Popliteal-crural bypass through the posterior approach with lesser saphenous vein for limb salvage

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Purpose: **A review of popliteal-crural bypasses via the posterior approach was done to evaluate the results of this technique.**
Methods: **During a period of 36 months, 21 patients with limb-threatening ischemia underwent 21 popliteal-crural bypasses via the posterior approach in the prone position with reversed lesser saphenous vein. All patients had limb-threatening ischemia, with rest pain in five patients, ulceration in nine patients, and gangrene in seven patients. Diabetes mellitus was present in 17 patients.**
Results: **The inflow site was the supragenicular popliteal artery in 12 patients and the infragenicular popliteal artery in nine patients. The outflow sites were the tibioperoneal trunk in five patients, the posterior tibial artery in six patients, the peroneal artery in eight patients, and the anterior tibial artery in two patients. Of the seven patients with gangrene, three patients underwent transmetatarsal amputation and four underwent toe amputation. The limb salvage rate for the entire group was 100% at 24 months. No early graft failures were seen, and the 12-month and 24-month primary graft patency rates were 89% and 77%, respectively, with life-table analysis. The primary assisted patency rate was 95% at 12 and 24 months. Patency was determined with duplex scan graft surveillance.**
Conclusion: **The posterior approach to popliteal-distal bypass is an acceptable alternative to traditional bypass procedure with excellent early patency and limb salvage results. The approach has the advantage of better utilization of lesser saphenous vein and easier operative exposure in patients with short segment infrapopliteal occlusive disease. (J Vasc Surg 2002;36:708-12.)**

Occlusive disease of the popliteal artery and its trifurcation with sparing of the superficial femoral artery is a pattern of atherosclerosis, which is often seen in patients with diabetes. These patients with single-level occlusive disease can have limb-threatening ischemia. Surgical revascularization is the treatment of choice for these patients. The use of the popliteal artery as an inflow to revascularize lower extremity ischemia caused by atherosclerotic occlusive disease was reported as early as 1966 by Garrett and DeBakey.[1,2] In 1981, Veith et al[3] challenged the established dogma that inflow to the lower extremity bypass procedure should originate from the common femoral artery. Since then, many centers[4-7] have reported excellent long-term patency rates of crural bypass with preferential use of the popliteal artery as an inflow vessel. In these reports, the greater saphenous vein was used as the conduit of choice and the popliteal artery was exposed via the standard medial approach. The exposure of crural vessels was done through the medial approach for the posterior tibial and peroneal arteries, through the anterolateral approach for the anterior tibial artery, or through the lateral approach for the peroneal artery. A posterior approach to the peroneal artery has also been described.[8] In 1994, Ouriel[9] reported the use of the posterior approach to the popliteal-crural bypass with the lesser saphenous vein. Advantages of this procedure included sparing of the greater saphenous vein, shorter length of bypass, and lower wound healing complication rates. In that study, the 18-month cumulative graft patency rate was 83%.

We initially performed a popliteal to peroneal bypass via the posterior approach with lesser saphenous vein in a patient with toe gangrene in whom the greater saphenous vein had been harvested for coronary bypass. The procedure was done with the patient in the prone position, which allowed ease in harvest of the lesser saphenous vein. We have now performed popliteal-crural bypasses through the posterior approach with lesser saphenous vein in 21 patients. The early results of this series of consecutive patients are presented here.

METHODS

During a 36-month period from 1998 to 2001, 287 infrainguinal lower extremity bypass procedures were performed. Of these, 21 consecutive patients (7.3%) underwent popliteal crural bypasses via the posterior approach with the lesser saphenous vein. The inclusion criterion for the posterior approach was short segment occlusive disease of the popliteal artery and its trifurcation. Patients with diffuse disease of the superficial femoral artery were excluded. Patients with target crural artery for the distal anastomosis in the distal half of the leg were also excluded.

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The median age of the patients was 72 years, with a range from 55 to 85 years. Of the 21 patients, 15 were men and six were women. Diabetes mellitus was the predominant comorbid condition and was present in 17 patients (81%). A history of coronary artery disease was noted in 11 patients (52%). Renal failure was present in three patients (14%). Fifteen patients (71%) had a history of smoking, and 14 patients (67%) had hypertension. All patients had limb-threatening ischemia, with rest pain in five patients (24%), ulceration in nine patients (43%), and gangrene in seven patients (33%).

