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IS ADJUNCTIVE ARTERIOVENOUS FISTULA OF VALUE IN PARAMALLEOLAR REVASCULARIZATION??

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Purpose: *To test the possible role of adjunctive AVF in maintaining patency of paramalleolar arterial reconstruction.*

Method: *Eleven diabetic patients with critical leg ischemia due to extensive femoro-popliteo-tibial disease, with poor arterial runoff in the form of one patent paramalleolar tibial vessel connected to a diseased or partially occluded arch, were submitted to arterial reconstruction in the form of femoro-distal or popliteo-distal bypass with reconstruction of "common ostium" distal AVF. Clinical and duplex follow-up was done for these patients for at least 12 months. The outcome of this group of patients (group A) was compared to another group of 14 patients with critical limb ischemia and similar runoff, who underwent distal paramalleolar bypass without construction of AVF (group B).*

Result: *One year patency rate for patients of group A was 64% while it was 50% for group B, while limb salvage rate was 73% for group A and 50% for group B. Above knee amputation was needed in 27% of patients of group A and 50% of patients group B.*

Conclusion: *The reconstruction of distal AVF improve the patency of paramalleolar bypasses, and especially should be used with diseased or partially, occluded arch.*

Key words: *Lower limb revascularization – adjunctive AV fistula.*

Abbreviations: AVF (Arterio-venous fistula)
PTA (posterior tibial artery)
ATA (anterior tibial artery)
CHD (coronary heart disease)
MI (myocardial infarction)
PTFE (Polytetra fluroethylene)
DAVF (distal arterio-venous fistula)
CFA (common femoral artery)
SFA (superficial femoral artery)
LSV (long saphenous vein)
AVF/VI (Arterio-venous fistula/vein interposition)

INTRODUCTION

In patients with critical limb ischemia, the autogenous vein bypass to the infrapopliteal vessels is a well accepted procedure with satisfactory patency rate [1]. Distal revascularization in patients with poor distal arterial runoff may be followed by amputation, however, attempted distal bypass may be a better option than primary amputation. The use of periperative heparin and post operative warfarine seems to improve patency [2]. One of the most common causes of tibial arterial bypass failure is the exceedingly high outflow resistance, so the use of adjunctive AVF might be an option in limb revascularization, especially in patients with poor distal runoff and patients who had had previous failed vascular reconstructive operations. The idea for using distal AVF is based on increased flow velocity along the graft that exceeds the critical thrombotic threshold level [3,4]. Adjunctive AVF was described by Dean and Read in canine model [5]. Ibrahim et al and Dardik et al., have the

credit of the use of adjunctive AVF to improve graft patency in ischemic patients, however, despite favorable results, the potential of this technique to improve graft patency has not been fully explored [6, 7].

Study design:

The high failure rate of paramalleolar bypasses reported by many authors and experienced in our cases, stimulated us to start this prospective study, in which paramalleolar bypasses using vein grafts with adjunctive AVF were done for 11 diabetic patients presented with critical limb schemia due to extensive femoro-popliteo-tibial disease. This group of patients was compared retrospectively to a matched group of diabetic patients with similar distal run off, who were operated upon with paramalleolar bypasses using vein grafts without an adjunctive AVF.

PATIENTS AND METHODS

During the period from January 1997 to March 2000, 11 patients with critical limb ischemia due to extensive femoro popliteo-tibial disease presented to the facility of the authors.

The limb salvage indications in these patients were, ischemic rest pain with non-healing ulcer in 6 patients (54.5%), focal gangrene in 3 patients (27.2%) and foot infection in 2 patients (18.1%).

All the 11 patients were diabetic with arteriographic runoff vessel in the form of a single paramalleolar tibial vessel which is continuous with a diseased or partially occluded arch. (Fig. 1, 2)

The runoff paramalleolar tibial artery was the PTA in 8 patients (72.7%) and ATA in 3 patients (27.3%).

