

Carbodissection as an Adjunct to Endarterectomy

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ENDARTERECTOMY, originally reported by dos Santos in 1947,⁴ has been widely used as a method of arterial revascularization. It retains technical limitations when compared with other methods. Bypass grafting, for instance, is faster and can be accomplished with less blood loss.

The main difficulty encountered when performing an endarterectomy is the separation of the adventitia from the occlusive plaque. Intraluminal material must be completely removed without damaging the filmy adventitia. This has been accomplished in various ways and leading authorities have attempted to improve methods of endarterectomy.^{1, 3, 6, 9, 10} The histology of the plane of separation was carefully investigated and documented by Chochinov.² He showed two natural planes of dissection, one deep to the internal elastic lamina and another superficial to the external elastic lamina.

dos Santos, working through two arteriotomies, made a cleavage plane against the musculature with a blunt spatula, inserting after that a forceps and grasping the core from below.

Many surgeons, discouraged with indirect approaches, have resorted to complete exposure of the vessel and often a total longitudinal opening of the artery. This method has obvious disadvantages.

Intrigued by the work of Sobel, Kaplitt, and Sawyer,⁸ we used their method of gas bolus separation of the adventitia.

Clinical Material

Endarterectomy using carbodissection has been performed 17 times in 15 patients.

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Eight aortoiliofemoral and four femoro-popliteal procedures were done. One patient (age 80) underwent profunda femoris endarterectomy and one patient distal superficial femoral endarterectomy. Three patients were diabetic. Ages ranged from 49 to 80 years; nine were in the sixth decade.

The total operative time for one team varied between 2 hours, 20 minutes and 9 hours, 10 minutes. The short procedures were carotid endarterectomies. The longest includes reoperation time. The average operative time for bilateral aortoilio common femoral endarterectomy was 5 hours, 45 minutes; for unilateral common femoral, superficial femoral, and popliteal endarterectomy 7 hours, 10 minutes. The average blood loss, excluding the carotid cases, was 1,320 cc. per case.

Indications for endarterectomy were intermittent claudication (5), gangrene or ulcer without rest pain (5), ulcer or gangrene with rest pain (2), cerebral vascular insufficiency (2), and hypertension (1).

All patients operated upon for intermittent claudication were improved with pulses restored to the level of operation. When operation involved the superficial femoral and popliteal vessels, pulses were restored in six of seven cases. Healing is progressing satisfactorily in all ulcer and gangrene cases except one. This patient has had direct flow restored to the profunda femoris but not to the popliteal level. One patient died as a result of ruptured renal artery. Intermittent cerebral vascular insufficiency symptoms disappeared after carotid endarterectomy in both patients.

Postoperative arteriograms have been done at 6, 5, and 3 months. These studies show

generally wide-open vessels with good collateral preservation (Fig. 1). One patient has multiple areas of narrowing along the course of the superficial femoral artery but patency at 6 months. One study shows a stenosis near the suture line in the distal popliteal artery. Several cases have areas of relative widening but no aneurysm formation (Fig. 2).

One death occurred from renal artery rupture on the fifth postoperative day; it occurred at the site of a cholesterol plaque within the adventitia of the anterior wall 1.5 cm. from its origin. Postoperative thrombosis of the superficial femoral artery occurred once due to retained media with flap formation. This problem was corrected in the immediate postoperative period.

Method

The method used was that developed by Sobel, *et al.*⁸ (Practice with the technic is readily obtained in the morgue by working on the aortoiliac arteries.) The affected segment of the arterial tree is exposed, the patient is heparinized, and occlusive vascular clamps are placed every 7 to 15 cm. Branches are secured by looping with heavy silk ligatures 2 to 3 mm. away from their origins. When a long segment of vessel is to be treated, such as the superficial femoral artery, only proximal and distal exposures are made.

