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Percutaneous Angioplasty for Infrainguinal Graft-related Stenoses

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Objective: *To assess the success of percutaneous transluminal angioplasty (PTA) in treating infrainguinal graft-related stenoses.*
Design: *Retrospective analysis of stenoses undergoing PTA over 6 years.*
Materials: *Fifty-seven stenoses in 42 grafts.*
Methods: *Site, length and type of stenoses recorded. Follow-up till discharge, graft occlusion or death.*
Results: *PTA was successful in 48/57 stenoses in 36 grafts (G), with a poor result in seven. Further PTA was required in seven stenoses (7 G). One graft occluded at PTA and one stenosis was inaccessible. Overall graft (G) patency (median 13 months) was 82% (1 year patency 84%). Of 48 successful PTAs (37 G), 36 remained patent (28 G), eight (4 G) occluded and four were lost to follow-up (4 G). Fourteen of thirty-six stenoses which remained patent required further intervention (seven PTA, six jump grafts, one vein patch). The four occlusions were associated with small veins (two), multiple stenoses (one) and a PTFE graft which occluded 10 days following PTA. Of the seven PTAs with a poor angiographic result, five remained patent, three after further intervention.*
Conclusion: *PTA is the best treatment for localised stenoses. Stenoses >2 cm or multiple (three or more) stenoses are best treated surgically. Follow-up is essential, as 20% require further intervention.*

Key Words: Angioplasty, Graft stenosis, Graft surveillance.

Introduction

Femoropopliteal and femorodistal bypass procedures are associated with failure rates of 20–75% at 5 years.[1] Thrombosis during the first postoperative month is due to errors of judgement or technique, or to a high peripheral resistance associated with poor run-off.[2] From 1 month to 2 years stenoses develop in 20–30% of vein grafts.[3,4] The reason for such stenoses is unknown. The pathology is intimal hyperplasia, but there is no relationship to sites of venous tributaries, valve cusps or clamp sites.[5] The presence of a macrophage or lymphocyte infiltrate and subendothelial smooth muscle cells in the pre-bypass vein may, however, be associated with subsequent graft stenoses.[1] When graft stenoses have been identified, surgical intervention has been reported to increase the secondary patency from 35–85%.[6] A recent randomised prospective trial has shown that regular graft surveillance improves patency rates with vein but not prosthetic femoropopliteal/crural grafts.[7]

The role of percutaneous transluminal angioplasty (PTA) is not well defined. Some have suggested that PTA has an important role in the primary treatment of vein graft stenoses,[3,8] while others consider that the long-term results of PTA are not good and recommend surgical treatment for such lesions.[6] It has been suggested that long stenoses (more than 2 cm) should be treated surgically, with the remainder undergoing PTA.[3]

Reported experience to date mainly deals with vein graft stenoses. There is almost no information on stenoses occurring in association with prosthetic grafts. The aim of this retrospective study was to assess the outcome of both vein and prosthetic graft-related stenoses submitted to PTA.

Patients and Methods

Information on all patients referred to a single radiology department with graft-related stenosis involving an infrainguinal graft was collated between September 1987 and June 1993. The patients were, with two exceptions, from two hospitals (Guys 22,

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Newham General 18) and one radiologist (JR) was involved in all the angioplasties. During the latter part of this period a graft surveillance programme was in operation, using continuous wave Doppler assessment (Quickscan – reference 9) of the whole graft and peri-anastomotic regions. All except six patients in the study were, however, picked up before the Quickscan became available, on the basis of symptoms and decreased calf/brachial indices when seen in outpatients. The graft stenosis was then diagnosed at intra-arterial digital subtraction angiography (IADSA).

Whenever possible, an ipsilateral antegrade femoral approach was used for angioplasty access. When this was not possible (e.g. proximal lesion, high graft origin) a contralateral femoral approach, brachial approach or occasionally direct graft puncture was used. In most instances a high pressure balloon (10–12 atmospheres) was used with several inflations, as graft stenoses are generally more resistant to dilatation than native vessel stenoses.