The mean age for this group of patients (Group A) was (55.6 years) (range 48:66) and all were males, 9 of them were heavy smokers, 8 with history of CHD and 5 with history of hyperchlostraemia.

Methods:

The status of available vein was preoperatively evaluated by duplex scanning. Epidural anaesthesia was used in 9 patients and general anaesthesia in 2 cases. The autogenous long saphenous vein (LSV) was the only conduit used in this study. It was used as in situ conduit in 6 cases (54.5%), where its upper end was anastomosed to the common femoral artery (CFA) in 4 cases and to the superficial femoral artery(SFA) in 2 cases. In the other 5 cases, the vein was used in a reversed manner, where the inflow artery was the upper popliteal (4 cases) or the lower popliteal artery (one case). In three cases of the last 5, the vein harvested from the contralateral limb, as the ipsilateral vein was previously used.

The posterior tibial artery (PTA) was explored behind and above the medical malleolus, where it was located between the flexor digitorium longus muscle and the calcaneal tendon. The approach is facilitated with the use of a self-retaining retractor, exposing a long length of the rather superficial distal posterior tibial artery to facilitate construction of the anastomosis[8]. The anterior tibial artery may be explored, for paramalleolar bypass- by an incision just lateral to the center of the anterior tibial compartment, which is deepened between tibials anterior and the two extensor muscle (digitorum longus and hallucis longus), however, the tibialis anterior muscle may be splitted to find the artery. A sufficient length of the artery should be mobilized and a cruciate incision in the interosseous membrane made 2cm above the proposed anastomosis through which the graft may be routed from the medial aspect of the leg[8].

The type of distal adjunctive arteriovenous fistula (dAVF) used in this study was the modified common ostium type as described by Dardik et al [9]. Three cm of the runoff artery and its dominant venous concomitant were mobilized and controlled. Arteriotomy and venotomy (2cm) were placed at 10 o'clock and 2o'clock coresponding positions. Side-to-side posterior wall anastomosis of the artery to vein with 7-0 polypopylene; started at the midpoint of both and continued to terminate at the artery-vein juncture proximally and distally, with care not to carry the sutures anteriorly, but to tie them to a single interrupted suture at each end. The ovoid ostium was then converted into a rectangular shape by doing four separate "nicks" in each quadrant. The bypass vein was then anastomosed with 7-0 polypropylene into the common ostium AVF by doing interrupted sutures at its heal, continuous stutuers was then run distally to the midpoint, while the distal toe was then sutured and tied in place using interrupted sutures, which run proximally in a continuous manner to midpoint to meat the previous one and terminate the anastomosis. The proximal or distal limbs of the concomitant vein was not ligated in any of the cases.

All patients were followed at monthly intervals in the first 6 months and then every two months for another 6 months.

Follow-up included clinical examination and 6-monthly duplex study. Special attention was paid to AVF flow and its outcome through the one-year follow up.

The previous group of patients (group A) was compared to another group of 14 diabetic patients (group B) in whom distal bypasses to paramalleolar tibial vessels were done without the creation of dAVF. In these cases, the tibial arteries were continuous to non-diseased arches in 4 cases and to a mildly diseased arches in 10 cases. The main characteristics of both groups appear in (Table I).

RESULTS

There was no perioperative mortality in group A, however, there was a record of death of one patient in group B due to MI late in the follow up period. The 30 day patency rate was (10/11, 90.9%) for group A, and (10/14, 71.4%) for group B (Table II).

It is to be noted that one case in group A experienced secondary hemorrhage with ligation of the graft and subsequently above knee amputation was done. The one year patency rate was (7/11 = 64%) for group A and (7/14 = 50%) for group B, however, the salvage rate was 73% & 50% for both groups respectively (Table III).