Using a long, sterile plastic tube, a 23-gauge needle is connected to the carbon dioxide tank. The necessary gas flow rate is judged by bubbling the gas through saline to a moderately heavy flow. The needle is then inserted obliquely through the adventitia until a plane is forced by the gas under the adventitia. This is immediately obvious when the adventitia expands off the core of atherosclerotic debris. The needle is inserted at multiple sites to obtain as complete a separation as possible.

Arteriometries are made at critical sites: in aortoiliofemoral disease, in the common femoral artery and the aorta; in superficial femoral artery disease, in the common femoral and distal superficial femoral arteries and, when indicated, in the distal popliteal artery. The plug is removed and residual media removed by passing tapes through the

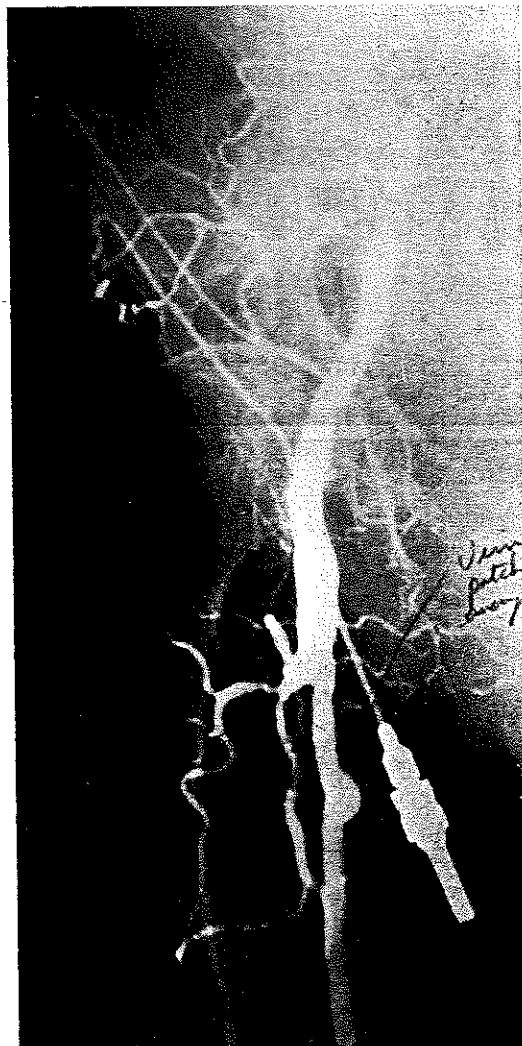


FIG. 1. Arteriogram 5 months following aorto-ilio-femoral endarterectomy and 3 months following superficial femoral endarterectomy. This study shows normal caliber of all vessels but some persisting stenosis of the profunda femoris and a poorly tailored vein patch. The collateral vessels are well preserved.

length of cleaned vessel. Usually a surprisingly clean inner surface is left. Sometimes, however, shaggy shreds of media cling to this inner surface. In the superficial femoral artery vigorous bleeding from side branches is often troublesome, giving rise to more blood loss than usual. In aortoiliofemoral occlusions, blood loss is mitigated by opening only the common femoral arteries to begin with, and opening the aorta only after the lower separation has been completed.



Fig. 2. Arteriogram 7 months following iliofemoral endarterectomy showing good caliber of the superficial femoral artery but only marginal flow through portions of the popliteal artery. Endarterectomy was carried down only to the proximal popliteal artery.

Discussion

Having used carbodissection I believe it greatly facilitates endarterectomy. In diabetics, endarterectomy remains difficult and is probably not eased by using this method.

Blood loss seems to be somewhat greater with this method, perhaps because collateral vessels are more completely opened. The average blood loss has been documented in this report.

Does carbodissection speed up endarterectomy? Perhaps it does. At least, longer segments of blood vessel are attacked at one sitting.

Some of the postoperative arteriograms

(Fig. 1) are impressive, however, many show the same defects seen using other techniques. As one would expect, as experience increases, results improve.

