Extracranial Occlusive Vascular Disease: Does Size Matter?

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SUMMARY A 47-year-old patient had lesser development of her left limbs and face, smaller left vascular structures, and severe occlusive disease of the left internal carotid, left subclavian, left vertebral and left iliac arteries. In 12 examples of occlusion of a carotid artery, 10/11 with unequal vascular luminal size had the occlusion on the smaller side. Of 20 patients with severe asymmetrical carotid stenosis, 13/17 with unequal size had more stenosis on the smaller side. These preliminary observations suggest that a small vessel may be more likely to occlude than its larger counterpart.

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As a girl, she had undergone surgery for a "wry neck." At age 40, she had attacks of a "black shade descending over vision in the left eye." These brief episodes recurred approximately 5 times over a matter of months, but were always transient. At age 42, her rheumatic heart disease was diagnosed when congestive heart failure prompted cardiac evaluation and catheterization.

Despite rheumatic heart disease, she had 11 normal pregnancies and living children, one born subsequent to her cardiac catheterization. For several years, she suffered from pain in her left calf while walking. She had no visual or other neurological complaints.

On examination, the patient's right face, right sternocleidomastoid muscle and right neck were clearly more prominent than her comparable left-sided structures. Her right-sided vasculature was relatively unaffected.

This unusual case stimulated closer scrutiny of the relationship between carotid size and occlusive disease. Accordingly, angiographic examinations of 32 consecutive patients with stenosis of the internal or common carotid artery lumen to 2 mm or less were evaluated.

Case Report

S.W., a 47-year-old female, was referred for evaluation in December 1973 after a routine visual examination had uncovered a right inferior quadrantanopsia. As a girl, she had undergone surgery for a "wry neck." At age 40, she had attacks of a "black shade descending over vision in the left eye." These brief episodes recurred approximately 5 times over a matter of months, but were always transient. At age 42, her rheumatic heart disease was diagnosed when congestive heart failure prompted cardiac evaluation and catheterization.

Despite rheumatic heart disease, she had 11 normal pregnancies and living children, one born subsequent to her cardiac catheterization. For several years, she suffered from pain in her left calf while walking. She had no visual or other neurological complaints.

On examination, the patient's right face, right sternocleidomastoid muscle and right neck were clearly more prominent than her comparable left-sided structures. Her right-sided vasculature was relatively unaffected. Her left arm and hand and left lower extremity were smaller than their right-sided counterparts.

Neurological examination was normal with the exception of a homonymous congruous right inferior quadrantanopsia, and slight right hyperreflexia. Central retinal artery pressure was 70 diastolic on the right and 45 on the left.

Cerebral angiography was performed by femoral
catheterization. The left common carotid artery was small (3.5 mm.). The left internal carotid was occluded at the carotid artery bifurcation (fig. 1A). The right common carotid artery measured 7 mm with no significant stenosis of the internal carotid (fig. 1B). Intracranially excellent opacification of the left anterior and middle cerebral arteries and the right posterior cerebral artery was demonstrated from a right internal carotid injection. (fig. 2) The left subclavian artery was 4.5 mm (right, 7.5 mm) and was severely stenosed 1 cm past its origin. The left vertebral artery was small (2 mm) and had stenosis at its origin. The right vertebral artery was larger and filled normally. The left common iliac artery was also smaller than its counterpart and was occluded.

Echocardiography confirmed the diagnosis of mitral stenosis. Brain scan was normal. The electrocardiogram revealed normal sinus rhythm with early right and left ventricular hypertrophy. An operation was performed on her left inferior extremity because of the severe claudication. One cm distal to the origin of the left common iliac artery, there was a 4 cm region of rock-hard obstruction with no distal pulsation or flow. Histologically, the specimen revealed focal calcification and it showed organizing thrombosis.

In the 5 ensuing years she remained asymptomatic neurologically and had no further claudication. She has a full-time secretarial job in addition to being a housewife and the mother of 11 children.

Materials and Methods

Cerebral angiographies of patients studied for occlusive vascular disease were reviewed. For inclusion in this study consecutive cases were selected in which both cervical carotids were visualized on selective common carotid injections at 2X magnification and in which the diameter of the residual lumen measured 2 mm or less (corrected for magnification). The vessel under investigation was positioned 18 in. from the film with a film-focal spot distance of 36 in. The changer was reversed on the lateral projections to insure uniformity. The diameter of the lumen of the vessel was measured on subtraction angiographies using a caliper and results were tabulated. Statistical significance was judged using the chi square analysis test and the binomial test.

Results

Twelve patients had occlusion of one internal carotid artery (table 1). In one patient, the common carotid arteries were equal in size. Of 11 patients with unequal common carotid artery size, the smaller common carotid artery gave rise to the occluded internal carotid artery in 10 patients. This difference is
CAROTID ARTERY OCCLUSION AND VESSEL SIZE/Caplan and Baker

**Figure 2.** Intracranial visualization from right internal carotid injection. Good filling of the left anterior and middle cerebral artery circulation occurs via the anterior communicating artery.

statistically significant, $\chi^2 = 7.36 \ p = 0.0067$, binomial test $p = 0.006$. The right common carotid artery was smaller in 5 patients and the left smaller in 5. The average size of the right common carotid artery was 5.94 mm and the left, 6.04 mm.

