Continuing interest in obstructive vascular disease of the cerebral circulation has led to more critical information regarding sites of obstruction, compensatory flow, and collateral pathways.

Though total cerebral blood flow may be normal in the presence of extracranial obstruction, such measurement cannot pinpoint the functional significance of a given extracranial lesion, since effective flow is determined in part by pressure within the distribution of a given artery. The cerebral vascular system can compensate within wide limits for poor input in one or more of the contributing vessels. Due to collateral deficiencies or secondary intracranial disease, however, the terminal distribution of an artery may be relatively ischemic, or at least unable to compensate for a blood pressure fall in the presence of an extracranial obstruction, though the total flow is normal. In consequence, angiography is of the utmost importance, and arteriographic findings need be interpreted in the light of symptoms and clinical findings in order to salvage those patients who have surgically remedial lesions. Since some ischemic states may reflect change in direction of flow as well as obstruction, sequential multiple films are of value as they can furnish this vital information.

Stimulated by previous demonstrations of vertebral artery contributions to collateral circulation about the shoulders seen in patients without cerebral symptoms, and alerted by a recent excellent article by Reivich et al., we recently studied two cases in whom the "vertebral-subclavian steal" was present.

The documentation by clinical and experimental work of the reversal of the vertebral flow beyond a subclavian stenosis in the above article and the impressive secondary reduction in total cerebral flow (41 per cent) in experimental animals led us to consider the phenomenon demonstrated by angiography as causally related to the cerebral symptoms in these cases. Shaw and Austen had stated in a review of vascular surgery that cerebral symptoms accompany gross involvement of the aortic arch branches, but report no such isolated lesion with cerebral signs. A recent review by Cohen et al., concerning their experience with occlusive lesions of the great vessels of the aortic arch mentions a single case of local occlusion of the left subclavian artery in which the patient had syncope and visual blurring as well as arm symptoms. The authors stated that the disappearance of symptoms postoperatively was not readily explained. We believe that this may well represent another such case as those presented here, since the mechanical situation is similar and the cerebral symptoms abated with the restoration of the subclavian artery pressure to normal.

Case 1

M.P., a 71-year-old white woman with known diffuse obstructive arteriosclerosis of her lower extremities, entered the hospital on January 9, 1962, with a history of syncopeal attacks. The first of these attacks occurred 3 years prior to entry, but they had become more frequent with two such attacks in the week prior to hospitalization. One attack occurred during the present hospitalization. The attacks consisted of sudden episodes of unconsciousness associated with premonitory bilateral visual blurring. Observers stated that the patient would suddenly hyperextend the neck and arms, arch the back, and fall over backward with bilateral mild tremors of all extremities. A similar episode accounting for hospitalization resulted in contusions of the occipital region and both elbows. There were no lateralizing neurologic findings or convulsive phenomena and no residual weakness following the attack.

Physical examination on entry revealed a blood

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pressure of 140/65 in the right arm and 110/85 in the left arm. The pulse rate was 72 and regular.

The physical findings were those of stenosis or occlusion of the left subclavian artery with bilateral bruits in the supraclavicular regions, and a faint bruit over the left carotid artery bifurcation. Carotid compression failed to produce the symptoms or any evidence of carotid sinus sensitivity. The neurologic examination was negative with the exception of nystagmus to the right. On exercising the left arm the patient had minor visual disturbances similar to those preceding her unconscious spells, and felt “peculiar.”

The electrocardiogram and the electroencephalogram were normal. A right subclavian arteriogram revealed rapid left vertebral and left subclavian filling from a right-sided injection; the filling occurred in a retrograde manner (fig. 1). The carotid arteriograms were normal on the right. The left side showed a minor plaque of the internal carotid. A venous aortogram showed definite reversal of flow from the right vertebral to the left vertebral artery and thence out the left subclavian distal to a stenosis of the subclavian takeoff (figs. 2 and 3). Multiple films obtained with a rapid cassette changer were helpful in demonstrating the direction of flow.