Summary

An early report on arterial reconstruction employing endarterectomy facilitated by carbon dioxide bolus dissection is presented. No complications occurred from the use of the gas. Short-term (6 months) patency was documented arteriographically in three cases with occasional focal stenoses. Good preservation of side branches occurs. This technique offers certain advantages when applicable.

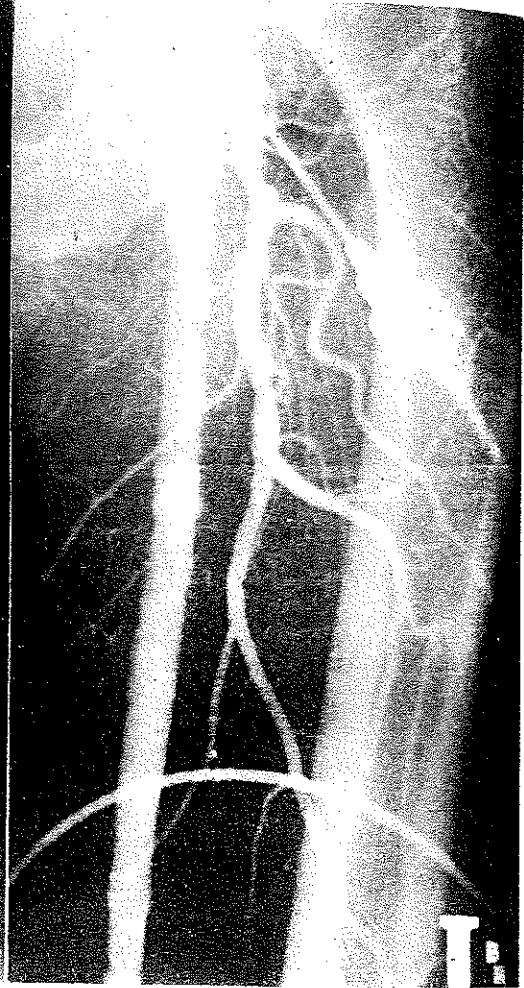


FIG. 2. Arteriogram 7 months following removal of the superficial marginal flow through the superficial femoral artery.

FIG. 3. Arteriogram 7 months following removal of the superficial femoral artery. The vessel has been carried down to the level of the knee.

Discussion

Having used carbodissection I should not greatly favor its endarterectomy. In difficult endarterectomies remains difficult and probably not a success using this method.

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Some of the postoperative arteriograms

showed a good result. However, many doubt the value of using other techniques. The author's own experience is limited.

Summary

An arteriogram of arterial reconstruction employing carbodissection facilitated by carbon dioxide gas dissection is presented. No complications occurred from the use of the gas. Short-term (6 months) patency is documented arteriographically in three cases with occasional focal stenoses. Good preservation of side branches occurs. This technic offers certain advantages when applicable:

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1) the use of autogenous tissues, 2) good preservation of side branches, and 3) large lumen diameter.

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Book Review

Practice of Intramedullary Nailing by Gerhard Kuntscher, Dr. Med. Habil. Springfield, Ill., Charles C Thomas, 1966.

No one person has done more than the author in the past twenty-five years to perfect and popularize the technic of intramedullary nailing of fractures, non-unions, and corrective osteotomies. Dr. Kuntscher presents a concise and erudite book on all phases of the technic from its history and development to his latest technic for closed intramedullary osteotomy, revolutionary in itself.

This text should be carefully studied by those surgeons who manage a large volume of fractures and desire to incorporate these advanced

methods into their surgery. Only the more capable men can hope to master these skills, but in so doing, they will vastly broaden their overall capabilities in fracture management.

The novice and occasional fracture surgeon will enjoy studying the concise precision surgery depicted, but should realistically appraise their own ability and avoid possible operative disasters until they are thoroughly familiar with and at ease with the practice of intramedullary nailing.

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