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Saccular Aneurysms in Basilar Artery Fenestration

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Of 59 cases of vertebrobasilar junction aneurysms diagnosed and treated from January 1977 to April 1986, 21 (35.5%) saccular aneurysms arose in a fenestration of the proximal basilar artery. Defects of the media at the junctures of the fenestrated segments, as well as the possible presence of turbulent flow at the vertebrobasilar junction, may explain the high incidence of vertebrobasilar aneurysms associated with proximal basilar artery fenestration.

Intracranial saccular aneurysms associated with arterial fenestrations are well known [1, 2] and are considered rare findings. Histopathologic analysis of intracranial arterial fenestrations reveals a defect in the media of the arterial wall at the angled junctures of the vessels [3], and a morphologic study of a case of basilar artery fenestration with aneurysm formation has demonstrated the same media defect in both the proximal and distal corners of the fenestration [4].

A basilar artery fenestration is observed in approximately 1% of the population and is found in 5% of some autopsy series [5], although angiographically it has been estimated to be 0.6% [6]. Fenestration is most frequently located in the proximal basilar trunk close to the junction of the vertebral arteries [7]. This developmental anomaly, and the presumed presence of an unusual axial blood-stream and turbulent flow at the junction of the vertebral arteries, should predispose to a high incidence of aneurysm associated with proximal basilar artery fenestration. This paper reports the incidence of basilar artery fenestration in association with proximal basilar trunk aneurysms, and the various angiographic and clinical characteristics.

Materials and Methods

Between January 1977 and April 1986, 59 cases of vertebrobasilar (V-B) junction aneurysms were diagnosed and treated at University Hospital, London, Ontario. Of these, 21 (35.5%) were aneurysms associated with basilar artery fenestration. These 21 cases form the basis of this report. The angiography, clinical presentations, surgical findings, and surgical results were analyzed in detail in each case.

Results

The study group consisted of 14 women and 7 men. Four patients were younger than 30 years old, five were between 30 and 39 years, seven between 40 and 49 years, four between 50 and 59 years, and one patient was 67 years old. Subarachnoid hemorrhage was the initial clinical presentation in 19 patients. A mass effect compressing the brainstem was the presentation in the two giant aneurysms in this series. Only three of the 21 patients had a history of hypertension, and one patient had a familial history of cerebral aneurysms.

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Complete angiography was performed in all patients. When standard angiographic views did not reveal all details of the aneurysm, additional views were obtained (Figs. 1 and 2). In one case there were actually two aneurysms at the proximal end of the basilar fenestration (see Fig. 4), and in the other 20 cases one aneurysm was seen at this site. In six cases the length of the fenestration measured less than 5 mm; in

14 cases it measured 6–10 mm; and in one case it was 15 mm. Twenty cases showed the fenestration just above the V-B junction; one case had the fenestration in the mid-basilar artery.

In eight patients, one of the anterior-inferior cerebellar arteries (AICA) arose from a limb of the fenestration (Fig. 3). In four cases, both AICAs originated from limbs of the fenestration.

