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PERCUTANOUS TRANSLUMINAL ANGIOPLASTY VS SURGERY IN CRITICAL LEG ISCHEMIA DUE TO POPLITEAL ARTERY DISEASE

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Surgical bypasses and percutanous transluminal angioplasty have evolved as possible treatment options for patients with popliteal artery steno-occlusive disease. In this retrospective study a comparison was made between the results of management of 43 patients who were subjected to surgical bypasses (group1) (group 1A); 25 with long bypasses and (group 1B) 18 with short bypasses) and those of 11 patients who were subjected to percutanous transluminal angioplasty (group2). In group 1(bypass group) limb salvage rate was 72% and 56% at one month and one year respectively for long bypass group1A. For those with short bypasses, (group 1B) limb salvage rate was 72% and 60% at one month and one year respectively. In group 2 (Angioplasty group), limb salvage rate was 64% and 45% at one month and one year respectively. These results denote that surgical bypasses have better short and long term patency rates than those of angioplasty, consequently, surgical bypasses can be considered the treatment of choice for good risk patients with popliteal artery steno-occlusive disease. High-risk patients and those with short stenotic segment and good run off can benefit from balloon angioplasty.

Keywords: Popliteal artery disease-bypass surgery- Popliteal angioplasty-critical ischemia.

INTRODUCTION

In some highly specialized centers and aggressive units, 90% of patients with critical leg ischemia (CLI) will undergo some form of surgical or endovascular procedure. In most, the figure is nearer to 50 to 60%. The primary amputation rate varies from 10 to 40%. The mortality rate in these patients with the standard therapy is around 20% at one year and between 40 to 70% at 5 years. Virtually all 95% patients who present with ischemic gangrene, and 80% of those presenting with rest pain are dead within 10 years [(1)].

Popliteal artery disease is a common problem that carries the risk of amputation. The incidence is very high especially in old ages and diabetics. Atherosclerosis is the commonest cause, however arteritis, thrombosed aneurysms, adventitial cystic disease and popliteal entrapment syndrome are other causes [(2-4)].

Regardless of the reason for popliteal artery disease revascularization is the only alternative to amputation. Surgical revascularization is considered the gold standard of treatment. Long bypasses have been proposed with the use of different types of grafts; reversed saphenous graft, in situ saphenous graft, synthetic and composite grafts. Excellent clinical results were reported with good rate of graft patency and limb salvage [(5-8)].

On the other hand, popliteodistal bypasses have been proved to be effective as foot salvage procedures. The clinical outcome is very much improved after the improvement in the technique and the use of distal arteriovenous fistula or Miller cuff at the distal anastomosis [(9-12)].

The new modality of percutanous transluminal angioplasty (PTA) and stenting opened a new way in the management of such cases especially in high-risk patients. It has the advantage of minimal invasive technique and low morbidity and mortality. The advent of different types of catheter, balloon, and different types of stent make all

lesions amenable to treatment by intervention. Although the results of popliteal and tibial angioplasty are inferior to that of the iliac artery, still there is a chance of getting better results in selected group of patients [13-15].

As for other therapeutic innovations, the results must be compared with the standard surgical techniques to evaluate safety, efficacy, and clinical outcome. In this study, various lines of treatment have been used and evaluated in patients with critical leg ischemia due to popliteal artery disease. The question is there a place for endovascular interventions in such cases? Or the standard surgical techniques will remain the ideal method of treatment of popliteal artery steno-occlusive disease?

PATIENTS AND METHODS

This retrospective study included 54 patients (15 women and 39 men) with age range between 32-73 years. All patients had critical leg ischemia due to popliteal artery disease. Their main complaints were rest pain, ischemic ulcers or tissue loss in the form of toe gangrene. Risk factors of atherosclerosis were smoking in 36, diabetes in 41, coronary artery disease in 20, previous coronary bypass surgery in 7, chronic obstructive lung disease in 6 and chronic renal failure in 5 (Table 1).

Clinical diagnosis and duplex studies revealed the diagnosis of popliteal artery stenosis or occlusion. The ankle brachial indices were between 0.3 and 0.5. Angiography was done for all and the distal run- off vessels were classified as poor (0 to one vessel patent) or good (2 to 3 vessels patent).

Revascularization was decided and the decision to proceed with PTA or bypass surgery as the initial treatment modality was made after reviewing the patients clinical, radiographic data and fitness for the procedure. However, selection criteria were based on the extent of the occlusive disease, technical feasibility of the procedure, the condition of the superficial femoral artery, poor or good distal run off and the severity of the associated medical condition.