Duplex follow up of the dAVF in patients of group A revealed gradual reduction of flow through the venous limb of the fistula ending with closure of the fistula as the antegrade flow through the graft-distal artery was maintained. (Fig. 3, 4, 5, 6, 7). Improvement of the digital circulation was also noticed with this gradual closure of the fistula, which is recorded in (Table IV). In one of the patients, the d AVF was still patent after 36 months, leading to repeated ulceration of the stump of the forefoot amputation. This necessitated banding of the venous limb of the fistula, with subsequent healing of the ulcer. (Fig. 8, a & b).

Other than occlusion and secondary hemorrhage, wound infection occurred in 2 patients of group A (18%), one of them experienced secondary hemorrhage, and in two cases of group B (14%). Above knee amputation was needed in three patients of group A (27%), one early in the 1st post operative month, and two during the follow up period due to occlusion of the graft. Seven cases (50%) underwent above knee amputation in group B due to occlusion of the graft. (Table V).

Table I: ***Main characteristics of both group (A & B)***

	Group A		*Group B*	
Number	11	(100%)	14	(100%)
Sex male	11	(100%)	11	(78. 7%)
Female	0		3	(21.43%)
Mean age	55.6		57	
Indications				
Rest pain & ulcer	6	(54.54%)	6	(42.85%)
Focal gangrene	3	(27.27%)	5	(35.71%)
Foot infection	2	(18.18%)	3	(21.42%)
Runoff				
Posterior tibial	8	(72.72%)	10	(71.43%)
Antenior tibial	3	(27.27%)	4	(28.57%)
Foot arches				
Non-diseased	0	(0 %)	4	(28.57%)
Partially occluded	11	(100%)	10	(71.43%)
Inflow				
CFA	4	(36.36%)	5	(35.71%)
SFA	2	(18.18%)	4	(28.57%)
Popliteal A	5	(45.45%)	5	(35.71%)
Graft				
In situ LSV	6	(54.54%)	7	(50%)
Reversed ipsilat.vein	2	(18.18%)	7	(50%)
Reversed contralated.vein	3	(27.27%)	0	

Table II: ***30 days patency rate:***

	Total		*Success*		*Occlusion*		*2nd hemorrhage*	
	No	%	No	%	No	%	No	%
Group A	11	100	10/11	90.90	0	0	1/11	9.09
Group B	14	100	10/14	71.43	3/14	21.43	1.14	7.14

Table III: *One year patency and salvage rates:*

	Total		*Patency*		*Occlusion*		*Salvage*	
	No	%	No	%	No	%	No	%
Group A	11	100	7	64	4	36	8	73
Group B	14	100	7	50	7	50	7	50

Table IV: *Follow up of the fistula in patients with patent grafts.*

	6 months	*12 months*	*18 months*	*27 months*	*30 months*
Patent grafts	8	7	7	7	5
Patent fistulae	7	6	5	3	1

Table V*: Complications:*

	Total		*Occlusion*		*2ry hemo.*		*Wound infection*		*AK Amp.*		*Death*	
	No	%	No	%	No	%	No	%	No	%	No	%
Group A	11	100	4/11	36	1/11	9	2/11	18	3/11	27	0	0
Group B	14	100	7/11	50	1/14	7	2/14	14	7/14	50	1/14	7

Fig.(1) : Paramalleolar PTA Connected to a diseased arch..

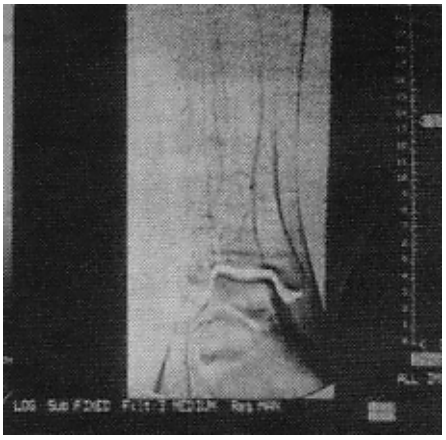


Fig.(2) : Paramalleolas PTA Connected to a diseased arch.