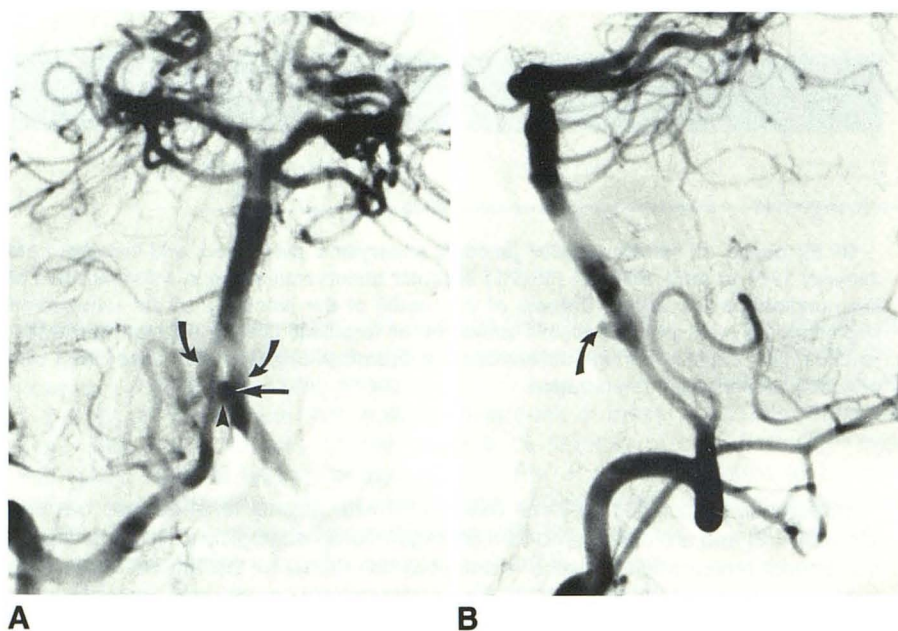


Fig. 1.—Small basilar aneurysm at proximal juncture of fenestration.

A, Caldwell view of right vertebral angiogram clearly shows basilar fenestration limbs (*curved arrows*) and proximal juncture (*arrowhead*) of fenestration. The aneurysm (*straight arrow*) is also seen. While the actual site of joining of the two limbs of the basilar artery is obscured by the aneurysm, the lateral course of these limbs is the clue that a fenestration is present.

B, Lateral view shows aneurysm (*arrow*) pointing anteriorly.

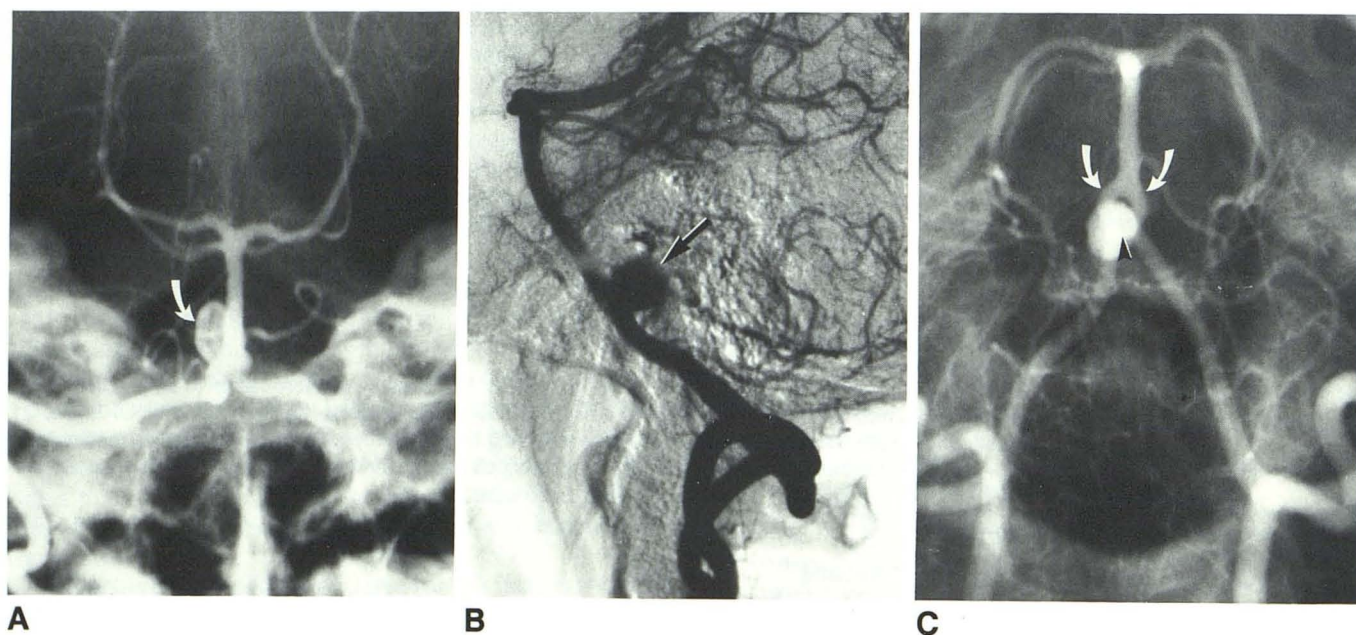


Fig. 2.—Large basilar aneurysm at proximal juncture of fenestration.

