

Current Status of Lower Extremity Bypass Grafts

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SUMMARY :

Mild, nonprogressive lower extremity claudication can be treated non-operatively. Progressive, disabling claudication or ischemic ulceration/gangrene are indications for limb revascularization. Autogenous vein is the preferred conduit for bypass. Acceptable immediate and late patency rates with resulting limb salvage are obtained with lower extremity bypasses.

Arteriosclerotic occlusive disease involving the lower extremities has a predilection for certain parts of the arterial tree. Symptoms generally result in intermittent claudication of the muscular portions of the extremities or ischemic rest pain or tissue loss in the form of ischemic ulcer or gangrene. Aortoiliac occlusive disease involves the aortic bifurcation and produces symptoms of buttock and thigh claudication. The most common site of chronic occlusive disease, however, is the supragenicular superficial femoral artery at the adductor canal. Asymptomatic occlusive disease at this site or higher that produces mild claudication symptoms does not warrant surgical treatment since the natural history for the most part is benign. Byod, in a study involving 1440 claudicants showed that limb loss in this group of patients was only 7% at five years.¹ Progressive, disabling intermittent claudication, ischemic rest pain or tissue ischemia with impending gangrene are valid indications for attempting reconstruction to relieve symptoms and achieve limb salvage. Local endarterectomy was the mainstay of vascular surgery until Kunlin in 1949 reported the first series of patients with superficial femoral artery occlusion treated by reversing autogenous saphenous vein using the bypass principle. Occasionally when autogenous saphenous vein (AV) is less than 3-4mm in diameter or unavailable, the cephalic vein or pros-

thetic materials become necessary. Expanded microporous polytetrafluoroethylene (PTFE) or glutaraldehyde preserved human umbilical vein (HUV) are the current preferred conduits for lower limb revascularization in the absence of AV. This report is an analysis of a consecutive series of patients with lower extremity arterial disease operated on by the author over a 48 month period.

MATERIAL AND METHODS

This study consisted of 113 patients who underwent 121 lower limb revascularization operations by the author between September 1979 and December, 1983. Patient population consisted of 65 men and 48 women, ranging in age from 33-93 years (mean 67.2 years). Seventy-eight were caucasian and 35 black. Atherosclerotic heart disease (63 patients), hypertension (56 patients), diabetes melitis (47 patients) and cerebrovascular disease (20 patients) were present. Two-thirds of the population were smokers. The indication for operation was limb salvage in 110 patients (90%) (resting ischemic pain 70, gangrene 28 and ischemic ulceration in 11 patients,) disabling intermittent claudication in eight (6.6%) and popliteal artery aneurysms in four (3.4%) limbs. Transfemoral catheter or translumbar arteriography was performed in all cases. Distal angiographic runoff vessel status was classified as poor (0-1 vessels) in 83 limbs, (68%), and good (2-3 vessels) in 38 limbs (32%). Noninvasive arterial evaluation was performed preoperatively

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an ankle/brachial systolic pressure indices recorded postoperatively. The operative procedures were performed under general or regional (epidural or spinal) anesthesia in the majority, although some elderly high risk patients had local anesthesia with sedation. Magnification loupes (x2.5) were used to construct small vessel anastomosis. Prophylactic cephalosporin antibiotics were administered prior to and for 72 hours in patients with prosthetic grafts. Previous operation for proximal aortoiliac disease had been performed in 16 limbs and one or more prior lower extremity bypasses had failed in 15 limbs prior to referral. Seventy autogenous vein (AV) (67 saphenous, 3 composite cephalic and saphenous), 41 polytetrafluoroethylene (PTFE), two human umbilical veins (HUV) and eight composite (PTFE and AV) grafts were utilized. The proximal anastomosis was to the common femoral artery in 107 and superficial femoral/popliteal artery in 14 limbs. The distal anastomosis was to the popliteal artery in 82 (above knee 35, below knee 47), tibial arteries in 27 (anterior 4, posterior 17, peroneal 6) and double sequential anastomosis in 12 limbs. Followup was complete in 107 patients (88%) and ranged from 1-51 months (mean 12.97).

All data were entered into a computer and frequency tables were generated. Chi square analysis with Yates correction was used for statistical computation and cumulative patency curves were generated using standard life table analysis.

RESULTS

One hundred twenty-one lower extremity bypasses were attempted in 113 patients. Synchronous procedures included proximal revascularization (10), lumbar sympathectomy (14) and minor or major amputations (11). Three deaths (2.6%) occurred within thirty days, two of myocardial infarctions and one of bilateral cerebral infarction. Post-operative complications included cardiac (8), incisional (9), cerebrovascular (3) and miscellaneous (6) events. One patent but infected graft required removal. Eighteen late deaths occurred during followup, the majority from cardiac events.

