The brains were harvested from 82 male and 68 female specimens with a mean age of 71 years (range 50 to 101 years). For each specimen the brain was removed in

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a routine manner. After the calvaria had been removed with an oscillating bone saw, the dura was opened and, by means of manual subfrontal retraction, the cranial nerves and internal carotid artery were transected with scissors in an anteroposterior direction. The tentorium cerebelli was cut from its petrous attachment with a scalpel and the spinal cord and vertebral arteries were transected with a scalpel introduced through the foramen magnum. Brains were stored in a formalin solution until dissection. With the inferior surface of the brain in view, the basilar arteries were identified and, usually after removal of the remnants of Liliquist's membrane, the basilar arteries were cut open in their midline with dissecting scissors and observations made of their internal surface. If magnification was necessary, 2.5 × loupes were used. Measurements were made with calipers and rulers.

RESULTS

One male specimen (0.67%), aged 68 at death resulting from colon carcinoma, was identified that harbored an intraluminal septum of the basilar artery (Fig. 1). The length and width of the septation were 3 mm and 1.5 mm, respectively. This septation occurred 4 mm cranial from the fusion of the left and right vertebral arteries. The length of this septated basilar artery was 3.8 cm and its diameter was 5 mm. This specimen had no known history of vertebrobasilar insufficiency or stroke. No specimen was found to have other anomalies of the basilar artery and in the single specimen with an intraluminal septum no signs were seen of intracranial pathology such as aneurysm. Additionally, no compensatory enlargement of other parts of the circle of Willis was observed.

DISCUSSION

As stated by Berry and Anson [2], the embryology of the basilar artery has been but scantily dealt with in most textbooks and the subject is often summarily dismissed. However, some authors have made observations of the early development of this vessel. The primitive blood supply to the brain was via the internal carotid arteries. As the brain evolved and became larger, especially posteriorly, this supply no longer sufficed, and thus an additional arterial supply developed from the subclavians by way of the vertebral arteries [2]. Padget [11] found that paired longitudinal neural arteries appear along the hindbrain and at the 4 to 8 mm stage they coalesce to form the basilar artery. These longitudinal arteries border on the ventral midline avascular strip and are

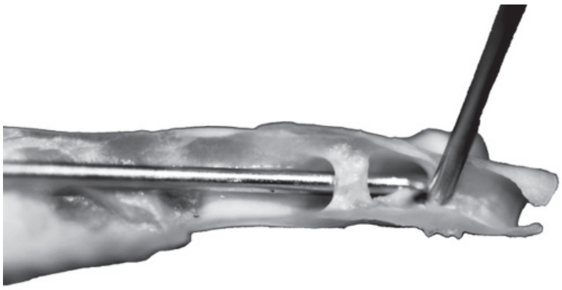

Figure 1. Septated basilar artery as identified in our study. The vertical pin is placed at the vertebrobasilar junction. The lumen of the right distal vertebral artery is seen to the right of the image. The septation within the basilar artery is seen crossing the shaft of the horizontal pin.

connected laterally at multiple locations with the primitive hindbrain arterial plexus [14]. Cranially, these vessels anastomose with the primitive trigeminal artery and caudally with the first cervical segmental artery [11]. Fusion of these longitudinal neural vessels to form the basilar artery occurs in a caudal to cranial direction at approximately the 5^{th} fetal week. During the first phase of fusion, the basilar artery surrounds numerous cell islands. The persistence of such islands may hinder proper fusion of the longitudinal neural arteries and may cause fenestration or segmental duplication of the basilar artery. De Caro et al. [3] have posited that some cases of fenestration of the basilar artery may be caused by persistence of the cranial part of a primitive lateral vertebrobasilar anastomosis rather than by incomplete fusion of the paired longitudinal arteries. Interestingly, in some animals, such as the testudo (tortoise), the basilar artery remains doubled for its whole course beneath the medulla oblongata [2].

Lang [7] described "island" formation within the basilar artery in 2% of his material and large island formation (i.e. an almost duplicated basilar artery) in 0.3% of his specimens. Such fenestrations of the basilar artery may be angiographically occult and seen only on postmortem studies, as other series have reported basilar artery fenestrations in 1.33% of dissections and 0.12% of angiograms [9, 10]. Parenthetically, basilar artery fenestrations have a greater prevalence in the caudal one half of this vessel [14]. Although the term "fenestrations" has been used interchangeably with "partial duplication", complete duplication of the basilar artery is extremely rare [16]. Some have found that the subendothelium is aligned differently in such vessels and that this may be due to hemodynamic alterations in blood flow [4]. Fenestration of cerebral vessels is sometimes misinterpreted as dissections or thromboses [12]. We would suggest that the septation seen in the one cadaveric specimen reported herein represents a forme fruste of such fenestrations, incomplete fusion of the fetal longitudinal vessels that will become the basilar artery. With current diagnostic methods, however, such intraluminal septa would be difficult to identify *in vivo*. A calcified intravascular septum would probably be apparent on a fine-cut computed tomography (CT) scan such as CT angiography, and newer technologies, such as virtual arterial endoscopy that combines perspective volume rendering and interactive visualization, may prove useful in the future [10]. Whether or not such septations predispose an individual to increased risk of intracranial pathology such as aneurysm is speculative. Clinically however, the literature suggests an increased incidence of aneurysm formation in patients with fenestration or duplication of the basilar artery [14, 18].

The clinician may also wish to consider such intraluminal septations as seen in our single specimen in procedures such as the use of endovascular coils to treat basilar tip aneurysms [6, 15] or during the placement of intravascular stents into the basilar artery [8].

CONCLUSION

To our knowledge, the incidence and anatomy of intraluminal basilar artery septation has not been reported. The true clinical consequences of such a variation are not clear, but awareness of this form of anatomical partition within this vessel may be important to neurosurgeons and neurointerventionalists.

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