Continued Patency of Canine Lingual-Basilar System

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Abstract

A canine lingual-basilar system has been helpful to study the use of extracranial vessels for perfusion of the cerebral circulation. This experimental system was patent in all nine long-term animals and enlarged with time.

The principles derived from this experimental investigation have been applied to six patients in whom the superficial temporal artery was used to enhance cerebral perfusion by anastomosis to a cortical branch of the middle cerebral artery. The first four patients have had follow-up arteriography which demonstrates patency of all five new vascular channels.

Additional Key Words: cerebral perfusion, middle cerebral artery, anastomosis, collateral blood flow, extracranial vessels, superficial temporal artery.

The possibility of creating additional collateral blood flow to the brain by anastomosis of extracranial vessels to cerebral vessels has been of interest to us for several years. In attempting to study this idea an experimental model was developed using a series of dogs. After end-to-side anastomosis of the lingual artery to the basilar artery (fig. 1), the basilar artery was ligated just proximal to the anastomosis and other sources of cerebral circulation were removed. The technical details of this procedure and early results have been reported.

The purpose of this presentation is to summarize the findings in nine animals, kept for extended evaluation, and to report an initial clinical case in which an anastomosis was performed between the superficial temporal artery and an anterior temporal cortical branch of the middle cerebral artery, as described by Donaghy and Yasargil.

Results

Arteriography was performed in each of the nine animals just prior to sacrifice: five animals at one year, one animal at 18 months, two animals at two years, and one animal at three years. Each anastomosis remained patent. The lingual-basilar system in each case remained at least as large as it had been during previous arteriographical studies. In most of the animals this channel enlarged with time. These findings are summarized by arteriograms from six animals illustrated in figure 2.

Examination of gross autopsy specimens of the anastomosis disclosed no evidence of thrombus formation, cicatricial deformity, or local degenerative change. There was no reaction about suture material. Free ends of sutures were found projecting into the lumen of specimens from two animals operated upon early in the series. This did not create evidence of reaction or interference with blood flow. Figure 3A shows the clean intimal surface characteristic of each specimen.

Histological sections through the anastomosis (fig. 3B) had a continuous undistorted intimal surface overlying a thin zone of mature collagen, which connected the thick muscular...
wall of the lingual artery to the thinner muscular wall of the basilar artery. There was considerable fibrous scar formation surrounding each anastomosis, but this did not extend to the brainstem. There was essentially no evidence of active inflammation.

Case Report
A 48-year-old man on June 10, 1970, suddenly had numbness of his left hand and the left side of his face, associated with right-sided headache. This subsided after 15 hours, but recurred a month later, and then at increasingly frequent intervals. During the more recent episodes his left upper extremity felt heavy and the left side of his tongue had the sensation that "it had been injected with Novocain." Arteriography, performed August 21, 1970, demonstrated a tight stenosis of the right middle cerebral artery (fig. 4A) with delayed filling of the right middle cerebral branches (figs. 4B and 4C).

On August 28, 1970, an anastomosis was performed between the right superficial temporal artery and an anterior temporal cortical branch of the right middle cerebral artery. The patient has been asymptomatic since surgery.

Arteriography (fig. 5), performed April 14, 1971, revealed that the right superficial temporal artery was open and perfusing the major vessels of the right temporal lobe.

Comment
Five subsequent patients have had a similar surgical procedure. Follow-up arteriography has been completed in the first three and is being reported elsewhere. All vessels proved to be open (one patient was studied at eight months; two patients were studied at six months, including one in which both branches of the superficial temporal artery had been utilized).

Discussion
With the use of the operating microscope,
Arteriograms of six animals at intervals after anastomosis (arrow) as follows:

1A. Two months, 1B. Same animal at one year.
2A. Three months. 2B. Same animal at one year.
3A. Four months. 3B. Same animal at one year.
4A. Two months, 4B. Same animal at two years.
5A. Two months, 5B. Same animal at two years.
6A. Eighteen months, 6B. Same animal at three years.

The second study usually shows enlargement of lingual-basilar system in comparison with earlier studies. Note: The vertical segment of lingual artery seen "end on" often suggests the false impression of a saccular aneurysm.

Microsurgical instruments, and microsutures, it is possible to perform precise anastomosis of small arteries with regular success and dependable long-term patency. Technical experience...
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and theoretical principles, derived from laboratory investigation, were essential prerequisites for successful clinical application.

Because of its length and uniform diameter, the canine lingual artery has proved an ideal donor vessel. The human has no such suitable artery.

FIGURE 3
A. Gross autopsy specimen two years after surgery shows smooth intimal surface at suture line connecting lingual artery (LA) and basilar artery (BA). X 9. B. Histological section through anastomosis 15 months following surgery. Lingual artery (LA) connected to basilar artery (BA) by thin zone of mature collagen tissue. H & E, X 34.

FIGURE 4
A. Right carotid arteriogram shows stenosis (arrow) of middle cerebral artery. Prominent posterior cerebral artery is an incidental finding. Note: Oblique views untangle anterior cerebral vessels which, seen “end on,” suggest false impression of a bilobular saccular aneurysm. B. Early lateral view shows prompt filling of anterior and posterior cerebral arteries, but no filling of middle cerebral vessels. C. Later view shows onset of filling in middle cerebral vessels.

The superficial temporal artery, however, has many desirable features. Its location is
Selective right external carotid arteriogram shows superficial temporal artery (STA) feeding the major vessels of temporal lobe. Anastomosis (arrow) is with an anterior temporal cortical vessel, which fills retrograde through the Sylvian fissure and irrigates the posterior temporal branch (PTB) of middle cerebral artery.

Anastomosis to a cortical branch has several advantages. The risk of temporarily interrupting flow to a small area while performing the anastomosis is minimal because of the rich epicerebral collateral network. Cortical branches are infrequently the site of disease, thus affording the anastomosis between two relatively healthy vessels. The superficial temporal-cortical system initially convenient to the Sylvian region, often the area of ischemia because of disease involving the middle cerebral trunk which has limited collateral circulation. It divides into a frontal and a parietal branch. Either or both branches may be satisfactory for anastomosis. Use of both branches may afford supra-Sylvian and infra-Sylvian perfusion beyond an occluded middle cerebral trifurcation.
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seems quite small. However, it supplies a large low-resistance vascular bed. This results in high-velocity flow which is a significant factor in preserving patency and leads to enlargement of the new feeding channel.

These factors should favorably influence the long-term value of this additional source of collateral blood flow. Furthermore, this procedure offers promise in attempting to perfuse regions previously isolated from circulation by troublesome lesions of the middle cerebral artery or in the carotid siphon or bifurcation (including occlusion of the internal carotid artery).

References
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