PATENCY

Immediate graft occlusion occurred in 14 limbs within 24 hours. Patency was restored in six of 11 limbs reoperated on, four of whom had

PTFE grafts inserted in place of failed AV. For purposes of analysis, grafts were counted as patent if reoperation was successful within 24 hours. If graft failure occurred after this time, it was counted as occluded even though reoperation may have rendered it patent. Overall 28 of 121 (23%) bypasses occluded at some time during followup. Patency of AV (87%) was better than prosthetic PTFE grafts (63%) ($p < .05$) (Table I, Figure-I). Femoral-popliteal graft patency (84%) was significantly better than small vessel tibial bypass (59%) ($p < .01$) (Figure-II, Table-I). Patency rate was not significantly different between diabetics or nondiabetics, and the number of runoff vessels had no correlation with patency. Patency rate was significantly better in limbs operated on for claudication (100%) compared to limb salvage (74.4%) ($p < .05$).

Cumulative patency rate by life table analysis was 91% at one month, 76% at 12 months, and 61% at 36 months. Patency rates for AV, PTFE, femoral-popliteal and tibial bypasses are shown in Table-I.

TABLE - I

COMMULATIVE PATENCY RATES BY LIFE TABLE ANALYSIS

	1 Month	12 Months	36 Months
All Bypass Grafts,	91%	76%	61%
Autogenous Vein	95%	83%	83%
PTFE Grafts	87.5%	66%	54%
Femoral Popliteal Grafts	96%	81.8%	67%
Tibial Grafts	78%	68%	68%

LIMB SALVAGE

No amputations resulted following operation for claudication. Twenty-three major amputations (below knee 16, above knee 7) resulted following

TABLE - II

LAST LIMB STATUS

GRAFT PATENT	+ NO MAJOR AMPUTATION	= 90
GRAFT PATENT	+ MAJOR AMPUTATION	= 4
GRAFT OCCLUDED	+ NO MAJOR AMPUTATION	= 8
GRAFT OCCLUDED	+ MAJOR AMPUTATION	= 19

revascularization attempts in limbs with impending limb loss (limb salvage 86/109, 79%). Minor amputations were required in 13 limbs (transmetatarsal 6, Symes 1 and digit 6) to excise previously gangrenous tissue (Table-II).

DISCUSSION

Nonoperative therapy is adequate in the majority of patients with lower extremity occlusive vascular disease, consisting of a no smoking and graduated exercise walking program. Pentoxifylline, a cyclic AMP inhibitor is one of a new generation of drugs that shows promise in the relief of claudication symptoms. For those with localized short segment arterial obstruction percutaneous transluminal balloon dilatation may be indicated, although long term results are not encouraging in the superficial femoral artery. Impending limb loss dictates an urgent attempt at revascularization. Certainly, bypass to an infrapopliteal tibial or peroneal artery should be reserved for patients with threatened limbs since the initial failure rate is in the order of 10-20%. Since the majority of patients are elderly and have multiple risk factors such as ischemic heart disease, hypertension, diabetes etc. Some risk

is involved and careful patient selection is mandatory. Amputation rather than revascularization is often advisable in the high risk, nonambulatory patient with extensive gangrene. Operative mortality in this patient population ranges from 1-5%, primarily from postoperative myocardial infarction or fatal arrhythmias.

OPERATIVE PROCEDURE

The traditional method in the use of AV requires complete dissection and gentle atraumatic removal of the long saphenous vein, reversal in order to orient the valves in the direction of blood flow. Proximal anastomosis to the common femoral artery and bypass of the occluded arterial segment with the distal anastomosis to a patent popliteal or tibial artery completes the operation. Intraoperative heparin is used to avoid thrombosis. Completion intraoperative angiography is performed to detect any technical errors. Circumferential dissection and handling of the vein necessarily damages the venous endothelium. Attention is now turning to leaving the saphenous vein in its natural bed, ligating its branches and performing an "in-situ" bypass. The venous valves are rendered incompetent by a