The site, length and type of stenoses arising in both vein and PTFE grafts were recorded. An anastomotic stenosis was defined as any stenosis of the graft or native vessel within 2 cm of graft insertion. The technique and results of the angioplasties were assessed, and follow-up was until discharge from the clinic, irretrievable graft occlusion or known death of the patient. In the first part of the study period ankle/brachial pressure indices were measured in the clinic. Subsequently, grafts were assessed by Quickscan at the time of outpatient clinic attendance. In both cases angiography was performed as indicated by patients' symptoms, ankle/brachial pressure indices or a stenosis shown on Quickscan. A successful angioplasty result is defined as when full inflation of the balloon occurs without wasting and when the post-PTA study showed unequivocal improvement with less than 30% residual stenosis.

Results

Angioplasty was attempted for 57 stenoses in 43 infrainguinal grafts (42 patients) between September 1987 and June 1993, with 56 stenoses in 42 grafts being dilated. Of the 42 grafts, 34 were vein and eight PTFE. Twenty-one of the stenoses were in the body of the graft (B) and 35 in the anastomotic regions (A). Thirty-one of the stenoses (B 14, A 17) were associated with grafts performed in the preceding 12 months, nine stenoses (B three, A six) between 12 and 24 months previously, and 16 stenoses (B four, A 12) with grafts operated on more than 2 years previously. Two out of the four graft body stenoses more than 2 years following surgery were in PTFE grafts.

Fifty-six angioplasty procedures were performed on the 43 grafts. The approaches were femoral antegrade (31), crossover femoral (14), brachial (six) and direct graft puncture (five).

Follow-up data was obtained in 52/56 (93%) stenoses (38 grafts) for a median time of 13 months (range 0.5–48 months). Four patients (four stenoses) were lost to follow-up. The 1-year graft patency was 84% (27 out of 32 grafts) and the overall graft patency at follow-up 82% (31 out of 38 grafts). Six grafts had occluded irretrievably (three V, three PTFE) and one patient had undergone an amputation for venous ulceration despite a functioning graft.

Table 1. Graft-related angioplasty – technical results in 57 stenoses.

Successful	48
Residual wasting/stenosis	7
Occlusion	1
Stenosis inaccessible	1

Table 2. Graft-related angioplasty – clinical outcome of 48 "successful" angioplasties (36 grafts).

Patent	36	No further intervention	27
		Further PTA*	6
		Jump grafts*	4
Occlusion	8	Grafts	4
Lost to follow-up	4		

* One patient had both PTA and jump graft.

Table 3. Graft-related angioplasty – outcome of seven angioplasties with poor technical result ($n = 7$ grafts).

Patent			
Further intervention	3	Vein patch angioplasty	1
		Jump graft (6 months later)	1
		Further PTA (35 months later)	1
No intervention	2		
Occlusion	2	(10 and 12 months later)	

Technical results (Tables 1–3)

A successful angioplasty was achieved in 48 stenoses. In seven, residual wasting of the balloon and/or significant residual stenosis was present on the post-angioplasty films. One PTFE graft occluded at PTA, requiring thrombectomy.

Table 2 shows the outcome of "successful" PTAs ($n = 48$). Thirty-six of the stenoses at follow-up were patent and associated with functioning grafts. Six of these had undergone further angioplasty procedures, and four had required jump grafts. Eight stenoses in

Table 4. Graft-related angioplasty – location and types of stenoses ($n=56$ in 42 grafts).

	Graft body stenoses			Anastomotic stenoses		
Vein	18	Long	5	28	Proximal	12
		Short			Distal	16
		web	2			
		tubular	11			
PTFE	3			7	Proximal	2
					Distal	5

four grafts had occluded irretrievably (three vein, one PTFE). Of the three vein grafts, two were of generally poor calibre and one had four stenoses.

Table 3 shows the outcome when the angioplasty result was considered technically poor ($n=7$). At follow-up, five stenoses were associated with patent grafts (5 G). In two, this was achieved without further intervention. Surgical procedures had been required in two and one stenosis had undergone further PTA 35 months later. The other two grafts had occluded: a vein graft with four stenoses and one PTFE graft.

Results related to types of graft stenosis (Table 4)

There were 21 graft body (B) and 35 anastomotic (A) stenoses. Of the 21 graft body stenoses, 18 were in vein and three in PTFE grafts.

Vein grafts. There were five long stenoses (Fig. 1) in five grafts. Although PTA was apparently successful in two, all five subsequently occluded or required surgery.