The preoperative work-up for these patients included intraarterial angiogram or magnetic resonance angiography. Five patients (24%) were noted to have a focal stenosis of the superficial femoral artery and underwent angioplasty to improve inflow before bypass. Three patients had previous ipsilateral bypass grafts, and two of these grafts were occluded. Ipsilateral greater saphenous vein was absent in 10 patients (48%).

During the course of this series, six additional patients were scheduled for popliteal-crural bypass via the posterior approach; however, they were excluded from this series. Reasons for exclusion were inadequate lesser saphenous vein in five patients and inadequate outflow crural vessel in one patient. In patients with inadequate lesser saphenous vein, two underwent bypass with the greater saphenous vein via the posterior approach, two had popliteal endarterectomy with vein patch, and one had a prosthetic bypass. In 26 of 27 patients, the procedure was completed via the posterior approach. In one patient with inadequate outflow vessel, the posterior incision was closed and the patient was placed in the supine position. This patient underwent bypass from the popliteal artery to the dorsalis pedis artery with greater saphenous vein.

General anesthesia was used in 14 patients, and spinal anesthesia was used in seven patients. All patients were placed in the prone position after induction of anesthesia, and the entire lower extremity was prepped circumferentially. Ouriel[9] described the operative technique for the posterior approach to popliteal crural bypass. A single S-shaped skin incision at popliteal fossa was made, and the proximal lesser saphenous vein was harvested. The popliteal artery was dissected between the two heads of the gastrocnemius muscle. The posterior tibial nerve and its branches were identified, and care was taken to avoid dissection or retraction injuries to these nerves. The proximal soleus muscle was divided for exposure of the crural vessels. This allowed complete exposure of the posterior tibial and the peroneal arteries. The proximal 2 cm of the anterior tibial artery could be dissected via the posterior approach before it dove into the anterior compartment (Fig 1). All patients underwent a short bypass procedure with a single posterior incision, except for one patient who needed a second incision for exposure to the mid anterior tibial artery. The mid anterior tibial artery was dissected with a longitudinal incision over the anterior compartment with the patient in the prone position with external rotation of the leg. The dissection of the crural arteries was facilitated with intraoperative use of a handheld Doppler scan or an angiogram to help locate the vessel. All patients underwent bypass with the reversed lesser saphenous vein. The technical adequacy of the bypass was confirmed with an intraoperative angiogram (Fig 2) and handheld Doppler scan examination at ankle level in all patients. The protocol for follow-up of these patients included a duplex scan at 3 months after surgery and then every 6 months thereafter. The data for limb salvage and patency were analyzed with the life-table method.

RESULTS

The inflow site was the supragenicular popliteal artery in 12 patients (57%) and the infragenicular popliteal artery in nine patients (43%). Outflow sites were the tibioperoneal trunk in five patients (24%), the posterior tibial artery in six patients (29%), the peroneal artery in eight patients (38%), and the anterior tibial artery in two patients. The distal anastomosis was made within the proximal one third of the crural arteries in 20 of 21 patients.

All 21 patients had complete healing of the posterior midline incision, with one patient needing postoperative evacuation of hematoma. Hematoma occurred in this patient because of thrombolysis treatment before surgery. No other patient in this series had wound infection or breakdown. Compression wrap dressings were routinely used to decrease swelling associated with dependency.

One patient (5%) died at 40 days after surgery of stroke and myocardial infarction. All other patients were able to leave the hospital and were able to ambulate. One other patient had a myocardial infarction in the early postoperative period, and pneumonia was diagnosed in one patient. Of the seven patients with gangrene, four have healed toe amputations, two have healed transmetatarsal amputations, and one had a partially healed transmetatarsal amputation. All nine patients with ulceration were able to have the skin ulcers heal in the postoperative period. Patients were followed with duplex scan of the graft within the first 3 months after surgery and then at 6-month intervals thereafter. During the past 3 years, six patients (29%) have died and 2 were lost to follow-up. No patient who has undergone this procedure has as yet needed limb amputation. Among the 11 patients who underwent bypass with 12 months or more follow-up, all retain their limbs. At 2 years after surgery, all five patients retained their limbs. One early graft occlusion, noted at 3 months, occurred in a patient who had anticardiolipin antibodies. The primary patency rates of this series were 89% at 1 year and 77% at 2 years with life-table analysis (Fig 3). The average length of follow-up in our series was 14 months. Two patients were noted to have focal mid graft stenosis and were treated with balloon angioplasty at 4 and 14 months. These two patients had patent bypass grafts at 6 months after the procedure with duplex scans. One patient needed a second distal bypass from the posterior tibial artery to the planter artery and angioplasty of the distal bypass. The primary assisted patency rate was 95% at 1 and 2 years (Fig 4).