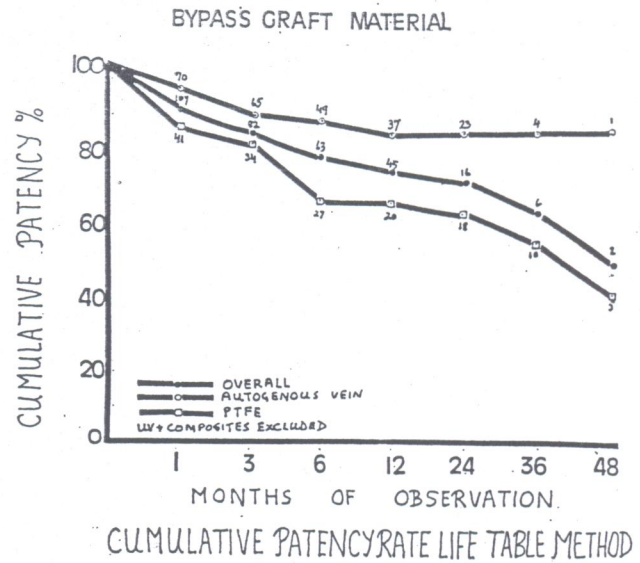


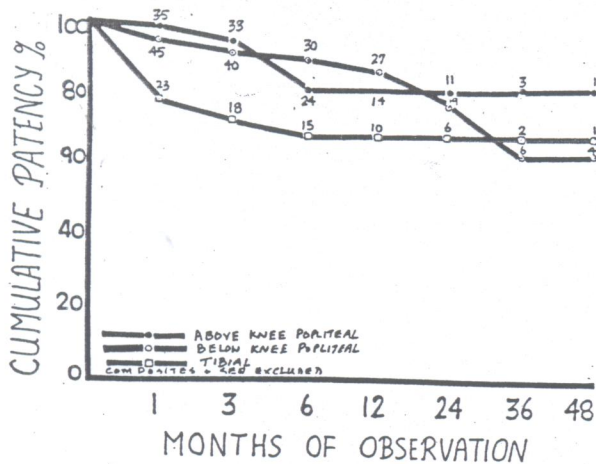
FIGURE 1

specially made instrument passed up from the distal end of the vein. Early results are encouraging and appear to be an improvement over the traditional reversed AV. A well developed cephalic vein is often useful when adequate length of saphenous vein is unavailable. Implantable PTFE grafts in the lower extremity were reported in 1975 by Campbell and associates. Aneurysmal dilatation developed in the earlier unwrapped grafts but has not been a problem with the newer PTFE grafts wrapped with an outer layer of dacron.

The HUV graft was developed by Dardik et al as an arterial substitute. The umbilical vein removed from human placenta is stabilized with glutaraldehyde and wrapped by a dacron mesh. The early results are encouraging and appear to justify HUV use when AV is unavailable or inadequate. Greater technical expertise is required because of the bulky nature of the graft.

Early failures of reconstruction are due to technical errors in anastomosis, presence of a thrombogenic surface and poor outflow. Other complications include hemorrhage, hematoma formation, lymphatic leaks and wound infection. Reoperation, thrombectomy and correction of any technical mishaps are often necessary within the first 24 hours. Most series report at immediate failure rate of 3-10% with femoral popliteal and 15-30% with femoral tibial bypasses. Late failures are a result of progression of proximal or distal atherosclerotic disease, degenerative changes in the AV, and intimal hyperplasia at the site of anastomosis. Repeat angiography, thrombectomy,

DISTAL SITE OF BYPASS GRAFT



CUMULATIVE PATENCY RATE LIFE TABLE

FIGURE 2

angioplasty or replacement of the occluded graft may be necessary to preserve the limb. However, not all occluded grafts require reoperation since the limb may remain viable.

Although the operative mortality is 0.5-4% depending on the general condition, age, and indication for operation this is equal to or actually lower than that with major limb amputation. The late mortality continues to be high due to the sequelae of generalized atherosclerotic disease, especially myocardial ischemia. The five year patency rates with AV vary from 60-75% depending on the indication for operation.⁵ Long term results are worse when the indication is impending limb loss rather than claudication.

References :

1. Boyd MA: The natural course of arteriosclerosis of the lower extremities. *Angiology* 11:10, 1960.
2. Kunlin J: Le traitement de l'arterite obliterante par la greffe veineuse. *Arch Mal Coeur* 42:371, 1949.
3. Campbell CD, Goldfarb D, Roe R: A small arterial substitute: expanded microporous polytetrafluoroethylene: Patency versus porosity. *Ann Surg* 182:138, 1975.
4. Dardik H, Ibrahim IM, Baier R, Spraygreen S, Levy M, Dardik I: Human umbilical cord. *J Am Med Assoc* 236:2859, 1976.
5. DeWeese JA, Rob CG: Autogenous venous bypass grafts five years later. *Ann Surg* 174:346, 1971.