Two vein grafts had web stenoses (Fig. 2) and nine (11 stenoses) short localised stenoses (Figs 3 and 4). These stenoses responded well to PTA, and nine out of 11 grafts were patent at median follow-up of 15 months, with a second PTA being required in only two cases. The graft occlusions which did occur (two) were due to an associated unsuccessful PTA (one graft), and a poor calibre vein (one graft).

There were 28 anastomotic stenoses in 27 vein grafts. These responded well to PTA, with 24 grafts (86%) being patent at follow-up. The three occlusions which occurred were two veins of generally poor calibre and the one with four stenoses.

PTFE grafts. There were 10 stenoses in eight PTFE grafts – three in the graft body and seven in the anastomotic regions.

Three grafts occluded – at the time of PTA, at 10 days post-PTA and 12 months later. All three had graft body stenoses. One of these graft body stenoses was not dilated but was associated with PTA of an anastomotic stenosis.

Fig. 1. Long stenosis in a below knee femoropopliteal reversed vein graft. Following PTA rapid restenosis occurred and a jump graft was performed.

Three grafts with anastomotic stenoses remained patent 4, 13 and 21 months later.

One limb was amputated 12 months later for venous ulceration after dilatation of an anastomotic stenosis. The graft was patent at the time of amputation.

One was lost to follow-up.

Grafts with multiple stenoses n = 8 *(G).* Three grafts had occluded: two poor quality veins with multiple

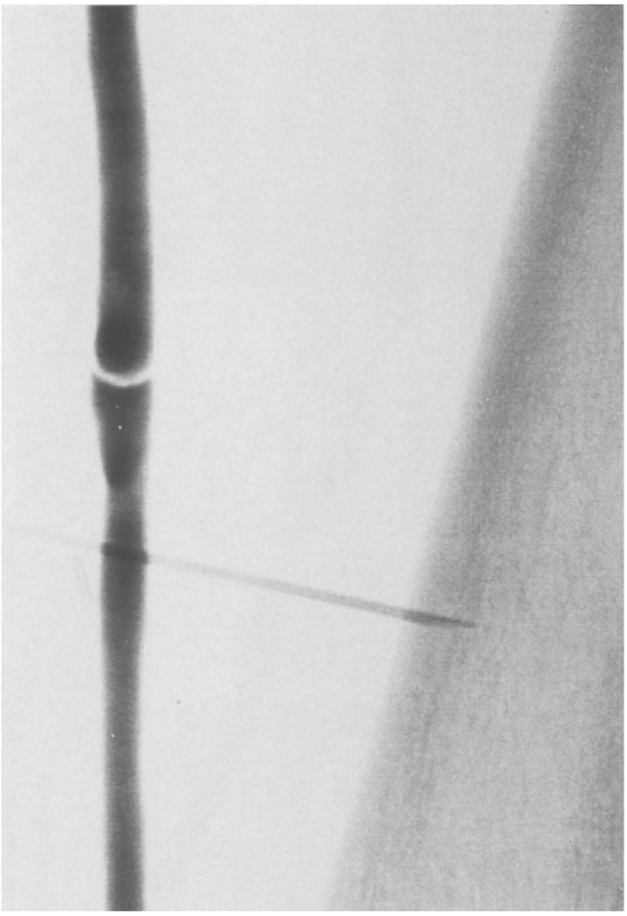

Fig. 2. Short web stenosis – successful PTA was performed.

Fig. 3. Short tubular stenosis.

stenoses and a PTFE graft with two stenoses. Five grafts, each with two stenoses, remained patent at median follow-up of 11 months. In one of these a jump graft had been performed.

Surgical intervention

Adjunctive surgery to maintain patency was required in six cases: three jump grafts and one vein patch angioplasty were performed for long stenoses with technically poor results at PTA. Two further jump grafts were performed for native vessel disease adjacent to the anastomosis, one the proximal and one the distal anastomosis.

Discussion

The results of this study are comparable with others[3] and both vein and some PTFE graft stenoses appear to benefit from PTA with an overall good outcome. Only one stenosis was inaccessible in this series, and the only significant complication was one PTFE graft occlusion occurring at the time of PTA of a mid-graft stenosis.