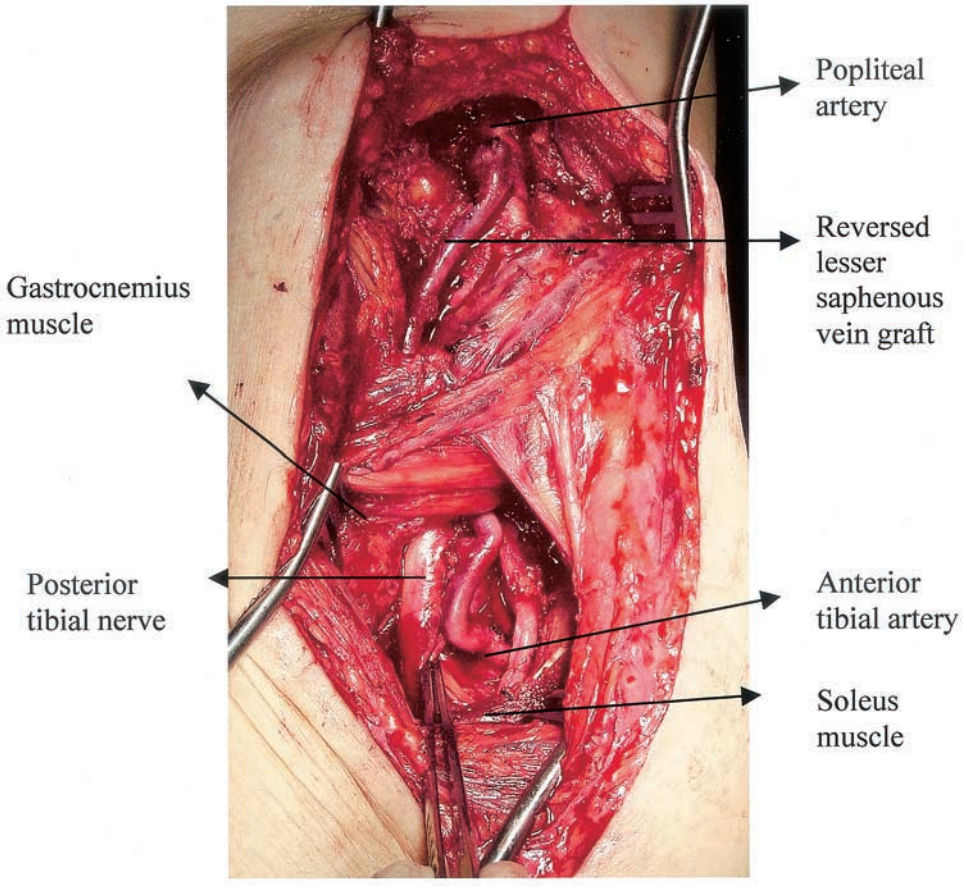

Fig 1. Popliteal to anterior tibial artery bypass. Proximal anterior tibial artery can be exposed via posterior approach.

DISCUSSION

The posterior approach to the popliteal to crural bypass was initially performed in a patient in whom greater saphenous vein was absent. After our initial experience, the posterior approach to the popliteal-crural artery with lesser saphenous vein became our procedure of choice for short segment popliteal and proximal crural artery occlusive disease. This series and a previous report[9] show that the posterior approach to the popliteal crural bypass with lesser saphenous vein is feasible, with early results comparable with standard popliteal-crural reconstructions. We like to emphasize that the average follow-up period in our series was 14 months and that long-term results are currently not available.

The lesser saphenous vein is reported as the preferred conduit for bypass when the greater saphenous vein is absent.[10] In this series, the ipsilateral greater saphenous vein was absent in 10 patients (48%). The lesser saphenous vein harvest is easier with the patient in the prone position as compared with the supine position. The lesser saphenous vein was adequate (>3 mm in diameter) in 81% of patients who underwent the procedure in the prone position. A preoperative vein mapping with duplex scan can be done to assess whether adequate vein is present, which was not routinely done in our series. In cases where lesser saphenous vein is not adequate, a short segment of greater saphenous vein can be harvested with the patient in the prone position, which was done in two patients not included in this series.

