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Early Vein Bypass Thrombectomy is Associated with an Increased Risk of Graft Related Stenoses

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Objectives: *To assess the risk of graft stenoses following early thrombectomy of peripheral vein bypasses.*
Design: *Prospective study of 371 vein bypasses performed at the Vascular Service, Rigshospitalet, Copenhagen from January 1991 through December 1992.*
Materials and methods: *Thirty-six vein bypasses reopened by thrombectomy within 30 days postoperatively (group I) and 335 bypasses not subjected to early thrombectomy (group II) were studied by ultrasound duplex scanning 3, 6, 9, 12, 18, 24, 36 and 48 months postoperatively. A localised increase in the peak systolic velocity of 250% or more was considered an indicator for significant stenosis.*
Results: *In the perioperative period nine (2%) patients died, 30 (8%) bypasses occluded and 14 (4%) patients were lost to follow-up. Among the 318 patients remaining at risk at 1 month graft stenoses were identified in 39% (9/23) in group I compared to 17% (51/295) in group II, p = 0.03. Late bypass revisions were required in 35% (8/23) in group I as opposed to 9% (28/295) in group II, p = 0.004. Despite this high number of revisional procedures the 12-months secondary bypass patency was lower in recanalised grafts (38% vs. 82%, p < 0.00001).*
Conclusion: *Early vein bypass thrombectomy is associated with a two-fold increased risk of graft related stenoses and a reduced secondary bypass patency.*

Key Words: Saphenous; Vein transplantation; Graft occlusion; Vascular; Ultrasonography; Doppler; Duplex

Introduction

Bypass using autogenous saphenous vein is the preferred method for below-knee arterial reconstruction.[1–3] Graft stenoses occur in 20–30%[4–6] of infrainguinal vein bypasses and remain a major cause of reconstruction failure within the first 1–2 years following surgery.[5,7] Intensive duplex surveillance followed by elective revision of failing but patent grafts has in a recent randomised study been shown to improve bypass patency by 26%.[8]

Though the aetiology of stenoses is largely unknown, perioperative injury of the saphenous vein is assumed to be of major significance.[7,9] In arteries, balloon catheter thrombectomy may lead to diffuse luminal narrowing.[10] We therefore found it of interest to assess whether thrombectomy of vein grafts in the early postoperative period is associated with an increased risk of stenoses and late bypass failure.

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Materials and Methods

In the 2 year period from January 1991 to December 1992 a total of 371 patients underwent infrainguinal vein bypass surgery at the Vascular Service, Rigshospitalet, Copenhagen. The median age of these 228 males and 143 females was 69 (range 36–92) years. The indication for surgery was life style disabling claudication in 38 (10%), rest pain in 139 (37%) and ischaemic ulcerations or gangrene in 194 (52%). Forty-one bypasses (11%) were reversed vein grafts, while 330 (89%) were *in situ* vein grafts. The level of the distal anastomosis was the above-knee popliteal artery in 48 (13%), the below-knee popliteal artery in 114 (31%) and a crural or pedal artery in 209 (56%). Preoperative evaluation included diagnostic arteriography and ultrasound duplex mapping of the greater saphenous vein. Vein size was considered adequate when the internal diameter was ≥ 2 mm. The surgical technique was similar to that described by Burnand and Browse[11] and Leather *et al.*[1] for reversed and *in situ* vein bypasses respectively. The reconstructions were routinely assessed with intraoperative continuous wave (CW) ultrasound Doppler. Completion

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angiography was performed when the ultrasound examination indicated a technical error. For thrombosis prophylaxis intravenous heparin 50 i.e./kg bodyweight was given prior to clamping. Postoperatively the patients received subcutaneous heparin until mobilisation and aspirin 500 mg/day thereafter.

Early bypass thrombectomy was performed in 36 (10%) patients with bypasses which thrombosed within 30 days after surgery (group I). In 19 of these, possible causes of bypass failure were identified and corrected simultaneously. Thrombectomy alone was used in 15 patients in whom no apparent cause of failure was identified and in two with incorrectable lesions located in run-off vessels. Among the 335 patients not subjected to early thrombectomy (group II) five revisions (fistula ligation (2), valvulotomy (2) and anastomosis revision (1)) of haemodynamically failing but patent grafts were performed in the perioperative period.

