Carotid Distal Vertebral Bypass for Carotid Occlusion: Case Report and Technique*

• Andrew L. Carney and Evelyn M. Anderson

Occlusion of the internal carotid artery has been the prime indication for superficial temporal-middle cerebral artery bypass[1,2]. If blood flow is directly related to cross sectional area of a vessel and to the square of its radius[3], then the flow potential of arteries of small diameter is severely limited. The larger the vascular bed being revascularized, the more critical becomes this limitation.

When the obstructed vertebral artery must supply both the posterior circulation and the anterior circulation through a large posterior communicating artery, then improving flow capacity in the large diameter vertebral artery may have the advantage over temporal-middle cerebral bypass. If the vertebral artery is obstructed within the cervical spine, then bypass must be to the distal unobstructed artery, preferably at the level of the axis or atlas.

CASE REPORT

On August 29, 1977, a hardy 77 year old white male presented with a transient right hemiparesis and with confusion, slurred speech and the inability to swallow which persisted and fluctuated in severity. The CT scan (Oct. 30) revealed a left parietal-occipital infarction of moderate size.

Angiography

The left internal carotid was totally occluded. (Figure 1B). A prominent loop appeared kinked in the midportion of the right internal carotid artery (Figures 1A, 2). The right vertebral artery was kinked within the cervical spine. The dominant left vertebral artery was sharply kinked at its origin, with a sharp loop within the cervical spine (Figure 3) and compression at the level of the axis. Through a well established posterior communicating artery, the left VA perfused the anterior and middle fossa, but the posterior fossa was perfused poorly (Figure 4).[4]

Cerebral Hemodynamic Evaluation - Table 1

The arterial occlusive process was generalized. The left Ophthalmic Artery Pressure (OAP) was reduced. The upright position was not tolerated because of loss of vasomotor stability.

The ocular pulses were of markedly reduced amplitude bilaterally with a severe pulse delay on the left. Right carotid compression failed to significantly reduce either the right or left ocular pulses suggesting that (1) the kinked loop of the right internal carotid was highly obstructed and (2) that the primary cerebral perfusion was through the vertebral basilar system.

Surgery

Thirty-seven days after acute cerebral infarction, the patient was taken to surgery. The anterolateral approach to the cervical spine[5,6] was employed. The greater auricular nerve is

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Andrew L. Carney, M.D., is Clinical Assistant Professor, Mercy Hospital and Medical Center, and Department of Thoracic and Cardiovascular Surgery, Abraham Lincoln School of Medicine, Chicago.

Evelyn M. Anderson, M.D., is Clinical Assistant Professor, Lutheran General Hospital, and Department of Electroencephalography, Abraham Lincoln School of Medicine, Chicago.

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Requests for reprints should be sent to Andrew L. Carney, M.D., 1323 Community Memorial Drive, LaGrange, Illinois 60525.