A, Towne view of right vertebral angiogram clearly shows aneurysm (*arrow*) but fails to demonstrate the fenestration.

B, Lateral view shows aneurysm (*arrow*) pointing posteriorly.

C, Basal projection, done because of inadequately detailed information on other views, clearly shows basilar fenestration limbs (*curved arrows*), as well as the aneurysm. Through the aneurysm, the proximal juncture (*arrowhead*) of fenestration is seen. Note lateral contours of the fenestration limbs.



Fig. 3.—Large basilar fenestration aneurysm shows anterior-inferior cerebellar artery arising from right limb of fenestration (arrow).

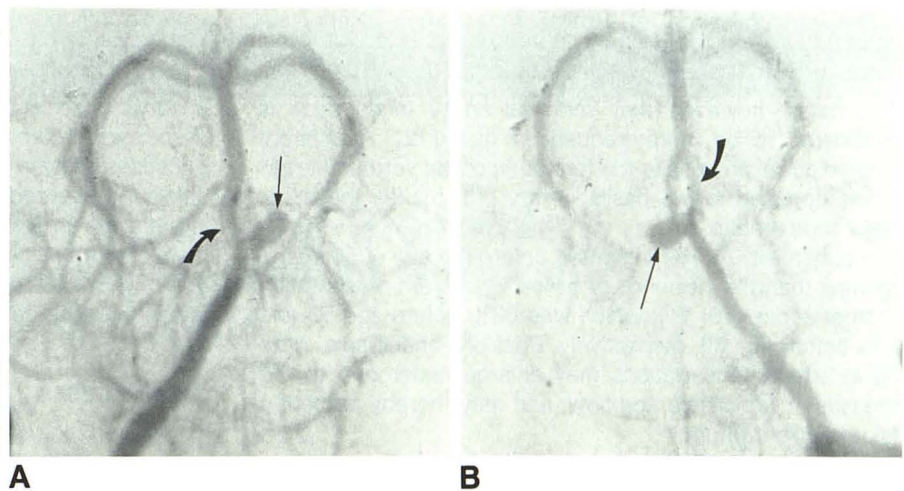


Fig. 4.—Basilar fenestration with two aneurysms.
 A, Right vertebral angiogram shows small aneurysm (straight arrow) projected to left. Note right limb of basilar fenestration (curved arrow).
 B, Left vertebral angiogram shows small second aneurysm (straight arrow) projected to right. Note limbs of basilar fenestration (curved arrow).

tration. In one patient, the posterior-inferior cerebellar artery (PICA) originated from the inferior aspect of a limb of the fenestration. All aneurysms arose from the proximal juncture of the fenestration. Aneurysms grew anteriorly from the fenestration in 13 cases, anterolaterally in four, and posteriorly in four. The widest luminal diameter of the aneurysm measured less than 5 mm in three cases, 6–10 mm in 12 cases, 11–15 mm in three cases, 22 mm in one case, and larger than 25 mm in two cases. The right vertebral artery was the larger in seven cases, while the left vertebral artery was dominant in 12 cases. In two cases, both vertebral arteries had an equal caliber.

Aneurysms of other intracranial vessels were observed in seven patients, including the basilar tip, cavernous carotid, carotid bifurcation, carotid posterior communicating, anterior cerebral, and carotid ophthalmic. The angiographic appearance of fibromuscular dysplasia of the internal carotid arteries was suggested in one case. A left vertebral artery duplication and a left middle-cerebral fenestration were both seen in one patient.

Surgical exploration of the V-B junction and proximal basilar artery was done in all but one patient, who refused therapy. It was possible to clip the aneurysm in 17 patients. Proximal occlusion of one vertebral artery was performed in two cases and occlusion of both vertebral arteries was successfully done in one case of a giant aneurysm that could not be clipped. Postsurgical angiography was performed in all cases and demonstrated complete obliteration of the aneurysm in 14 patients and incomplete clipping in three patients, with some residual aneurysm neck seen on postoperative angiography.

In the early postoperative period, temporary lower cranial nerve palsy was experienced by 13 patients, a permanent severe neurologic deficit occurred in one patient, and another patient died.

