Distal Percutaneous Transluminal Angioplasty Through Infrainguinal Bypass Grafts

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Aim: to evaluate the results of transluminal angioplasty (PTA) performed through infrainguinal bypass grafts for stenotic or occlusive lesions at the distal anastomosis and/or in the runoff arteries.

Design: retrospective clinical study.

Material and methods: forty-one patients underwent 57 procedures at the distal anastomosis (n=13), in the runoff arteries (n=32) or at both locations (n=12) at a median of 9.6 months (range, 2–76 months) after infrainguinal bypass grafting. Nineteen procedures were on the popliteal artery, the rest on the crural arteries. Eleven procedures related to occlusions less than 5 cm in length.

Results: technical success was achieved in 91%. Primary and primary assisted graft patency rates at 3 years were 32% and 53%, respectively. There were no significant differences in patency rates with regard to the graft material, the type of lesion, the level of PTA, the status of runoff and the use of thrombolysis before PTA. No patients underwent amputation as a direct consequence of failed PTA or graft occlusion. One patient underwent acute surgical intervention due to graft occlusion at the time of attempted PTA.

Conclusion: the results of PTA at the distal anastomosis and/or in the runoff arteries in limbs with infrainguinal bypass seemed to be inferior to the results of surgical revisions reported in literature. However, as failed PTA did not jeopardise vein-patch angioplasty or jump grafting, it is a reasonable alternative to surgical intervention in selected cases.

Key Words: PTA; Infrainguinal bypass; Runoff; Distal anastomosis.

Introduction

Infrainguinal bypass grafting remains the most established procedure for treatment of atherosclerotic disease of the femoropopliteal and crural arteries, especially in limbs with critical limb ischaemia (CLI). However, occlusion of bypass reconstruction continues to occur and might lead to limb loss in a substantial number of patients. Inflow, graft or runoff related lesions are responsible for the majority of failures occurring beyond the initial 30 day period. Localised lesions in the iliac arteries are usually managed with endovascular intervention while the choice of intervention for graft stenoses is still controversial. Lesions affecting the distal anastomosis or runoff arteries can be successfully treated with vein patch angioplasty or a jump graft to the crural arteries; but this can be technically demanding. Percutaneous transluminal angioplasty (PTA) is mainly used for the treatment of vein graft stenosis. There is little information on the use of PTA as an alternative to surgery. The aim of the present study was to assess the feasibility and the results of PTA performed through infrainguinal bypass grafts for treatment of stenotic or occlusive lesions at the site of distal anastomosis and/or in the runoff vessels.

Material and Methods

Patients

Between June 1992 and January 2000, the records of 41 patients undergoing 57 PTA procedures performed through femoropopliteal or femorocrural bypass (a total of 46 grafts, five patients with bilateral infrainguinal bypass) due to stenosis or occlusion at the site of distal anastomosis and/or in the runoff arteries were retrospectively studied. Patient characteristics are shown in Table 1. Infrainguinal grafts with stenoses at the proximal anastomoses or in the graft (including PTFE-vein anastomosis stenosis) without associated distal lesions undergoing PTA were excluded as were
those receiving intra-arterial thrombolytic therapy for graft occlusion without additional PTA. Grafts with combined proximal and distal lesions as well as patients receiving thrombolysis followed by PTA at the distal anastomosis or in the runoff vessels were included. Distal anastomotic stenosis was defined as a stenosis of the graft or native artery within 2 cm of graft insertion (Fig. 1). More distal stenosis or occlusion in the recipient artery or crural vessels was defined as runoff lesion (Figs 2 and 3).

The median (range) duration from the initial bypass grafting to the PTA procedure was 9.6 (2–76 months). The indications for intervention at the time of bypass grafting were rest pain in 36 and ulcer or gangrene in 10 limbs. Thirty limbs had CLI according to SVS/ICSVS reporting standards while 16 limbs had either falsely elevated ankle pressures or ankle brachial pressure index (ABPI) <0.5 but ankle pressures over 40 mmHg.¹ The latter group was considered as having subcritical ischaemia.¹⁴ In 24 limbs, the distal anastomosis was onto the popliteal artery (12 cases below the knee level) and in the remaining 22 cases, onto the crural arteries. The graft material was saphenous vein in 33, composite polytetrafluoroethylene (PTFE)-vein in four and PTFE in nine limbs.

