

# Femoro Tibial Bypass

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THE popliteal artery is the most distal artery in the leg, considered to be useful for reconstructive vascular surgery. In 1963, the anterior tibial artery in mid leg was first used to preserve an ischemic extremity in our institution. Subsequently we reported our experience<sup>3</sup> with 14 patients, of whom ten had extremities salvaged after bypass surgery involving the vessels below the popliteal arteries.

In 1967 the group from Baylor<sup>2</sup> reported a 70% rate of salvage among 56 patients who had been studied for 2 years. Other cases have been sporadically reported of instances in which the arteries below the knee have been repaired following trauma as well as for treatment of occlusive vascular disease.

The following report describes our 5½-year experience—which has now grown to include more than 50 cases. We have successfully treated the area just distal to the tibia and on occasion the viability of the intervening tissues that were bypassed have caused concern.

## Case Selection

Most instances represent true salvage situations because of our method of case

selection (Table 1). We have also used these criteria for all instances of arterial insufficiency. In this group we have had only two patients in whom operation was indicated by threatened loss of employment. These latter two patients should have the best prognosis. Ironically, after 2 years, one patient decided that deep knee bends were no longer contraindicated and the graft became occluded within a week after starting this exercise. The other patient's graft is still functioning after 5 years.

Having met either of these criteria the patient underwent general evaluation and arteriogram. We prefer a percutaneous femoral arteriogram because of its simplicity which assures better visualization since no dye is lost from the leg. Injections were repeated until either dye could be seen in the collateral vessels distally, one of the major distal arteries was visualized or we were convinced that the passage was completely obstructed (Fig. 1). We believe that if dye is seen in the collaterals at a given level but is not seen in a main conduit, the main conduit is almost certainly occluded. At times no dye has been seen in collateral vessels at a given level but it has been visualized in a main conduit (Fig. 2). We believe that dye in a main conduit implies that is open for some distance and suggests a usable vessel. Preferably we would like to follow the dye column down into the foot, however, in

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TABLE 1. *Indications for Reconstructive Arterial Surgery*

1. Threatened loss of tissue
Gangrene
Ischemic ulcer
Rest pain
2. Threatened loss of occupation

TABLE 2. *Femoro Tibial Bypass, 5½ Years*

	Total	Diabetics
Bypass performed	48	16
Explored only	7	3
Total	55	19

TABLE 3. *Femoro Tibial Bypass, 5½ Years*

	Total	Diabetics
Bypassed	48	16
Bypass open	37	11
Bypass closed	11	5
Bypass insufficient	4	2
Bypass closed late	4	1

some instances this is not possible. After a distal main conduit has been visualized on arteriogram, the patient becomes a candidate for surgery. If some overwhelming concomitant problem contraindicates operation, one must decide if major amputation and rehabilitation would carry more risk than successful bypass surgery. One must also consider the odds of bypass surgery succeeding; failure would necessitate amputation, thus imposing two operations rather than one. Peripheral surgery is not very traumatic; it can be performed with epidural or light general anesthesia and is well tolerated by the infirm.

### Procedure

With the patient in the supine position, the popliteal, posterior tibial and peroneal arteries are approached through medial incisions (Fig. 3). The femoral and ante-

rior tibial arteries are approached through anterior incisions. Intervening incisions are made as needed to remove the saphenous vein. In most instances the incisions used to expose the artery and remove the vein are also used to construct the tunnel. The distal artery is exposed first, about which is placed rubbery, soaked catgut. The artery is incised longitudinally at a soft spot; a plastic catheter is introduced that fits without effort distally and 20 c.c. of saline containing heparin are injected rapidly. Heparin saline is also injected proximally. If this solution is accepted without the catheter being pushed out or undue resistance we proceed with bypass. The soft catgut is tied loosely but sufficiently about the vessel to control bleeding. This method is atraumatic to the vessel and occupies little space. These ties will be cut with a scalpel at the conclusion of the procedure. After the proximal artery has been exposed, the saphenous vein is removed and the tunnel is made which follows the course of the artery. After the vein is irrigated with saline, the tributaries are tied with triple "0" black silk and the vein is



FIG. 1. Contrast is seen in collateral channels to the ankle but no contrast is in the main conduits.

distended to minimize spasm. A levine tube is threaded through the tunnel and used to pull the vein through after inserting the irrigating cannula into the flared end of the levine tube. No malpositioning of the graft has resulted from this method.

The distal anastomosis is performed end-to-side, using small instruments, magnification and seven "0" coated dacron sutures. A simple over and over suture is used. The excess vein is removed which is cut obliquely and opened lengthwise a short distance and anastomosed to the proximal artery in a similar fashion, end-to-side with six "0" suture material. Usually, the proximal anastomosis has been performed at the femoral bifurcation but it has also been performed to the common femoral, superficial femoral and popliteal arteries. Clo-

TABLE 4. *Femoro Tibial Bypass, 5½ Years*

Bypass Functioning	Number
3-5½ years	7
1½-3 years	9
½-1½ years	9

TABLE 5. *Femoro Tibial Bypass, 5½ Years*

	Total	Open	Closed	Salvaged
Anterior tibial	10	7	3	7
Posterior tibial	23	18	7	16
Peroneal	11	8	4	6
Tibio-peroneal	4	4	1	4

sure is accomplished usually with skin only.