In patients treated by bypass procedures, long bypass (Femoro-distal bypass) was done in 25 cases. The popliteal artery could not be used as an inflow artery due to diffuse atherosclerotic changes of the superficial femoral artery (Fig1) or the popliteal artery is totally occluded. On the other hand, those who had good popliteal pulse and relatively healthy superficial femoral artery (Fig2), short bypass (popliteo-distal bypass) was done in 18 cases with the use of distal arteriovenous fistula when saphenous vein graft was used (Fig3A&B) and use of Miller cuff when synthetic graft was used (Fig. 4).

For patients treated by PTA, selective angiography was performed after the procedure to document evidence of recannalization of an occluded or stenotic arterial segment (Fig 5A, B&C) and improvement in the perfusion of the distal collateral and outflow vessels Patients were given heparin intravenously 48 to 72 hours after the procedure and subsequently given aspirin 325 mg per day. Whether surgery or PTA was performed, clinical evaluation was based on relief of symptoms, satisfactory wound or ischemic ulcer healing, leg and foot salvage and degree of minor or major amputation. Clinical evaluation and duplex studies were used for follow up at three months interval after surgery or angioplasty.

Study Design:

Group 1: Bypass Group (43 cases)

Group 1A: Long bypasses

25 patients (21 men and 4 women, mean age 60 years) underwent femoro-distal bypasses in 25 limbs. Saphenous vein was the used conduit (15 in situ, 10 reversed). Distal anastomoses were placed at the posterior tibial or the anterior tibial artery at mid leg or at the ankle level.

Group 1B: Short bypasses:

18 patients (7 women and 11 men, with mean age 58 years) underwent popliteo-distal bypasses in 18 limbs. Popliteal artery was used as an inflow artery. Reversed saphenous vein was used in 13 procedure with arteriovenous fistula at the distal anastomosis and Gore-Tex. 6mm graft was used in 5 procedures with the use of Miller's cuff at the distal anastomosis to avoid mismatch between the graft and the recipient artery. Distal anastomosis was made at the posterior tibial artery, anterior tibial artery or the dorsalis pedis artery at or above the ankle level.

Group II: Percutanous transluminal angioplasty (13 cases)

11 patients (4 women and 7 men with mean age 61 years) underwent popliteal artery angioplasty in 11 limbs. All patients had co-morbid risk factors, diabetes in 9, coronary heart disease in 7, previous CABG in 5 and COPD in 3 patients. All lesions were stenotic short segment except 3 with total occlusion. Ipsilateral antigrade femoral puncture was performed under conscious sedation and local anesthesia.

Catheterization was performed using a 6-7 F introducer sheath, which is kept patent by continuous infusion of 0.9% normal saline using a special pump. To bypass a stenotic lesion, a straight hydrophilic guide wire (0.18, 0.32, 0.35inch) was used. After bypassing the lesion, a 0.38 or 0.25 Teflon coated guide wire was applied through a straight catheter. The latter was removed and a balloon catheter introduced. The balloon catheter used for

angioplasty had a shaft size 5 F and 5 -7 mm cross sectional diameter. The balloon was inflated repeatedly for 20 seconds for three times maximally until a homogenous deflation and inflation mode was obtained. Post angioplasty angiogram was done in successful cases.

Primary angioplasty was successful in 9 cases, and unsuccessful in 2 cases due to failure to pass the lesion or occurrence of major dissection. No secondary intervention was tried in the last two cases and above knee amputation was the end result**.**

RESULTS

Group 1A:

Femorodistal bypasses were successful in 20/25 with early postoperative patency rate of 80% (30 days after the operation). Graft thrombosis occurred in 5 cases with failure to restore function even after thrombectomy due to bad quality of the recipient artery. Limb salvage was achieved in 18/25 (72%) at one month with minor amputation in 7 cases in the form of toe or forefoot amputation. Major amputations included above knee amputation in 2 cases and below knee amputation in 3 cases. Two patients died during the early postoperative period due severe myocardial infarction follow up showed graft patency of 12/25 (48%) at one year. Limb salvage rate was 14/25 (56%) at one year, as even after graft occlusion some limbs still surviving due to development of more collaterals. Postoperative amputation rate was 5/25 (20%) in the form of below knee amputation and above knee amputation. Equal results were obtained with the reversed or in situ saphenous vein bypass although the latter is technically easier (Table 2).