One has to question whether the graft angioplasties were all necessary, and whether the stenoses which were treated would have progressed to cause graft occlusion in all or most cases. The only way to answer this would be a controlled clinical trial, randomising grafts with stenoses to either PTA or observation only. In view of the known natural history of graft stenoses, which are associated with a three-fold increased risk of graft occlusion,[10] the results of retrospective comparisons suggesting very much higher secondary patency rates in stenotic grafts in which intervention has been performed,[11] and the authors' previous experience when stenoses which were treated too late were associated with graft occlusion,[12] this would appear unethical.

It is clear that some graft-related stenoses are not suitable for PTA. These are: grafts with three or more stenoses; stenoses longer than 2 cm; mid-graft stenoses in PTFE grafts.

Fig. 4. Successful PTA of the stenosis shown in Fig. 3.

Fig. 5. Anastomotic stenosis at the lower end of a PTFE graft.

The presence of three or more stenoses in a graft is most likely an indicator of poor quality vein, and surgical revision is usually more appropriate than PTA. Long stenoses >2 cm in length did badly with PTA in this series, and this is in agreement with the results of other groups.[10,11] Surgery is indicated for these stenoses.

The aetiology of mid-graft stenoses in PTFE grafts is unclear. There were five in this series, and all were situated in close proximity to the knee joint. This suggests that repeated flexing of the knee may damage the graft pseudointima, with resulting local thrombus formation. The right treatment of these stenoses is also unclear. One of the stenoses was left alone and was associated with graft occlusion 10 days later. The other four stenoses (three grafts) occluded at the time of and at 2 and 12 months following PTA. It would appear likely that these lesions are a precursor of PTFE graft occlusion and some form of treatment would therefore appear indicated. Local thrombolysis has recently been suggested,[13] but for this to be effective an adequate concentration has to be maintained locally for a sufficient time, and this is difficult with a patent graft. By contrast, a recent similar PTFE graft stenosis in our experience disappeared spontaneously, which suggests that dissolution of local thrombus may occur in some cases.

There remains controversy over whether the primary treatment of vein graft stenoses should be PTA or surgery. The proponents of surgery point to the higher recurrence and failure rates of stenoses treated by PTA, with combined rates of 33–50% being reported.[9] Although these figures would appear too high, it is likely that there is indeed a higher recurrence rate of stenosis following PTA when compared to surgery. However, PTA is easily repeatable and well tolerated by the patient when repeated on several occasions. In the study by London *et al.* a single PTA was effective in 70% and two PTAs in 85% stenoses.[3] In our study, if the long stenoses, grafts with three or more stenoses

Fig. 6. The lower anastomosis of the graft shown in Fig. 5 3 months after PTA.

and PTFE graft body stenoses are excluded from analysis, a single PTA would have been effective in 76% (31/41 stenoses), with further PTAs increasing this patency to 90% (37/41 stenoses). Only two graft occlusions occurred in this group; one vein which was reported to be of poor calibre, and one PTFE graft; and only two surgical interventions were required in these grafts. This data would suggest that PTAs should be the initial treatment of short graft and anastomotic stenoses, with surgery being used as the primary treatment of long and multiple stenoses.

There is a need for close surveillance of grafts following PTA of graft-related stenoses, especially if a poor technical result has been achieved. Fourteen further procedures (six surgical, eight further PTA) were indicated following PTA and all were associated with patent grafts at follow-up a median of 21 months later.

Most centres with a graft surveillance policy advocate regular surveillance of vein but not PTFE grafts. The results of PTA for anastomotic stenoses in PTFE grafts would suggest that the anastomotic regions of these grafts should be surveyed so that intervention can be planned prior to thrombosis occurring. The numbers are, however, too small to draw any firm conclusions.

With four exceptions, all the vein graft stenoses occurring more than 1 year following surgery were anastomotic in nature. These late stenoses presented as a result of symptoms and were not detected by a graft surveillance programme. Because of this, no conclusions regarding the duration of a graft surveillance programme can be drawn. These data would suggest, however, that some grafts will be threatened by anastomotic stenoses indefinitely following surgery and may benefit from PTA. Further studies are needed to investigate this.

We conclude that PTA should be the first line treatment for graft-related stenoses in vein grafts and for anastomotic stenoses in PTFE grafts. Close surveillance of all grafts following the initial PTA is important, as 20% will require further intervention. Intervention while the graft is still patent, though haemodynamically compromised, will maximise the primary assisted and secondary graft patency rates.

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