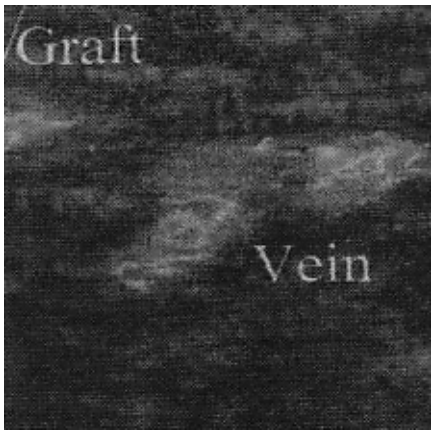


Fig. (3) : Distal anastomosis with an AVF.

Fig. (4)

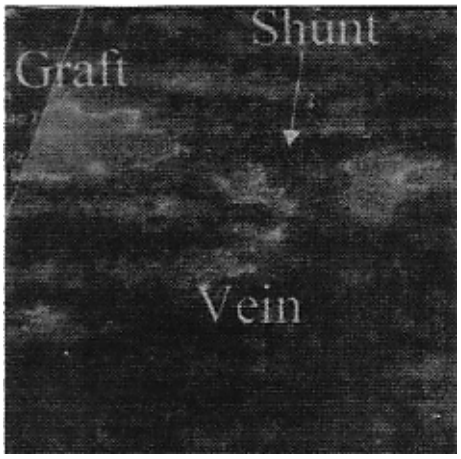


Fig. (5)

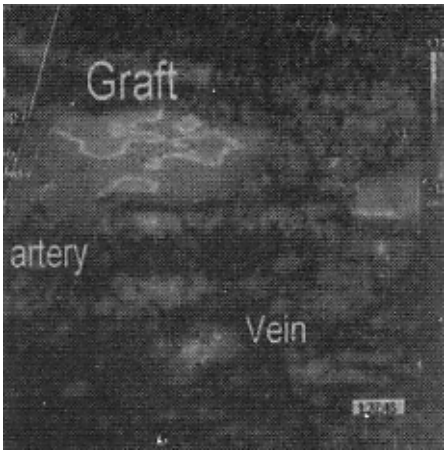


Fig. (6)

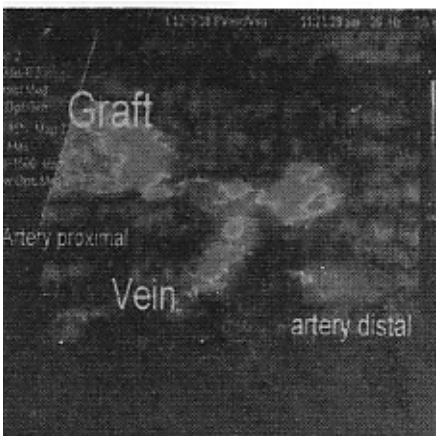
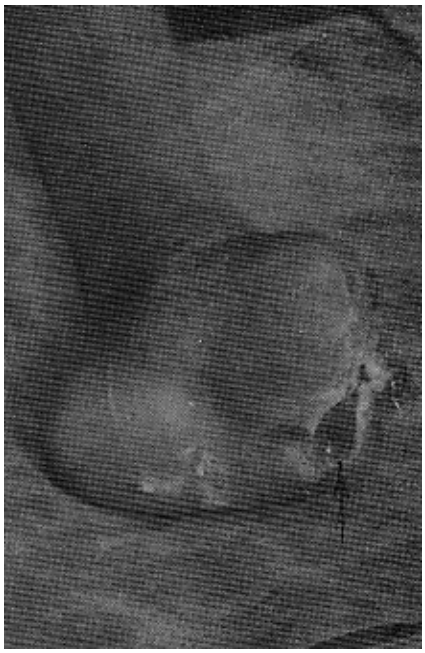


Fig. (7)

Fig. 4 ,5 ,6 ,7 : Distal Anastomosis , AVF and Native proximal artery.