Group 1B:

Popliteo-distal bypass was used in 18 cases. Reversed saphenous vein graft was used in 10 with creation of distal arteriovenous fistula at the distal anastomosis Dacron graft 6mm was used in 8 cases with the use of Miller cuff at the distal anastomosis. Good run off vessels were found in 10 cases and poor run off in the remaining 8 cases. Graft thrombosis occurred in 7 cases with successful thrombectomy in only 2 cases. Graft patency was 13/18 (72%) at one month after successful thrombectomy in 2 cases. Limb salvage rate at one month was 13/18(72%), major amputation was 5/18 (28%) and minor amputation was 8/18 (44%) as these patients usually present with toe or forefoot gangrene. Graft patency was 9/18 (50%) and overall limb salvage 11/18 (60%) at one year as the graft might be occluded and the limb is still viable (Table 3).

Group II:

Popliteal artery angioplasty (with stenting in some cases) was tried in 11 cases. Technical success was obtained in 9/11 (82%) and technical failure occurred in 2 cases due to failure of the guide wire to pass through the occluded popliteal segment. Poor run off was found in 4/11 (36%) and good run off was found in 7/11(64%). Successful results were obtained in 7/11(64%) with good recanalization proved by post angioplasty angiography. Wallstent was applied in only one case as apparent dissection had to be corrected. Successful clinical outcome was noticed by improvement of limb perfusion, relief of rest pain, healing of ischemic ulcers or the site of amputated toe. Post- procedural patency was 7/11 (64%) and 5/11 (45%) at one and 12 months respectively (Table 4).

Complications included small groin hematoma in 2 cases, popliteal dissection in 2 cases (Fig6) managed conservatively and distal embolization leading to toe gangrene in one case. Amputation rate was 2/11 (22%) immediately after the procedure and 3/11(27%) after one year.

Table (1): ***Risk factors of atherosclerosis:***

Total No. of patients	***54***
Women	12
Men	42
Age	32 – 73 years
Smoking	36
Diabetes	41
Coronary	20
Previous CABG	7
COPD	6
CRF	5

Table (2): *Long by pass group (1A):*

	Graft used	*Distal anastomosis*	*Graft pat ency (30 days)*	*Limb salvage*	*Late graft patency 24m.*	*Early Minor amputation*	*Early Minor amputation*
1	Reversed saphenous vein	PT	Patent	Saved	P	Toe amputation	
2	Reversed saph	PT	P	Saved	P	Toe amp	
3	Reversed s	Tibio- peroneal	P	Saved	P	Fore Foot amp	
4	Reversed s	AT	P	Saved	O	Saved	
5	Reversed s	PT	Occluded	Amputation-BKA	O		BKA
6	Reversed s	PT	P	Saved	P	Saved	
7	Reversed s	PT	Occluded	Amputation-BKA	O		BKA
8	Reversed s	PT	P	Saved	P		
9	Reversed s	PT	P	Saved	O		
10	Reversed s	PT	P	Saved	O		
11	Reversed s	AT	Occluded	Amputation-AKA	O		AKA
12	Reversed s	AT	P	Saved	P		
13	Reversed s	PT	P	Saved	P		
14	Reversed s	PT	P	Saved	P		
15	Reversed s	PT	P	Saved	O		
16	In situ saph	PT	P	Saved	P		
17	In situ saph	PT	P	Saved	P	F.foot	
18	In situ saph	PT	P	Saved	P	F.foot	
19	In situ saph	AT	P	Saved	P	T.amp	
20	In situ saph	AT	O	Amp	O		AKA
21	In situ saph	Dp	O	Amp	O		BKA
22	In situ saph	PT	P	Saved	O	T.amp	
23	In situ saph	TP	P	Saved	P		
24	In situ saph	TP	P	Saved	P		
25	In situ saph	DP	P	Saved	O		

Table (3): *Short by pass group (1B):*

No	*Graft used*	*Distal anastomosis*	*Run off*	*G. patency*	*Limb salvage*	*Minor amp*	*Major amp*	*A-V fistula*	*Miller cuff*
1	Saph	PT	Good	P	S			Used	
2	Saph	PT	Poor	P	S			Used	
3	Saph	AT	Poor	O	Amp		BKA	Used	
4	Saph	PT	Good	P	S	T.am		Used	
5	Saph	PT	Poor	P	S			Used	
6	Saph	PT	Poor	O°	Amp		BKA*	Used	
7	Saph	PT	Good	P	S	T.am		Used	
8	Saph	AT	Good	P	S	T.am		Used	
9	Saph	PT	Good	P	S	F.foot		Used	
10	saph	AT	Poor	O°	Amp		AKA*	Used	
11	PTFE	PT	Poor	O	Amp		BKA		Used
12	PTFE	PT	Good	P	S	T.am			Used
13	PTFE	PT	Good	P	S	F, foot			Used
14	PTFE	PT	Good	O	Amp		BKA		Used
15	PTFE	PT	Poor	O	amp		AKA		Used
16	PTFE	PT	Poor	P	S	T.am			Used
17	PTFE	PT	Good	P	S	F.foot			Used
18	PTFE	AT	Good	O	Amp		BKA		Used