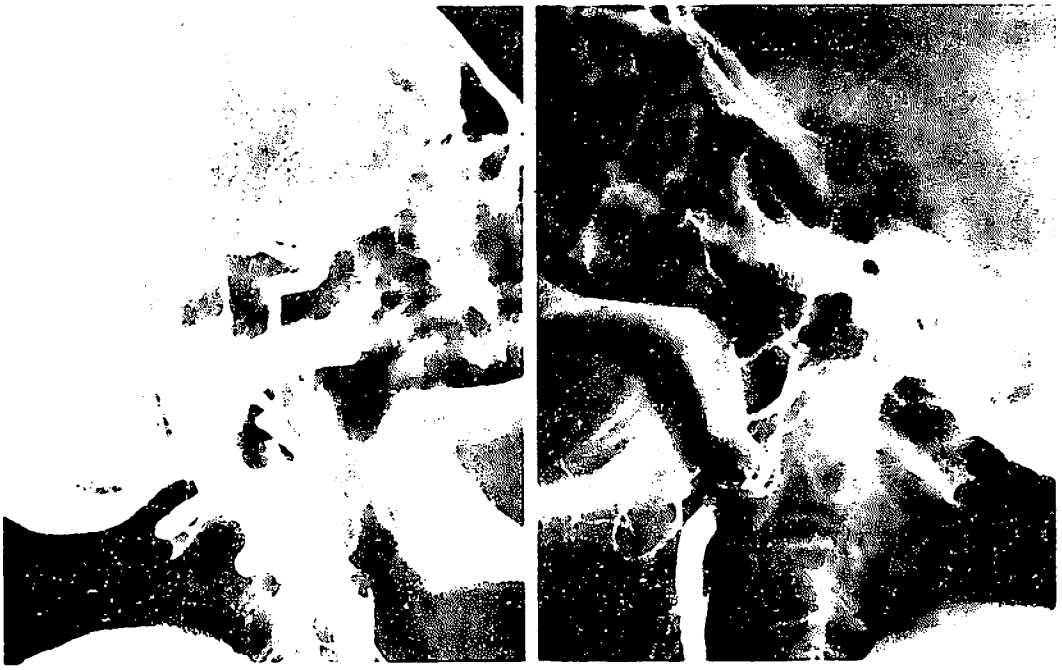

Figure 1 A. RIGHT CAROTID AND VERTEBRAL ARTERY - Right retrograde brachial injection.

B. LEFT CAROTID ARTERY - Percutaneous injection. Findings: Total occlusion of left internal carotid artery. Minimal plaque at right carotid bifurcation with a prominent loop of the internal carotid artery which appears to be kinked.

spared and the sternocleidomastoid was detached from the mastoid process. The spinal accessory nerve was identified and protected. The transverse process of the axis was freed of its muscular and tendinous attachments before resection. The superior cervical ganglion was mobilized and retracted, exposing the anterior ramus of the second cervical nerve and the underlying vertebral artery.

A 1.5 cm length of vertebral artery is desireable for the application of the vascular clamps and performance of the anastomosis. If vertebral artery occlusion is tolerated, then a window is excised approximating one-third of the circumference of the vessel.

The distal saphenous vein was sharply beveled with a scalpel. The anastomosis was completed with continuous fine suture. The vascular clamps were removed, vertebral blood flow was re-established and the suture line was secured.

Attention was directed to the common carotid artery which was mobilized proximally. Excision of a generous window permits tailoring of the plaque within the lumen of the artery. In this patient, distal and proximal anastomosis were completed two hours and thirty-two minutes after the skin was incised. The divided structures were approximated and the incision was closed.

Post-Operative Studies

Nine days following surgery, the carotid distal vertebral artery bypass filled the anterior and posterior circulations (Fig. 5). Healing was uneventful. Post-operative isotope studies demonstrated marked improvement in flow.

DISCUSSION

Hemodynamic assessment of angiographic lesions is critical to rational cerebral revascularization. The significant obstruction of the right internal carotid and both vertebral arteries cannot be assessed by angiography. Flow demand of the vertebral system is markedly

TABLE 1

CEREBRAL HEMODYNAMIC EVALUATION

Extremities:
- Severely Reduced Ankle/Brachial Pressure Index
- R 0.46 L 0.37

Brachiocephalic:
- Left Carotid Bruit
- Supraorbital Flow
  - R - reversed
  - L - absent
- Common Carotid Velocity
  - Low Bilaterally R>L

Passive Tilt:
- Not Tolerated.

Ocular Plethysmography:
- a. Pulse Propagation Time - Prolonged.
- b. Delay - Left marked delay: 19.2 msec.
- c. Amplitude - Markedly reduced with significant asymmetry, R>L 28%
- d. Carotid Compression

	HR	R	OPG	L
Supine	82	5.8	:	4.2
RCC	83	3.8	:	3.6
LCC	82	6.4	:	0.0

- e. Collateral Ocular Pulse

COP R 3.8 : 0.0 L

Ophthalmic Artery Pressure:
- a. Supine

144/94 82 R 110 : 94 L
- b. OAP/BP 0.76 : 0.65

N.B. With right carotid compression, the right ocular pulse amplitude falls only 34% suggesting that the primary flow is not carotid and that a well developed collateral system exists.

All ocular measurements made by Binocular pneumatic vacuum ocular plethysmography and ophthalmodynamography. Manufacturer: Electro-Diagnostic Instruments Burbank, California

Figure 2 INTRACRANIAL CAROTID SYSTEM - Right retrograde brachial injection. Findings: The left anterior and middle cerebral arteries fill from the vertebral basilar system. The elongated loop of the right internal carotid artery is more clearly delineated.