Twenty patients had severe asymmetrical stenosis of the carotid arteries (table 2). In 13 patients the smaller common carotid artery gave rise to the more stenotic internal carotid artery, in 4 patients the larger carotid artery was stenosed and in 3 patients, the carotids were equal in size. This difference is also statistically significant, $\chi^2 = 4.76, \ p = 0.029$, binomial test $p = 0.025$. The left common carotid artery was smaller in 13 patients, and the right common carotid artery smaller in 7. The right common carotid artery averaged 5.68 mm, while the left averaged 5.50 mm.

| Table 2 Vascular Lumen Size (mm). Carotid Artery Stenosis |
|-----------------|---------------|---------------|---------------|
| Right CCA       | Right ICA     | Left CCA      | Left ICA      |
| 1) 6.2          | 4.35          | 4.9           | 3.7           |
| 2) 5.25         | 3.6           | 4.9           | 3.75          |
| 3) 6            | 3.6           | 6.35          | 3.9           |
| 4) 5.85         | 4.15          | 5.2           | 3.3           |
| 5) 6.4          | 4.25          | 5.7           | <1            |
| 6) 6.75         | 4.2           | 6.75          | 4.4           |
| 7) 5.5          | 3.25          | 5.8           | 5.0           |
| 8) 5.1          | 4.25          | 4.55          | 2.8           |
| 9) 6.7          | 4.3           | 6.35          | 2.8           |
| 10) 5.6         | <1            | 5.5           | 3.75          |
| 11) 5.25        | 3.5           | 5.65          | 3.1           |
| 12) 5.75        | 3.0           | 5.0           | 3.5           |
| 13) 4.25        | 2.8           | 4.55          | 4.25          |
| 14) 5.7         | 2.9           | 5.5           | 3.7           |
| 15) 5.95        | 3.95          | 5.6           | 3.8           |
| 16) 6.0         | 3.4           | 5.75          | 3.9           |
| 17) 5.65        | 3.8           | 5.3           | 4.1           |
| 18) 5.35        | 3.9           | 5.3           | 4.0           |
| 19) 4.0         | 2.05          | 6.35          | 3.9           |
| 20) 5.5         | 3.9           | 5.0           | 3.6           |

occ = occlusion.
CCA = common carotid artery.
ICA = internal carotid artery.

**Discussion**

Progressive atherosclerosis with vascular calcification and subsequent occlusion affected our patient's left internal carotid artery, left subclavian artery, left vertebral artery and left common iliac artery, while leaving virtually unscathed comparable vessels in the right circulatory system. The histologically studied...
specimen of the left iliac artery revealed atherosclerosis without dysgenesis of the vessel wall. The angiographically visualized left vascular system differed from the right only in the size of the vessels. The smaller left limbs, smaller left carotid canal and abnormal left neck development suggest that the smaller vascular size was congenital and not acquired. Vascular occlusion in this case was likely secondary to in situ thrombosis. An alternate possible etiology, multiple emboli secondary to rheumatic valvular disease, seems unlikely because of the lack of systemic vasculitis.

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This patient raises the more general question: Does size of vessels affect occlusion? It is a common observation that patients will frequently have severe stenosis or occlusion in one vertebral or carotid artery, and not have significant disease in the same vessels on the opposite side of the body. To provide a statistically more accurate answer to this question we accumulated data in our 32 patients with occlusive vascular disease.

In this group of patients, the smaller vessel was more likely to be stenotic or occluded than its larger counterpart. Angiography, when performed with uniform systematic technique allows accurate assessment of the size of the residual vascular lumen, but does not exactly depict size of the blood vessel (lumen + clot or plaque + vessel wall). Since no device is presently available which can measure actual vessel size, and the error of measurement introduced should equally affect vessels with small and large lumina, angiography was used as the best presently available measure of vessel size in life. From the angiographic data alone, we cannot be certain that the smaller common carotid was congenitally smaller. Alternatively, small size could result from shrinkage of the vessel because of reduced flow or from atherosclerotic involvement of the entire vessel. Studies following endarterectomy were not available to help determine if removal of the obstruction would lead to subsequent increase in the common carotid artery lumen size. A postmortem analysis is planned which may better answer the dilemma although atrophy of the vessels subsequent to occlusion is well recognized.

Chiari, Fisher et al., and Keele all emphasized the frequency of pathological changes due to atherosclerosis at the carotid bifurcation in the neck and in the carotid siphon. These studies and the anatomical studies of the circle of Willis by Fisher all comment on frequent asymmetries of anatomy and occlusive disease, but do not contain precise data on the size of the vessels.

Others have commented on the role of dysplastic carotid arteries in producing symptoms in later life. This occurs by occlusion of the small carotid artery and/or by hemorrhage developing from extensive collateral vessels. In all of the patients with hypoplastic carotid arteries, the vessel ended in a thread or stopped abruptly. Our patient’s common carotid artery was not as small as those previously reported.

In addition to the patient reported herein, 2 others with early life unilateral cerebral infarction (ages 18 and 21) have been seen. In each, infarction followed excessive alcohol intake, and the only abnormality seen at postmortem examination was a small carotid artery occluded by thrombosis. The size of arterial vessels has been given too little attention. This report suggests that a small vessel may be more likely to occlude than its larger counterpart.

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