Discussion

The basilar artery is formed by the fusion of two primitive longitudinal neural arteries during the second to fourth stage of embryonic development. The fusion usually occurs during the fifth week of fetal life when the two primitive arteries of the ventral side of the neural tube are approximately 5–6 mm long. In the first steps of this fusion the basilar artery shows multiple irregularities and includes many cell islands. These cellular islands, if they persist, produce separation of the longitudinal neural arteries; that is, fenestration or segmental duplication [8]. There has also been a report of a complete basilar artery duplication coexisting with multiple arterial anomalies and agenesis of the corpus callosum [9].

The embryology of the formation of the basilar artery that predisposes to skip some areas of nonfusion, resulting in basilar artery fenestration, presumably is the reason that the basilar artery is the most commonly observed site of intracranial artery fenestration [5–7]. The angled junctures of the fenestrations have been shown to have defects of the media [3, 4]. It is not surprising that aneurysms form most commonly along the proximal juncture of the fenestration, as they did in all 21 of the cases reported here, because this point is subjected to the greatest stresses of flow and turbulence from below.

The basilar fenestration associated with aneurysms in this series was in the region of the V-B junction in all but one case, in which it was in the mid-basilar artery. In 12 patients, one or both AICAs (Fig. 3) arose from the limbs of the fenestration, and in one patient PICA arose from the fenestration. Clearly, it is important to discover these arterial data and to identify the fenestration separate from the aneurysm before surgery in order to prevent inadvertent clipping of a limb of the fenestration, including these important branches.

The predominance of basilar fenestration aneurysms among women in this series coincides with a slight increase in the incidence of basilar aneurysm among women [10, 11]. It is noted, however, that vertebral artery fenestration is considered to be more frequent in men [12]. A different embryological process in the formation of the vertebral arteries as opposed to the basilar artery [13] makes these not really comparable.

In our cases, 76.1% presented before the age of 50 years, younger than the incidence of basilar aneurysm presentation in other series [10, 11], which was 62% before age 50 and 41% before age 50, respectively. Possibly, aneurysms forming in arterial fenestrations may enlarge faster due to the stresses of turbulence and flow, and may thereby present a risk of earlier rupture.

The majority (85.7%) of aneurysms in this series were more than 5 mm in diameter, coinciding with the observation of a greater chance of rupture occurring with an aneurysm of greater than 5–6 mm diameter [14]. In the instances where the aneurysm had a right or left lateralization, it was noted to be contralateral to the dominant vertebral artery, conforming to the theory of hemodynamic alteration and turbulence associated with the growth of saccular aneurysms [15]. In the case with two aneurysms at the fenestration, each aneurysm filled angiographically from injection of the contralateral vertebral artery (Fig. 4). This appears to be the first reported case of two aneurysms within the same basilar fenestration. While all the aneurysm necks in our series were located in the inferior aspect of the basilar fenestration, best conforming to the flow and turbulent theory of aneurysm growth [15], there has been one case report of a basilar aneurysm arising from the distal end of the fenestration [16], a site also known to have a media defect [4].

The case of two aneurysms (Fig. 4), in which each vertebral angiogram filled only one aneurysm respectively, is difficult to explain. Presumably, the two vertebral axial streams of blood flow do not mix in the region of the fenestration in this case, and perhaps these separate stresses caused two aneurysms to develop rather than one.

The angiographic diagnosis of a fenestration in association with a proximal basilar trunk aneurysm can be made by combining a high index of suspicion that this association is common (35.5% in our series) with the use of various oblique or basal projection views as an attempt to separate the aneurysm neck from the fenestration. Visualization of surrounding normal branches, the AICA and PICA, is also essential in the angiographic assessment in order to allow the safest surgical approach.

While V-B junction aneurysms seen at our institution represent only 4% of the total of posterior circulation aneurysms [17, 18], the fact that more than one-third of the V-B junction aneurysms coexist with basilar artery fenestration makes this association a rather common finding. The surgical results in our series indicate that aneurysms of this type have a reasonable surgical prognosis, aided, we believe, by the understanding that the fenestration exists in association with the aneurysm. A correct angiographic diagnosis and exact appreciation of the adjacent normal vessels is important for optimal surgical results.

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