Infrainguinal bypass grafts with totally or partially vein conduits were followed by routine clinical examination, ankle brachial pressure index meas-
after the initial 6 month period following surgery. PTA was also the choice of initial treatment for stenoses or occlusions <5 cm in length in the runoff arteries. In cases where PTA was considered unsuitable due to extensive crural artery changes, femorodistal jump bypass grafting was the choice of treatment if technically feasible (presence of a patent distal vessel). During the same period, 35 redo surgery were performed for treatment of distal anastomotic or runoff lesions (16 vein patch at the distal anastomosis and 19 jump grafts).

The patients were selected for endovascular intervention with the findings obtained from duplex scanning. Peak systolic velocity (PSV) ratio >3 was the indication for intervention in grafts with stenosis.15 The following duplex criteria were used for definition of grafts at risk of occlusion in limbs with runoff lesions: PSV in the graft <45 cm/s irrespective of symptoms and/or decrease in ABPI measurements greater than the initial 6 month period following surgery. PTA was also the choice of initial treatment for stenoses or occlusions <5 cm in length in the runoff arteries. In cases where PTA was considered unsuitable due to extensive crural artery changes, femorodistal jump bypass grafting was the choice of treatment if technically feasible (presence of a patent distal vessel). During the same period, 35 redo surgery were performed for treatment of distal anastomotic or runoff lesions (16 vein patch at the distal anastomosis and 19 jump grafts).

There were no strict guidelines for selection of treatment modality in limbs with infrainguinal graft lesions. However, PTA was the treatment of choice for localised stenotic lesions (less than 2 cm in length) in the graft and/or at the distal anastomosis detected after the initial 6 month period following surgery. PTA was also the choice of initial treatment for stenoses or occlusions <5 cm in length in the runoff arteries. In cases where PTA was considered unsuitable due to extensive crural artery changes, femorodistal jump bypass grafting was the choice of treatment if technically feasible (presence of a patent distal vessel). During the same period, 35 redo surgery were performed for treatment of distal anastomotic or runoff lesions (16 vein patch at the distal anastomosis and 19 jump grafts).

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balloon diameter ranging from 2.5 to 5 mm were used. Prophylaxis against vasospasm was not routinely used but when it occurred, 200 μg nitroglycerin was injected in the graft or in the runoff arteries. For recanalisation of total occlusions a low friction 0.035 inch guide wire was used (Terumo Co., Japan). Immediate post-angioplasty angiograms were obtained in all cases. Technical success was defined as PTA resulting in less than 50% residual stenosis after dilatation. Intra-arterial heparin (5000 units) was injected before crossing the lesion. The patients received low molecular heparin (enoxaparin 40 mg/s) 4–6 h after procedure and were put on life-time antiplatelet (acetylsalicyclic acid/160 mg daily) treatment.

Thirteen procedures were performed only at the distal anastomosis, 12 at the distal anastomosis combined

Fig. 3. (a) Angiography showing a patent femorotibial in situ vein bypass 16 months after insertion in a 58-year-old male with end-stage renal disease and severe rest pain. (b) Multiple lesions in the recipient artery were successfully dilated. The patient had a patent graft after 12 months and still had intermittent rest pain.

than 0.15 combined with rest pain or ulcer. At the time of PTA procedures, 26 limbs were symptom free, four had claudication, 23 had rest pain and four had ulcers. The median (range) ABPI was 0.42 (0.2–0.8) in 42 limbs without falsely elevated ankle pressures.