Two patients in this series had myocardial infarctions, and one patient had pneumonia. All patients underwent cardiac risk assessment before surgery. In patients with bypass procedures in the prone position, airway management for the anesthesiologist is challenging. We had a team of anesthesiologists who were familiar with procedures in the prone position, such as spinal surgeries. No specific problems with intraoperative positioning and monitoring of these patients were encountered.

Popliteal and proximal tibial vessel atherosclerosis is generally present in patients with diabetes mellitus (81% of this series) with relative sparing of superficial femoral artery.[4-7] In five patients (24%), a focal stenosis (<2 cm) in the superficial femoral artery was noted during preoperative imaging studies. All of these patients were treated with

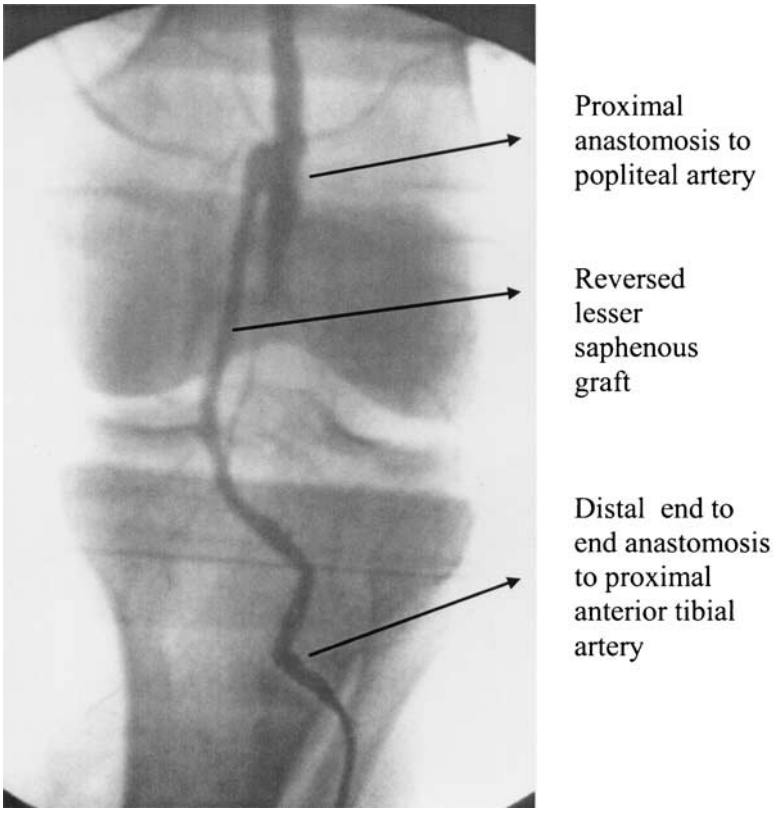

Fig 2. Intraoperative angiogram of popliteal to anterior tibial bypass.

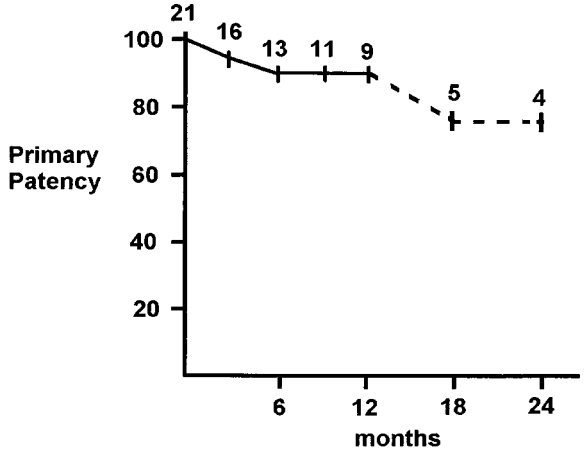

Fig 3. Primary patency curve with life-table method. *Dotted line* indicates that standard error exceeds 10%. Details of life-table calculations are available online.