A *B*

Fig. (8):

a- *Sites of incisions for Paramalleoler bypass and healed stump of forefoot amputation.*

b- *Ulcer at the stump of amputation 36 months after operation due to persistent fistula.*

DISCUSSION

One common cause of infrapopliteal arterial bypass failure is the exceedingly high outflow resistance, particularly when prosthetic grafts are used. Complementary distal AVF was proposed to solve the problem encountered with the use of small caliber vessel with a low-flow, high-resistance system as a runoff vessel [10].

The concept of using an AVF to improve graft flow and patency is well known. The idea of using adjunctive AVF is based on increased flow velocity along the whole graft exceeding the critical thrombotic thresold level. However, it may create turbelance at the anastomsis and steal blood away from the distal artery [11].

Dean and Read [5] used adjunctive femoral AVF to improve patency of Dacron interposition grafts placed in the iliac artery in a canine model, later on Ascer et al,[10] used an iliofemoral PTFE bypass model in dogs to compare the patency results with and without a complementary AVF and there was a significant improvement in patency rate in the AVF group. Blaisdell et al[12], reported the first clinical use of autogenous AVF with limited success in femoro-popliteal bypass reconstruction. Adjunctive AVF incorporated in the distal anastomosis, was described by Ibrahim et al[6], and Dardik et al[7], and in such a population undergoing limb salvage with multiple failed reconstructions, they achieved a one year patency rate of 39% and limb salvage rate of 52%.

The most important aspect of the AVF concept relates to the issue of stealing. Dardik et al[9], performed completion and surveillance sonography to confirm the abscence of steal by demonstration of continued prograde flow in the face of functional fistula, however, they were obliged to do banding of the venous outflow in 2 instances out of 290 cases. Ascer et al[13], banded the venous outflow in almost one half of their patients. They noticed that if a significant pressure gradient (>30 mmHg) was detected between the distal graft and the radial artery, an operation was needed to narrow the venous outflow. They reported also that deep veins larger than 4mm in external diameter were almost always associated with a significant pressure gradient, as a safeguard against massive dilation of them, they routinely placed a short sleeve of 4mm PTFE graft around the deep vein just proximal to the AVF.

Jacobs et al[14], suggested routine ligation of the cephaled vein component of the fistula, however, this concept is completely refused by Dardik et al, as this in their view significantly negated the potential effect of these fistulae. Their data indicate that total flow into the venous circuit and distal arteries is sustained by the increased flow

and velocity induced by construction of AVF, and, the higher patency rate in patients with AVF might be due to the larger anastomosis and therefore the delayed obstruction by fibrointimal hyperplasia.

According to Holman & Tayler[15], the size of the fistula should be less than or equal to the diameter of the artery or vein involved to avoid the steal phenomenon. Kistner and Vermeulen[16], suggested that the fistula should be less than 60% of the diameter of the proximal artery, conversely, Schenk et al,[17] did not detect any decrease in distal arterial flow subsequent to a one to one and half cm femoral fistula in dogs, up to one year after fistula construction.

Dardik et al[9], speculated that the steal phenomenon observed in Ascer et al series was due to the use of incompliant polytetrafluroethylene grafts allowing restricted amount of blood flow through it, particularly with large venous return. This situation is analogous to an inflow stenosis proximal to a crossover graft which causes donor limb ischemia.

Placing the fistula proximal or remote to the distal anastomosis, originally proposed by Harris et al,[18] and Paty et al[19], respectively was considered as a means to obviate or lessen the possibility for steal to occur. In fact, reverse flow can be precipitated by the vascular channels between the distal anastomosis and the downstream fistula in the distal fistula type. This is proved by finding that the arterial flow in the arterial segment distal to the fistula is 11% of that proximal to the fistula in Paty et al[19] series, and no evidence supports the continued placement of a fistula proximal to the distal anastomosis.