Techniques of angiography and PTA

In 40 procedures PTA was performed with a crossover technique from the contralateral side in order to avoid post-PTA compression of the graft. Antegrade puncture of the femoral artery was used in 17 procedures where pre-PTA duplex scanning showed patent iliac arteries without significant stenoses and where the proximal anastomosis of the graft was not in conflict with the puncture site. Catheterisation was made through a 6–8 F introducer. Balloons with a shaft size of 5 or 6 F (Schneider-Europe AG, Zurich, Switzerland) and a balloon diameter ranging from 2.5 to 5 mm were used. Prophylaxis against vasospasm was not routinely used but when it occurred, 200 μg nitroglycerin was injected in the graft or in the runoff arteries. For recanalisation of total occlusions a low friction 0.035 inch guide wire was used (Terumo Co., Japan). Immediate post-angioplasty angiograms were obtained in all cases. Technical success was defined as PTA resulting in less than 50% residual stenosis after dilatation. Intra-arterial heparin (5000 units) was injected before crossing the lesion. The patients received low molecular heparin (enoxaparin 40 mg/s) 4–6 h after procedure and were put on life-time antiplatelet (acetylsalicyclic acid/160 mg daily) treatment.

Level of PTA

Thirteen procedures were performed only at the distal anastomosis, 12 at the distal anastomosis combined
with runoff arteries and 32 in the runoff arteries. No attempts were made to recanalise more than 5 cm long occlusions. In 11 patients with graft occlusion, PTA of the distal anastomosis (n = 2), runoff arteries (n = 7) or both (n = 2) were performed following successful thrombolysis (t-pA with doses ranging from 0.2–0.5 mg/h and a total dose of 10–20 mg). In 12 patients additional PTA in the body of the graft or at the proximal anastomosis were performed following a distal procedure during the same session. The level of PTA and the type of lesions are shown in Table 2.

### Definition of runoff

The concept of angiographic runoff classification has been described in detail previously. In summary, good runoff was defined as patency of two or three lower leg arteries to the foot, or one patent vessel continuous with an intact anterior or posterior pedal arch in femoropopliteal and proximal femorodistal bypasses, and integrity of both arches in low femorodistal bypasses where the distal anastomosis was placed at midcalf or at ankle level. All other angiographic flow patterns were considered as poor.

### Follow-up

The patients were followed with clinical examination, ankle-brachial pressure index (ABPI) measurements and duplex scanning according to the above mentioned surveillance program. Life-tables for patency rates were constructed by the actuarial method according to SVS/ICSVS reporting standards. All the patency rates were calculated from the time of PTA, not from the time of original graft insertion. Primary patency was defined as uninterrupted duplex scan verified patency with no additional endovascular or surgical procedures performed on the graft or its anastomoses. Primary assisted patency was defined as uninterrupted patency but allowed endovascular procedures to be performed on a patent bypass.

### Results

#### Immediate technical success rate

A technically successful PTA was achieved in 52 procedures (91%). In two cases with acute femorodistal graft occlusion (both PTFE grafts with distal vein cuff) following successful thrombolysis, the stenoses at the distal anastomosis could not be successfully re-canalised. Both patients underwent surgical revision with vein patch angioplasty. One of these patients died 4 months after surgery with patent graft and the other underwent amputation after graft occlusion at 3 months. In one patient with femoropopliteal vein graft and poor distal runoff, PTA of multiple short stenoses in the proximal anterior tibial and peroneal arteries failed. This patient underwent amputation with patent graft after 1 month. In the fourth patient with femoropopliteal vein bypass and poor distal runoff the graft occluded following PTA attempt at the distal anastomosis. Following urgent graft thrombectomy and patch angioplasty, the graft occluded after 2 months and the patient underwent amputation after 28 months. In the fifth patient with femoropopliteal vein bypass, there was a residual stenosis greater than 50% after PTA at the distal anastomotic site. The graft was patent at 26 months with duplex verified distal stenosis and the patient had moderate claudication.

#### Early complications (within 30 days)

There was no mortality during the initial 30 day period. In five cases, insignificant haematoma was observed at the puncture site, i.e. did not require surgical intervention or blood transfusion. Only in one patient PTA attempt at the distal anastomosis resulted in graft occlusion and this patient underwent urgent graft thrombectomy and patch angioplasty as mentioned above.

#### Patency and limb salvage

The median (range) ABPI measurements increased from 0.42 (0.2–0.8) to 0.53 (0.3–1) following technically successful PTA. Overall primary patency following

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Table 2. Level of PTA and type of lesions.