***** Late amputation

° Early graft thronbectomy

Table (4): *Angioplasty group (2):*

No	*Lesion*	*Run off*	*Tech. Success*	*Improvement*	*Limb loss*	*Limb salvage*	*patency*	*Complication*
1	Stenosis	Good	Yes	Yes		+	+	No
2	Stenosis	Good	Yes	Yes		+	+	No
3	Occlusion	Good	No	No	AKA	_	_	Grion hema.
4	Stenosis	Good	Yes	Yes		+	+	No
5	Occlusion	Poor	No	No	BKA	_	_	Hematoma
6	Stenosis	Good	Yes	Yes		+	+	No
7	stenosis	Good	Yes	Yes		+	+	No
8	Stenosis	Poor	Yes	Yes		+	+	Hematoma
9	Occlusion	Poor	Yes	No	BKA*	_	_	Dissection
10	Stenosis	Poor	Yes	No		_	_	Dissection
11	Stenosis	Good	Yes	Yes		+	+	No

BKA*: Late empution.

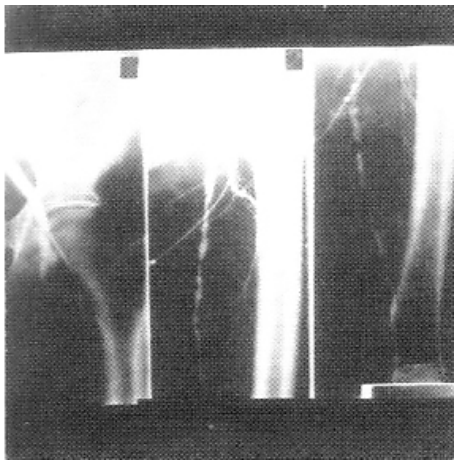

Fig. (1): Popliteal artery block with diseased atherosclerotic superficial femoral artery

Fig. (2): Popliteal artery occlusion with healthy and patent superficial femoral artery

Fig. (3): A: Arteriovenous fistula at the distal anastomosis. B: completion arteriography with filling of the peroneal artery through the posterior tibial artery and filling of the deep veins through the A_V fistula at the distal anastomosis.

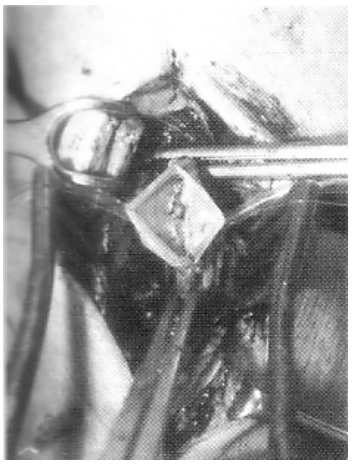

Fig. (4): Miller cuff is shown before graft anastomosis (PTFE) to a small sized posterior tibial artery

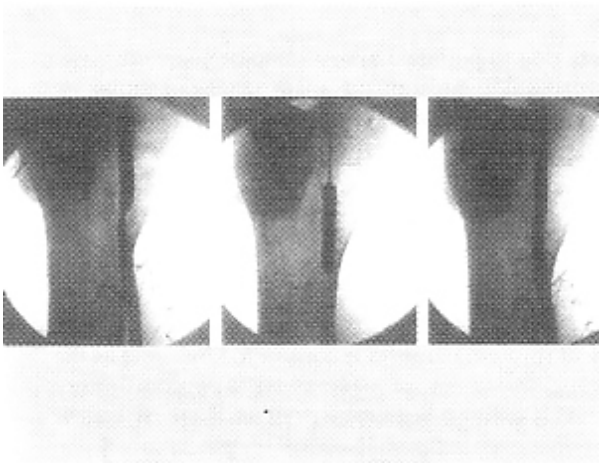

Fig. (5): A-Popliteal artery stenosis for patient with disabling claudications B-Popliteal angioplasty with 5 mm balloon catheter. C-End results in post-angioplasty angiogram

Fig. (6): Popliteal artery dissection as a complication of popliteal angioplasty

DISCUSSION

Atherosclerotic disease of the lower extremity remains a significant cause of limb ischemia. Popliteal artery steno-occlusive disease is responsible for limb loss in many cases. Popliteal artery occlusion and the disease process leading to it cause morbidity and mortality by decreasing or completely blocking blood supply to the lower leg and foot. Claudication usually is the first manifestation, followed by rest pain, and tissue loss. Once a portion of the foot becomes gangrenous, infection becomes a constant threat.

