INTRACRANIAL ANEURYSMS

I. SOME CLINICAL OBSERVATIONS CONCERNING THEIR DEVELOPMENT*

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The fact that most aneurysms of the cerebral circulation are congenital in origin is general knowledge. Much evidence has been examined and inference and analogy have been drawn concerning the development of these lesions.1,3,6,7,8,9,10,16 It seems to be generally agreed that in all likelihood defects within the muscular and elastic coats at angles of bifurcation of vessels eventually succumb to long-time persistent stress resulting in the formation of saccular dilatations.6,7,8,9,10,16

Less attention has been shown to the mechanism of development of the primitive cerebral vascular network offering through the complexity of its genesis a more simple and logical explanation for these anomalies.1,17 Some writers, having noticed the presence of anomalous vessels, have by-passed the significance of these structures; others, however, have emphasized their importance.1,5,6,9,11,12,14

The following cases illustrate the point in question:

Case 1. F. M., 24-year-old white male. The aneurysm arose from the mid-portion of the left posterior inferior cerebellar artery and had blown out into the left cerebellar lobe. There were multiple anomalies of the surface and pial vessels (Fig. 1).

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Fig. 1. Case 1. Anomalous vascular stalk of aneurysm arising from left posterior inferior cerebellar artery. Multiple anomalous dilatations of pial vessels.

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Case 2. M. Z., 40-year-old white female. The aneurysm was an elongated tortuous sac arising from the right anterior cerebral artery midway between the bifurcation and the anterior communicating artery, projecting forward and medially across the dorsum of the optic chiasm (Figs. 2 and 3).

Case 3. F. B., 57-year-old white male. The aneurysm was situated within the sella turcica, elevating the chiasm and optic nerves to an angle of approximately 30°. The chiasm was almost completely bisected. The aneurysm represented a balloon-like termination of a tortuous anomalous vascular stalk arising from the medial wall of the left internal carotid artery beneath the left optic nerve (Figs. 4 and 5).

Case 4. G. R., 31-year-old white male. The aneurysm was a doubly lobulated structure arising from the mid-portion of the right anterior cerebral artery between the bifurcation and the anterior communicating artery. Hemorrhage had occurred from the smaller and more mesial of the two sacs to the left. Two anomalous vessels arose from the larger sac, one coursing superiorly with the right anterior cerebral artery and the other traversing the dorsum of the chiasm and dura of the floor of frontal fossa just to the right of the midline (Figs. 6, 7 and 8).

Case 5. C. S., 32-year-old white female. The aneurysm was situated below the
right optic nerve, elevating this structure. It extended medially, obscuring the diaphragma sellae, touched the left optic nerve and had its posterior limits just under the chiasm. It was almost completely thrombosed except for the portion of the sac near the tortuous neck, which arose from the mesial surface of the right internal carotid artery beneath the right optic nerve (Fig. 9). This situation was similar to that of Case 3 on the opposite side.

FIG. 6. Case 4. AP views. (A) Left-sided angiogram shows marked displacement to the left of the left anterior cerebral artery. (B) Right-sided angiogram shows bilobulated aneurysmal sac arising from right anterior cerebral artery and anomalous vessels which proved to arise from the sac.
As early as the 3 mm. stage in development of the foetus, vascular channels are well defined as such—containing primitive nucleated erythrocytes.\(^2,13,15\) Definite morphological characteristics of artery and vein are undeveloped, a single endothelial layer forming the walls of the vessels.\(^15\)

Vascularization occurs in response to metabolic demands from centers of proliferation.\(^4,15\) Early the primordial endothelial channels give rise to innumerable buds forming a plexiform germinal circulatory bed. This gradually differentiates into efferent and afferent structures forming a fine capillary mantle.\(^15\) Cleavage of vessel layers for skull, dura and brain next occurs, beginning in the basilar regions with multiple intricate anastomoses followed by adaptation to developmental alterations in form, size and rate of growth of the brain.\(^15\)

Wyburn-Mason\(^17\) has stressed this strategic relationship between proliferative vascular centers over and about the base of the developing brain with particular reference to the combined arterial and venous anomalies. This is especially true about the developing optic stalks\(^16\) and is significant with respect to Cases 3 and 5 above.

Differential evolution to artery, vein, capillary and sinus types represents the final step in development. Not until mural structure is well developed are the arteries physiologically and anatomically
fixed as such, since there is much shifting about of arterial channels in young embryos. 11,15

The development of the hyaloid artery to the primitive lens structure and its subsequent atrophy after capillary vascularization of the posterior lens capsule is a well known embryologic phenomenon suitably analogous to the question in point since this structure bears an intimate relationship to the proliferative vascular centers about the primitive optic pits, a site most commonly favored by aneurysms of the circle of Willis. This type of development, dissemination and atrophy of vascular channels where a specific need no longer exists is multiplied many times throughout the complex altering development of the brain and its vascular mantle (Cases 1, 2 and 4).

The carotid artery is the earliest branch of the primitive aortic arches ascending from the dorsum of the first arch to the midbrain, arborizing over the lateral aspects of this structure and anteriorly to the forebrain. 2,13,16 Its evolution is complete when atrophy of the connection between the dorsal aorta and the 3rd and 4th arches occurs.

Segmental dorsal aortic branches known as dorsal intersegmental arteries course between somites, the first pair atrophying early. The pair between the 2nd and 3rd somites remain longer, traveling with the hypoglossal nerve, and anastomose anteriorly with the internal carotids as paired primitive vertebral arteries, thus becoming a not too unlikely source for error in the development of the intradural aneurysms of the carotids below the circle of Willis. These primitive hypoglossal arteries soon atrophy and the vertebral arteries are formed by anastomosis of the 1st through the 7th cervical intersegmental arteries, which then fuse cephalad anterior to the brain stem to form the basilar artery. 2,11,13

All of the above steps and fusion of the posterior portion of the circle of Willis through the posterior communicating arteries to the anterior portion through the internal carotid arteries have been completed by the 9 mm. stage (4 weeks). 4

SUMMARY

Considering the embryological facts, congenital aneurysms of the cerebral circulation exist most likely as unresolved vestiges of a primitively normal circulatory system.

This primitive system has erred in its response to the evolutionary stimulus of resorption or modification for the pattern of normality as seen in the embryologically mature organism.

Five cases of congenital aneurysm of the cerebral circulation are offered as confirmatory evidence for this most likely mode of development.

REFERENCES