<table>
<thead>
<tr>
<th>Site of PTA (artery)</th>
<th>Type of lesion</th>
<th>Patency (n = 46)</th>
<th>Occlusion (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Popliteal</td>
<td>Stenosis</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>Tibioperoneal trunk</td>
<td>Stenosis</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Peroneal</td>
<td>Stenosis</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Posterior tibial</td>
<td>Stenosis</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Anterior tibial</td>
<td>Stenosis</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Dorsal pedal</td>
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PTA and one jump graft). The median (range) interval from the time of initial PTA to amputation was 5 (1–23) months.

Discussion

There are no universally accepted guidelines for detection and management of inflow, graft or runoff related problems. Atherosclerotic disease affecting the inflow arteries are usually managed with endovascular intervention as the results of iliac artery PTA are satisfactory. The choice of treatment between endovascular or surgical intervention with regard to intrinsic lesions located in the graft itself depends on the time interval after surgery and the policy of the centre. The durability of PTA for treatment of vein graft stenoses has been questioned by some authors, yet others have reported patency rates of more than 80%. 

Sanchez et al. reviewed 95 cases of vein graft and anastomotic lesions treated with PTA. They did not use strict selection criteria for selection of treatment modality. The 21 month patency rate for the surgically treated group (86%) was significantly better than the 42% patency rate for all lesions treated with PTA. There were no PTAs performed for treatment of runoff lesions. The early patency rates (6 months) of proximal anastomotic, mid-graft and distal anastomotic lesions were comparable. Simple lesions had a significantly better patency rate at 24 months (66%) compared with that of complex lesions (17%). Complex lesions were defined as multiple, recurrent, >1.5 cm in length, or within grafts that had a <3 mm minimal diameter.

Lesions affecting the distal anastomoses or the runoff vessels that jeopardize the graft patency can be successfully managed by surgical intervention. Long-term assisted graft patency in excess of 80% have been reported following vein patch angioplasty or jump grafting. However, these procedures are more technically demanding than the surgical management of more proximal lesions and many of these patients, do not have suitable vein conduits. Endovascular interventions might be an alternative in these cases and that was the reason for separate analysis of results of distal PTA through infrainguinal bypass grafts in the present study. Previously, few studies with a limited number of patients have been reported on the use of PTA in the runoff arteries, following infrainguinal bypass grafting. In these studies, the results of runoff PTA were difficult to interpret as the series included graft lesions at other locations and separate analyses were not performed. We have previously analyzed...
reported a high technical success rate of crural artery PTA in patients with severe lower limb ischaemia. Although the secondary cumulative patency rate at 3 years was only 44%, we suggested that crural artery PTA might be an alternative to surgical intervention in selected patients with localised lesions. The complication rate necessitating amputation directly related to the procedure was very low. Failed PTA did not alter the possibility of performing bypass grafting.

The results of the present study demonstrated a high technical success rate (91%) and no major complications directly related to the procedure. Graft occlusion related to the PTA procedure occurred only in one patient in whom graft thrombectomy and patch angioplasty resulted in early success. The primary patency rates following PTA at 12 and 36 months were 41% and 32%, respectively. Sixteen additional PTA procedures were required due to restenosis or re-occlusion at the PTA sites in order to achieve 53% primary assisted patency at 3 years.

Duplex scanning plays an important role in detection of these lesions and surveillance is strongly recommended. Analysis of several anatomical factors such as the site of PTA, the type of lesion, the status of runoff, the presence of diabetes and the use of thrombolysis before PTA in occluded grafts did not show a subgroup with significantly lower patency rates. However, as the numbers in each group are limited, no clear conclusions can be made. Early or late failures of PTA did not negatively affect the possibility of performing bypass surgery.

In conclusion, PTA at the distal anastomotic site or runoff arteries following infrainguinal bypass grafting is technically feasible and offers satisfactory but inferior results compared to surgical revisions reported in literature. As the complications with regard to technical failures did not affect the possibility of performing surgical intervention, PTA might be considered as an alternative in a selected group with suitable lesions. Multiple factors should be taken into consideration when deciding on the treatment modality, including surgical risk, the absence of vein conduits, the type of lesions and the time interval between initial surgery and the detection of lesions. The guidelines for surveillance after infrainguinal bypass grafting and indications for intervention in patients with asymptomatic atherosclerotic lesions in the runoff arteries are still controversial and larger series with longer follow-up are needed.

Acknowledgement

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References

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