Surgery performed on January 12, 1962, consisted of a thromboendarterectomy of the stenosis of the takeoff of the left subclavian artery (fig. 4). Pressures recorded with the vertebral artery clamped and unclamped revealed a definite contribution of the vertebral to the distal subclavian artery pressure. Pathologic examination of the specimen was consistent with arteriosclerotic degeneration of a major vessel.

The patient did well postoperatively. The blood pressure was equal in both arms, and she has had no further attacks of syncope in the 10 months since surgery.

Case 2

R.P., a 50-year-old white woman, entered the hospital on September 3, 1962, with a history of intermittent attacks of paresis of the four extremities and tunnel vision occurring episodically and associated with nausea and dizziness, but no true vertigo. In an attack the patient was unable to speak or move any extremity, but was not
totally unconscious. These attacks were associated with occipital headache and with extreme fatigue. They usually lasted for 3 or 4 minutes and left no permanent neurologic residual. She has had occasional attacks over the past 8 years, but they have become much more frequent in the last 6 months. The patient had two such episodes while hospitalized with aphasia and flaccidity of all extremities. Examination immediately after an attack revealed only nystagmus to the right.

Physical examination revealed the blood pressure to be 180/110 in the right arm, and 140/100 in the left arm. The pulse rate was 72 and regular. The neurologic examination was negative except for the nystagmus to the right. Vascular examination revealed a very harsh systolic bruit in the right supraclavicular region and a similar but less loud bruit in the left supraclavicular region. A skull film was negative. The cerebral spinal fluid examination was negative. A retrograde aortogram on September 7, 1962, revealed an occluded left subclavian artery just beyond its takeoff and reversal of flow via the right vertebral into the left vertebral and thence out the left subclavian distal to the obstructive lesion. In addition, there was a takeoff stenosis of the right vertebral artery (figs. 5 and 6). At surgery on September 12, 1962, through a left fourth intercostal thoracotomy incision an occlusive atheroma of the first portion of the subclavian artery between the aorta and the vertebral-subclavian artery junction was removed, and a Dacron patch was placed in the arterotomy. Postoperatively the patient’s blood pressure in both her arms was the same, and the bruit in the right side of the neck disappeared. The patient has had no further attacks since surgery, although the follow-up is short.

**Discussion**

The production of a low pressure area in the distal subclavian artery by stenosis or occlusion of its origin can be theoretically and practically demonstrated. The vertebral artery and consequently the basilar artery are then subjected to a draining off toward this low pressure area by reversal of flow. Demonstration of retrograde opacification of the left vertebral and left subclavian artery by right subclavian arteriography tends to support this contention in case 1. Aortoangiography with similar direction of flow, and the pressure recordings at surgery of a significant contribution by the vertebral artery to the subclavian pressurehead documents this point.

**Figure 4**

Operative findings at thromboendarterectomy of the left subclavian takeoff.

**Figure 5**

Retrograde aortogram in case 2 early in the sequence demonstrates occlusion of the subclavian takeoff, stenosis of the right vertebral takeoff, and no visualization of the left vertebral or subclavian arteries.
ischemia typically appears as a "crossed" neurologic picture or alternating sides of transient deficit with coordination disturbance. It can, however, show as it did in these cases. Nystagmus and the decerebrate posture assumed in the first case and the paresis of four extremities and visual disturbance in the second case suggest brain-stem involvement. To attribute the arteriographic and surgical findings to chance seems far fetched, as the lesion appears to fit the disorder.

Summary

Two cases are presented of basilar artery insufficiency with reversal of flow in the left vertebral artery secondary to obstruction of the subclavian artery at its origin. The symptoms have been relieved by restoration of pressure in the subclavian artery. The hemodynamics are reviewed, and the value of arteriography in cerebral vascular insufficiency is supported.

References

Basilar Artery Insufficiency Secondary to Obstruction of Left Subclavian Artery
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