Because of our and other experience<sup>3</sup> in the femoro-popliteal area, we have tried to avoid using prosthetics, although, composite grafts have been used occasionally. In a few instances a prosthetic was present or had been placed in the arterial system, proximal to the femoro tibial bypass. In one instance the unsuitability of the vein precluded bypass and subsequently part of the vein became viable. Perhaps, after improved prosthetics are available, they should be used when the vein is not suitable. Local endarterectomy has also been used when it seemed appropriate.

### Results

The function of a leg must be preserved if the result is to be considered successful. Invariably a degree of heat and a distal pulse develops within the limb within thirty-six hours after successful operation. The degree of heat which develops seems to be a function of the severity of the pre-existing occlusive problem and the adequacy of the bypass. The local heat will be apparent for 3 to 5 days. Early loss of the heat as well as loss of the pulse may signify occlusion of the bypass.



FIG. 2. Contrast fills the peroneal artery.



FIG. 3. Incisions for posterior tibial bypass. The common femoral incision is not shown.

Fifty-five patients were operated on (Table 2), seven of whom underwent only exploratory procedures. Forty-eight patients underwent bypass procedures. Diabetic patients comprised less than half of the group. The reasons for undergoing only exploratory procedures were; extremely high levels of calcium in one patient; an unusable vein in another which could have been identified by preoperative venogram detecting multiple areas of obstruction. The remaining five patients could not undergo irrigation procedures without undue resistance. Our rate of success was 66% which does not include late closures that occluded after 3 months to several years. The results of diabetic patients followed the same pattern but were not as good (Table 3). Table 4 illustrates the number of years that the bypasses have successfully functioned. Some patients have died of unrelated causes; one patient with whom recent communication has been impossible is listed as a successful result only for the period of follow-up study. If this patient's bypass is still functioning he would be listed in the 3 to 5½ year group. Table 5 indicates which distal vessel was

used and records subsequent success or failure. The figures under the salvaged column are not the same as those appearing under the open column since not every bypass that was performed preserved the extremity. The most distal successful bypass was to the dorsalis pedis, and was performed on our oldest patient (87 years).



FIG. 4. A peroneal artery bypass functioning that did not preserve the foot.

Our longest functioning bypass was also our first procedure. Our youngest patient is 33 years old. The most common vascular problem has been atherosclerosis, although we have had a few patients in whom a diagnosis of arteritis seemed justified. There was one case of possible trauma.

In four patients a functioning graft failed to preserve the leg. Two of these patients were diabetics, but we found nothing else to be unique about these patients or their arteriograms (Fig. 4). This situation has not previously occurred with other areas after treatment of occlusive disease. We had always associated a functioning graft with preservation of the leg, however, when we consider the ubiquity of atherosclerosis we should not be surprised. Incidentally this led us to regard the presence of a *hot foot*, postoperatively, as being more indicative of a successful result than the presence of a pulse.

Seven of our patients have proximal prostheses. Most underwent prosthetic bypasses or interposition to meet local needs. In these procedures, the autogenous veins were anastomosed to the side of the prostheses and carried distally. Most subsequently occluded possibly due to widespread disease. We have wondered if a prosthetic femoro-popliteal bypass plus a distal tibial autogenous vein bypass, perhaps arising from the prosthetic bypass, might not be mutually supporting. Contrary to past experience the only true composite bypass has been functioning for 6 months. Our reasons for using prosthetics in conjunction with vein grafts have been because of previous occlusive disease proximal to the femoral artery; the presence of a femoral aneurysm; inability to attain the needed length of vein and the desire to verify for ourselves that composites are not useful. In any event our experience in this area has been too limited to warrant any conclusions.

We have encountered less than normal surgical wound healing in some patients with severe atherosclerosis even in the presence of a successful bypass. However, in a few patients, we encountered good healing of an ulcer in the foot with prolonged and difficult healing of a knee incision that failed to heal *per primam*. In two instances, poor healing was sufficiently severe to momentarily entertain the thought of removing the knee area but we did not know how to proceed to salvage the foot. Fortunately, both healed eventually. This experience suggests that an intermediate anastomosis should be performed in a long bypass to provide blood supply to the knee area, when suitable vessels are present. Or might it be possible, some day, to interpose a knee prosthetic between thigh and foot?

### Conclusion

We believe we have presented ample evidence that small vessels below the knee, when properly utilized, will salvage a leg in a surprisingly large number of occurrences. The technic has been learned and practiced by three other surgeons, who have contributed to the treatment of this group of patients. I do not believe we have reached the distal limit as yet, but would not expect to go distal to the planter arches.

These same technics are applicable to renal arteries in children, accessory renal arteries and coronary arteries. These technics might be applied to the middle cerebral artery or branches of the arteries to the gut as well as for transplantation of tissues.

### References

1. Dale, W.: Grafting Small Arteries: Experience with 19 Shunts Below the Knee. *Arch. Surg.*, **86:22**, 1963.
2. Garrett, H. E., Kotch, P. I., Green, M. T., Jr., Diethrich, E. B. and De Bakey, M. E.: Distal Tibial Artery Bypass with Autogenous Vein Grafts: An Analysis of 56 Cases. *Surgery*, **63:90**, 1968.
3. Tyson, R. R. and DeLaurentis, D.: Femoro Tibial Bypass. *Circulation*, **33:183**, 1966.