Some observations on aneurysms of the proximal internal carotid artery

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The author reports on 41 aneurysms of the proximal internal carotid artery (PICA) demonstrated in 36 patients with subarachnoid hemorrhage. The patients included a striking preponderance of women, and there was a high incidence of multiple aneurysms. In cases with multiple aneurysms the PICA aneurysm was usually found incidentally, a more distal aneurysm on the internal carotid artery being the source of hemorrhage. An infundibulum at the origin of a posterior communicating artery was unusually common in these patients. The origin of the ophthalmic artery is proposed as the angiographic landmark of the level at which the internal carotid artery penetrates the dura mater.

KEY WORDS: proximal internal carotid artery • subarachnoid hemorrhage • aneurysm • multiple aneurysms • ophthalmic artery • dura mater

The internal carotid artery (ICA) is a common site for intracranial aneurysms, the majority of which arise around the origin of the posterior communicating artery. Very few arise proximal to that point. This paper is a review of such aneurysms, notably their incidence, their association with other intracranial aneurysms, and their potential for causing subarachnoid hemorrhage (SAH). During this study it became apparent that the point at which the ICA penetrates the dura mater is ill defined, and is without a precise radiographic landmark. On the basis of anatomical studies, the origin of the ophthalmic artery was taken as an angiographic marker of this point (Fig. 1). It is proposed that aneurysms arising more than 1 mm proximal to the origin of the ophthalmic artery are extradural, and therefore unlikely to be the source of SAH.

Summary of Cases

Of 1034 intracranial aneurysms demonstrated by cerebral angiography at the Wessex Neurological Centre between November, 1965, and November, 1976, 55 were aneurysms of the proximal internal carotid artery (PICA).* Of these, 14 were found in women who had presented with cavernous sinus syndromes, headache, or facial pain; all but two were extradural and these patients are not considered further. Forty-one aneurysms of the PICA were encountered in 36 patients who had presented with subarachnoid hemorrhage, and these cases form the basis of this study.

There were 27 women and nine men. All the patients were examined by bilateral carotid angiography, and 10 also by vertebral angiography. The

*In this review the term “proximal internal carotid artery” describes the portion of the intracranial internal carotid artery lying proximal to the origin of the posterior communicating artery.

Fig. 1. Diagrammatic representation of the proposed relationship of the dura mater to the origin of the ophthalmic artery (Ophth. A). I.C.A. = internal carotid artery; P.Co.A. = posterior communicating artery.
36 patients had a total of 74 aneurysms which were disposed as shown in Table 1. The position of the 41 PICA aneurysms is shown in Fig. 2. An incidental finding of 13 infundibula at the origin of the posterior communicating artery was observed in 10 patients.

In 13 patients the aneurysm of the PICA was single. Three of these aneurysms arose more than 1 mm proximal to the origin of the ophthalmic artery; they were therefore regarded as extradural and not the source of the patient's hemorrhage. In each case there was clinical or autopsy evidence that the hemorrhage was not due to the ICA aneurysm. The other 10 aneurysms in these patients were thought to be intradural, and thus were probably the source of hemorrhage. Multiple aneurysms were found in 23 patients. In six cases the aneurysm situated proximally on the ICA was thought to be extradural: in each case there was definite clinical, angiographic, operative, or autopsy evidence that this aneurysm had not ruptured. In the remaining 17 cases the aneurysm of the PICA was intradural, but was the undoubted source of the hemorrhage in only four. In eight cases another aneurysm could be shown to have ruptured. Of these eight the culpable lesion was situated more distally on the ICA itself in seven (posterior communicating, anterior choroidal, or terminal carotid), and on the anterior communicating complex in one.

### Discussion

In the present study, we found 55 PICA aneurysms among 1034 intracranial aneurysms demonstrated during an 11-year period. This represents an incidence of 5.3%, with 2% of all intracranial aneurysms being extradural, and confirms the findings of two other large surveys (Table 2).

#### Anatomical Observations

A previous classification related the intracranial ICA to the anterior clinoid process and separated it into infraclinoid and supraclinoid segments. By inference the infraclinoid segment is extradural. This classification is satisfactory for purely descriptive purposes, but does not distinguish whether a particular aneurysm arises outside or inside the dura. This is a practical problem in cases of subarachnoid hemorrhage with PICA aneurysms, and especially since they frequently accompany other aneurysms (see below). Previous anatomical studies have identified the origin of the ophthalmic artery as the point at which the ICA pierces the dura. The ophthalmic origin is intradural in 89% of dissections, lying at the level of penetration of the dura by the ICA in 83%, or within 1 mm distal to this point in 6.5%. In the remaining 11% the artery arises extradurally. Since the ophthalmic artery is clearly visible in most carotid

![Fig. 2. Location of 41 aneurysms on the proximal internal carotid artery relative to the origin of the ophthalmic artery (Ophth. A). I.C.A. = internal carotid artery; P.Co.A. = posterior communicating artery.](image-url)
Aneurysms of proximal internal carotid artery

angiograms, its origin serves as a practical landmark of the point at which the ICA becomes intradural (Fig. 1). Thus any aneurysm arising from the ICA from a site more than 1 mm proximal to the origin of the ophthalmic artery can reasonably be viewed as extradural. None of the nine such aneurysms in the 36 patients with SAH in the present series had ruptured. Aneurysms arising from this part of the ICA may attain great size, but rarely rupture because their walls are supported by the dura. Extradural carotid aneurysms can usually be discounted when determining the management of patients with SAH.

Multiplicity of Aneurysms

The incidence of multiple intracranial aneurysms has been reported as 18.5% at angiography, rising to 31% in autopsy studies. In the present review, 23 of the 36 patients (64%) had more than one aneurysm, and 10 patients had three or more. Since only 10 patients had vertebral angiography, the true number may have been higher. This exceptionally high incidence of multiple aneurysms in patients with PICA aneurysms has been noted previously in respect of carotid-ophthalmic aneurysms. Multiplicity has little prognostic importance because the risk of future hemorrhage from "incidental" aneurysms has been reported to be low.

Associated Infundibula

Ten patients exhibited 13 infundibula at the origin of a posterior communicating artery. This incidence is far greater than the 6.7%, rising to 14% in patients aged over 60 years, reported in a large series of normal and abnormal angiograms. Histological studies have suggested that infundibula might be early aneurysms, and the present observation of a high incidence of infundibula in a group of patients with a concomitantly high incidence of ICA aneurysms and multiple aneurysms implies that infundibula are indeed pathogenetically significant.

Which Aneurysm has Ruptured?

Despite the advent of computerized tomography, the question of which aneurysm has ruptured continues to challenge neurosurgeons when confronted with a case of multiple intracranial aneurysms. Clinical signs are often unhelpful. The value of angiography by showing vessels displaced by hematomas or narrowed by spasm has been questioned, and the site, size, and shape of aneurysms have been found to be more useful. Computerized tomography performed within 1 week of hemorrhage may reveal a hematoma, however, relatively few ICA aneurysms are accompanied by hematomas. Of the 17 cases of multiple aneurysms in the present study in which one aneurysm arose intradurally from the PICA, the latter was the proven source of hemorrhage in only four. A more distally situated aneurysm of the ICA, such as one on a posterior communicating artery, was almost twice as likely to be the culpable lesion (seven out of 17 cases). Previous authors described 10 cases of multiple aneurysms in which a carotid-ophthalmic aneurysm was "incidental." The present study supports this observation; we found the PICA aneurysm was "incidental" in 13 of 17 cases.

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References


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