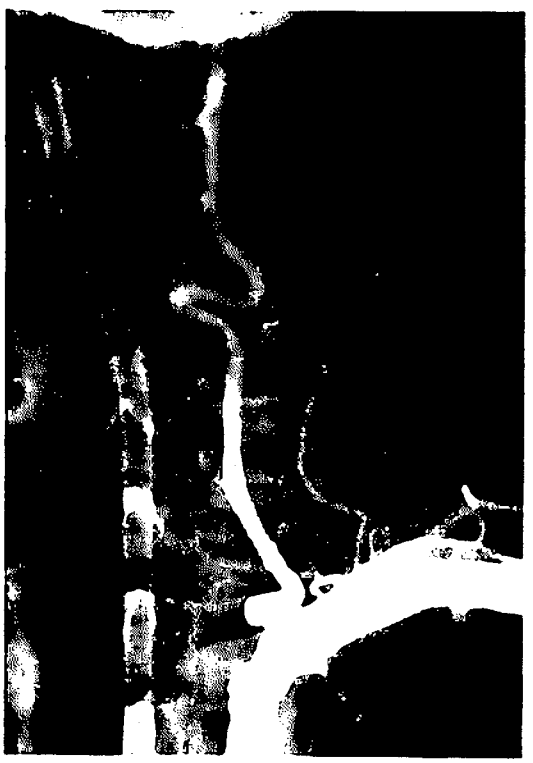

Figure 3 LEFT VERTEBRAL ARTERY - Selective subclavian injection. Findings: The dominant left vertebral artery is tightly kinked at its origin with a sharp loop at C-4. A point of compression at the level of the axis is not demonstrated.

Figure 4 LEFT VERTEBRAL ARTERY - INTRACRANIAL STEAL Findings: The late phase of the angiogram demonstrates fair visualization of the anterior and middle cerebral arteries with poor visualization of the posterior fossa consistent with active intracranial steal to the large vascular bed of the carotid artery.

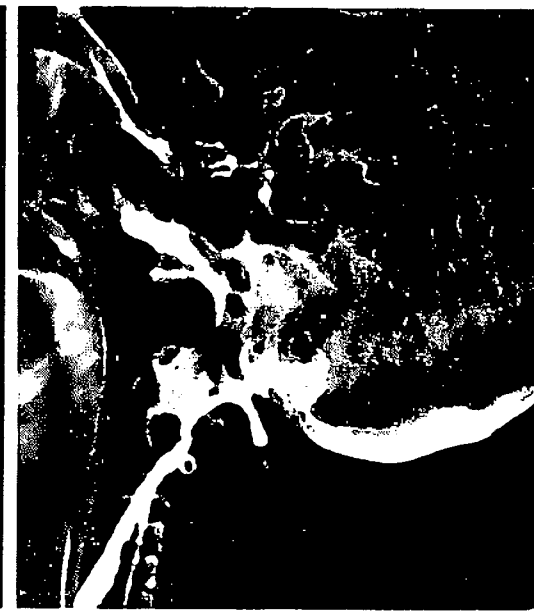

Figure 5 CAROTID DISTAL VERTEBRAL ARTERY BYPASS INTRACRANIAL FILLING Injection of the left carotid reveals improved visualization of the anterior and posterior circulations.

increased in the presence of bilateral carotid obstruction[7]. Bypassing all potential vertebral artery obstruction to the level of the axis is necessary to enhance cerebral perfusion through the vertebral basilar system.

The late phase of the pre-operative vertebral angiogram reveals scanty filling of the posterior fossa consistent with intracranial steal to the anterior and middle fossa. The post-operative angiogram reveals improved filling of both anterior and posterior circulations through the carotid distal vertebral bypass.

Head Motion - a Consideration

The impact of head position on cerebral perfusion has not received adequate emphasis and must be considered in detail for successful CDVA bypass. The orientation of the graft is important and should parallel the axis of the neck to minimize acute kinking due to head rotation. The proximal stoma should be positioned well below the carotid bifurcation. The graft must be free of kinks, torsion and tension to withstand the extremes of head flexion, extension and rotation.

Other Applications

In this case, the CDVA bypass was employed in the revascularization for carotid occlusion, but vertebral basilar insufficiency with normal carotid arteries is not rare[8,9,10]. The critical anatomical variable is the posterior communicating artery. The same principles of blood flow and vessel diameter apply to occipital-PICA anastomosis for posterior fossa ischemia.

CONCLUSION

If the pre-existing posterior communicating artery is adequate and vertebral artery obstruction exists, then carotid distal vertebral artery bypass can improve the anterior cerebral perfusion compromized by internal carotid occlusion. If the anatomical prerequisites

are satisfied then the CDVA bypass constitutes a viable alternative to temporal-middle cerebral and occipital-PICA bypass for revascularization of the anterior and posterior cerebral circulations.

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