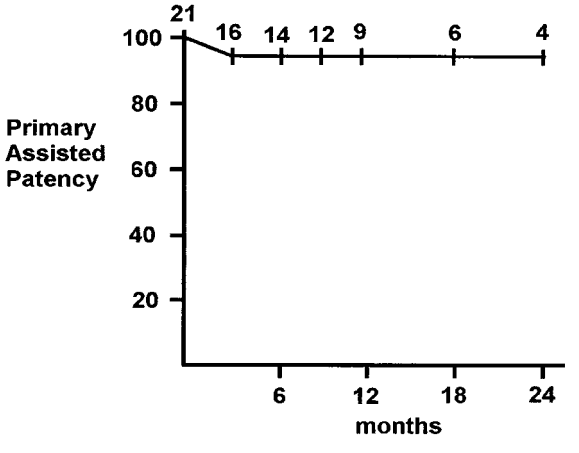

Fig 4. Primary assisted patency curve with life-table method. Details of life-table calculations are available online.

successful superficial femoral artery angioplasty before the popliteal-crural bypass procedure. The patency results for angioplasty of focal superficial femoral artery stenosis (<3 cm) have been reported to be satisfactory.[11] The popliteal-crural bypasses were selected in patients with short segment occlusive disease of the popliteal trifurcation. In patients with more extensive superficial femoral artery and crural artery atherosclerosis, standard infrainguinal reconstructions were performed.

The exposure of the mid popliteal artery through the standard medial supragenicular or infragenicular incisions is difficult.[12] The posterior approach allows better exposure

of the entire popliteal artery and its trifurcation, the peroneal artery, the posterior tibial artery, and the proximal anterior tibial artery. Because of the complete exposure, the length of bypass conduit is minimized as compared with the standard medial technique. Reports show that the shorter length of vein bypass results in better graft patency as compared with the longer graft.[13] The bypass grafts conduits are placed in an anatomic position next to the artery and have lower potential risk of exposure to the outside environment with wound dehiscence.

In conclusion, the posterior approach to the popliteal to crural bypass with the lesser saphenous vein is an acceptable alternative to the traditional bypass procedure with good early patency and limb salvage results. This procedure also has morbidity and mortality rates similar to the standard medial approach. This is a useful tool for revascularization in the select group of patients with short segment occlusive disease of the popliteal and proximal crural vessels.

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Table I, online only. Life table of limb salvage

Interval (mo)	*No. at risk*	*No. failed*	*No. lost to follow-up*	*No. died*	*No. did not complete*	*No. withdrawn*	*Failure rate*	*Limb salvage rate*	*Standard error*
0-3	21	0	1	2	0	3	0	100%	0
3-6	18	0	0	0	2	2	0	100%	0
6-9	16	0	0	0	2	2	0	100%	0
9-12	14	0	0	0	3	3	0	100%	0
12-18	11	0	0	1	3	4	0	100%	0
18-24	7	0	0	1	1	2	0	100%	0
24-30	5	0	0	2	0	2	0	100%	0
30-36	3	0	0	0	3	3	0	100%	0

Table II, online only. Life table of primary patency

Interval (mo)	*No. at risk*	*No. failed*	*No. lost to follow-up*	*No. died*	*No. did not complete*	*No. withdraw*	*Failure rate*	*Patency rate*	*Standard error*
0-3	21	1	2	2	0	4	0.053	94.7%	4.89
3-6	16	1	0	0	2	2	0.065	88.5%	7.50
6-9	13	0	0	0	2	2	0	88.5%	8.32
9-12	11	0	0	0	2	2	0	88.5%	9.04
12-18	9	1	0	0	3	3	0.133	76.7%	12.34
18-24	5	0	0	0	1	1	0	76.7%	16.56
24-30	4	0	0	2	0	2	0	76.7%	18.51
30-36	2	0	0	0	2	2	0	76.7%	26.18

Table III, online only. Life table of primary assisted

Interval (mo)	*No. at risk*	*No. failed*	*No. lost to follow-up*	*No. died*	*No. did not complete*	*No. withdrawn*	*Failure rate*	*Patency rate*	*Standard error*
0-3	21	1	2	2	0	4	0.053	94.7%	4.89
3-6	16	0	0	0	2	2	0	94.7%	5.45
6-9	14	0	0	0	2	2	0	94.7%	5.82
9-12	12	0	0	0	3	3	0	94.7%	6.29
12-18	9	0	0	0	3	3	0	94.7%	7.27
18-24	6	0	0	1	1	2	0	94.7%	8.90
24-30	4	0	0	2	0	0	0	94.7%	10.90
30-36	2	0	0	0	2	2	0	94.7%	15.41