Dardik et al[9], reported their experience with the common ostium AVF during crural bypasses. The results reflected their learning curve and effect of the modification they used and described early in this study. During the period from 1979-1983, the cumulative secondary graft patency rates at 1, 2 & 3 years were 39%, 20% and 5%. Between 1984-89 they obtained 60%, 30% and 20% patency rates, while in the period from 1990-95 the patency rates for the three years follow up were 77%, 69% and 61%. The salvage rates for the three study period for three years were 70%, 47% and 42% for 1st period, 72%, 50% and 50% for the 2nd period and 81%, 79% and 75% for the last period.

Less acceptable results were published by Snyder and associated[20], who found a high rate of 8 months fistula failure (10%) and limb loss (37%) in 30 common ostium AVFs.

Ascer et al,[13] used a fistula combined with deep vein interposition. The procedure is performed by anastomosing the cephaled portion of the ligated vena comitant to the runoff artery and then piggy-backing the graft on top of the vein.

The interposed vein acts not only as a fistula for venous compression, but also serves as a vein cuff for improved compliance. The combined AVF and deep vein interposition attempts to correct the two main causes of infrapopliteal PTFE graft failure, namely the limited runoff and intimal hyperplasia. It widens the distal anastomosis with the same adjacent vein used as a part of the fistula. A definite explanation for the discrepant patency results between the graft and the fistula is not available. Ascer et al,[13] believed that the threshold for prosthetic graft thrombosis may increase over time. In support of this theory, they have identified 9 grafts that have remained patent despite late (>1 month) AVF / vein interposition graft closure, whereas non of the three grafts with early AVF-VI closure experienced patency.

There is no data to support or refute the superiority of a particular configuration of an AVF. Maurer et al,[21] showed in transparent models that the 2cm common ostium fistula was advantageous compared with smaller fistula, by exhibiting smooth flow patterns and improved hemodynamic parameters. Ascer et al,[13] described the use of the distal superficial venous system as an additional outflow site for high risk-perimalleolar bypasses. This gave 42% one year graft and fistula patency rate.

The common ostium method and the interposition vein model appear to be comparable in their activity and function, but randomized prospective studies are necessary to demonstrate the superiority of one or the other if such exists. It may be appropriate to consider each of these fistula to be performed on the basis of local anatomy and other technical factors.

In this study, we used the common ostium d AVF as modified and used by Dardik et al, with precise attention given to the location of the arteriotomy and venotomy, and prevention of strictures, stenosis and twisting by precise suture technique as well as four quadrant nicking to convert an ovoid common sotium to a more rectangular shape. We obtained primary patency rate of 64% at one year while the salvage rate was 73% as one graft occluded but without worse effect. Our results approached those obtained by Dardik et al[9] in their last series, however, these were better than those of Snyder et al[20]. This may be due to the use of venous graft only.

The duplex follow up of the AVF in this study revealed that the fistula tend to close with time in those cases with patent grafts and this tendency increased with time, a fact previously noticed by Derdik et al[9],.

The problem of steal was only found in one case of our patients where the fistula was still patent 30 months after surgery, and the patient presented with repeated ulceration of the stump of forefoot amputation, so banding of the venous limb of the fistula was obligatory.

One other potential disadvantage of an AVF is to overload the right ventricle and precipitate congestive heart failure. However, there is no clinical or experimental data to support that.

Flinn et al[22], achieved infrapopliteal PTFE bypass patency rate of 45% at 24 months by using continuous anticoagulation without an adjunctive AVF. Therefore the clinical results reported for AVF have not been convincing enough, and its place in the vascular armamentarium continuous to be controversial.

Unquestionally, a prospective randomized study that compares infrapopliteal bypasses with and without AVF in chronically anticoagulated patients will be necessary to delineate the final role of adjunctive AVF.

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