Both bypass procedures and PTA have allowed limb salvage in patients with advanced atherosclerosis despite the presence of multiple obstructions, long segment occlusion, poor distal run off, and gangrene [16]. PTA has been advocated as both an adjunct and an alternative to bypass surgery, which indicate its role in treating specific patient populations continues to evolve. The effect on leg and foot salvage of selecting bypass surgery or PTA as the initial procedure in patients with critical ischemia due to popliteal artery disease has not been determined.

This study focused specifically on patients with critical

leg ischemia due to popliteal artery steno-occlusive disease. It is a retrospective study of the cases managed either by bypass surgery or PTA for revascularization of the popliteal artery. It is important to note that the results of both modalities may be comparable but the consequences of failure are not equivalent. Evaluation of the outcome of each modality may determine the parameters that affect both the choice and the factors that affect the success or failure of each of them.

Surgical revascularization is considered by some as the gold standard treatment for patients with popliteal artery disease [17-18]. Common femoral artery is the best inflow artery for bypass procedures. However, popliteal artery can be used as an inflow if the superficial femoral artery is healthy or at least stenosed by less than 40% luminal reduction. Femoro-distal or popliteo-distal bypasses can be used for limb salvage according to the severity of the disease and the availability of the vein graft.

Femoro-distal bypass has been proved to be effective in limb salvage using either reversed or in situ saphenous vein graft. Previous studies revealed graft patency rate of 57% to 61% and limb salvage rate of 64%to 75% at 60 months. These results were better than our results of early and late graft patency of 80%, 40% and Limb salvage rate of 72% and 48% at 12 and 48 months respectively. In our study, the overall amputation rate was 48% in the form of major amputation 20% and minor amputation 28% compared to 36% amputation rate in other studies [1]. The latter results were explained by the fact that most of these patients had already toe or forefoot gangrene before operation. There was no difference using reversed or in situ saphenous vein graft as regard patency or limb salvage in this study.

On the other hand, short bypass has been proved to be a viable alternative for revascularization of the critically ischemic limbs. Our results showed 60% and 50% graft patency rate at 12 to 18 months respectively and limb salvage rate of 60% at 12 months. This was compared to other series of 80% and 74% graft patency at 12 and 24 months and limb salvage rate of 76% at one year [19]. The amputation rate was 28% as major amputation and 44% as minor amputations.

It seems that our results were inferior to that reported in literature. This might be explained by extensive atherosclerosis and calcifications of the tibial vessels and high incidence of foot infection in our patients population.

Adjunctive techniques to improve patency of the popletio-distal bypass as arteriovenous fistula or vein cuff has been suggested. Acceptable primary and late patency rates were obtained but the main value is to provide a technical solution to the difficulty in sewing a rather inelastic PTFE graft and tibial vessel and influence the location of intimal hyperplasia. Creation of distal arteriovenous fistula helps to maintain flow in the graft by the low resistance of the venous side [20]. In our study it made the procedure easier and gave a greater opportunity to reoperate when bypass failure occurred.

The new modality of percutanous angioplasty has opened a new era in the management of this group of patients. It has the advantage of noninvasive technique, low morbidity and mortality. Although the results are inferior to that of iliac artery angioplasty still there is a chance of getting good results in selected group of patients. Previous reports showed 69% and 46% patency at 1 and 24 months [21]. These results are comparable to our results of patency rate of 64% and 55% at 6 and 12 months. Technical success was reported as 83% to 93% in some series [22-23] compared to 82% in our study. From our patients data, expected high success and good clinical outcome can be obtained in cases with short stenotic segment, good run off and less severe foot lesion. High failure rate and complication of the procedure is expected in cases with total occlusion, long segment stenosis and poor run off vessels.

Comparing the results of the study groups we noticed that the immediate limb salvage could be obtained by both methods of revascularization. The long- term outcome was better with surgery than that by angioplasty. Factors affecting the outcome were nearly similar in both groups. The final decision of choosing the initial procedure to start with depends on many factors that are related to the patient, the lesion, and the efficiency of the treating surgeon. However, angioplasty is recommended in selected group of patients with high operative risk and special characters of the lesion and severity of atherosclerotic arterial disease.

Still we believe that surgery is the gold standard of treatment and angioplasty is resorted to in special types of lesion and when the operation carries a major risk to the patient survival. Moreover, in the near future, the number of surgical cases with critical ischemia due to popliteal artery disease will decrease as more cases will be managed by angioplasty. Increasing learning curve, technological development in catheters and balloons and long term follow up will determine which modality to start with for the best benefit of each patient.

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