After discharge the patients entered a surveillance protocol consisting of ultrasound duplex examination and ankle blood pressure measurements 3,6,9,12,18,24,36,48 and 60 months postoperatively. A localised increase in the peak systolic velocity of more than 250% was considered an indicator for significant stenosis.[12,13] In patients with no contraindications for reintervention significant stenosis associated with an interval reduction of ankle brachial index exceeding 0.2 were revised.

Statistics

Proportions among two groups were compared by Fischer's exact test. Bypass patency rates were calculated by the life-table method and compared by Log-rank test. A confidence limit of less than 5% was regarded as significant.

Results

Group I (Bypass thrombectomy within 30 days) (n = *36)*

Of the 36 patients subjected to early bypass thrombectomy one (3%) died in the perioperative period. Twelve (33%) bypasses reoccluded within 1 month of the primary bypass operation and repeated thrombectomy was considered futile (Fig. 1).

Among the 23 patients remaining at risk at 1 month, graft stenoses occurred in nine (39%). The median time interval from surgery to stenosis detection was 8 months (range 3–19). Three stenoses were juxta-anastomotic whereas six lesions were located in the body of the graft (Table 1). In eight (35%) of the 23 patients graft stenoses were treated by surgical revision (n = 7) or percutaneous transluminal angioplasty (PTA) (n = 1). One recurrent stenosis following PTA was corrected surgically.

The secondary 12 months bypass patency rate for all 36 thrombectomised patients was 38% (Fig. 1). Considering only the 23 patients remaining at risk at 1 month the 12 months bypass patency was 57%. Re-occlusion after thrombectomy was not significantly related to age, diabetes, hypertension, smoking, inflow artery disease, number of patent run-off arteries or whether contributary causes of bypass failure were corrected.

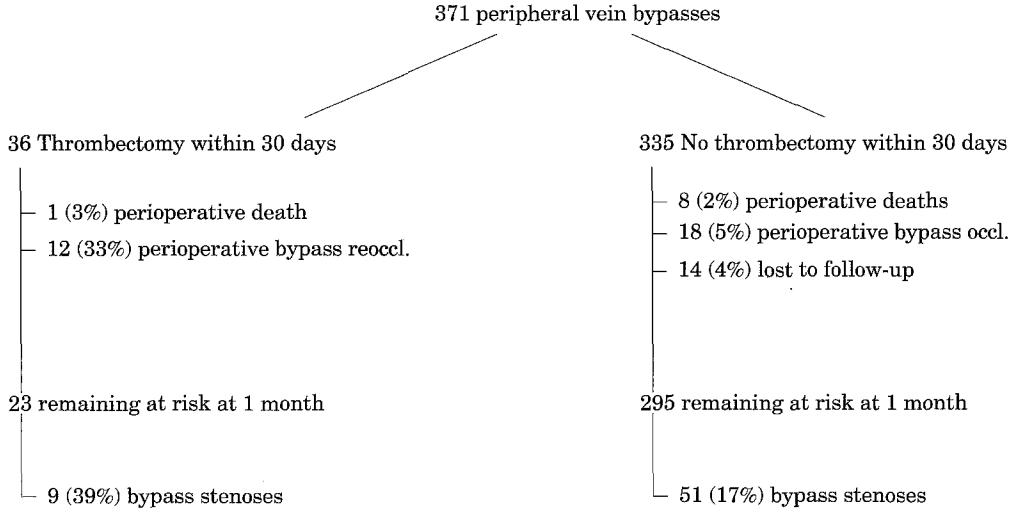

Fig. 1. Perioperative events and bypass stenoses among 371 patients with peripheral vein bypasses.

Table 1. Site of stenosis in 60 patients with vein graft stenoses, group I: patients undergoing early (within 30 days) postoperative vein bypass thrombectomy; group II: patients not subjected to early thrombectomy.

	Proximal anastomosis	Graft	Distal anastomosis
Group I (*n*=9)	3 (33%)	6 (67%)	0 (0)%)
Group II (*n*=51)	13 (25%)	30 (59%)	8 (16%)

Group II (No early bypass thrombectomy) (n = *335)*

Of the 335 patients not subjected to early bypass thrombectomy, eight (2%) patients died and 14 (4%) were lost to follow-up during the perioperative period. Eighteen (5%) grafts occluded within 30 days of the bypass operation.

Among the 295 patients, which were followed for at least 1 month, bypass stenoses were identified in 51 (17%) (p = 0.03 compared to group I). The median time interval from surgery to stenosis detection was 6 months (range 2–46). Site of stenosis is listed in Table 1. Thirty-three stenosis revisions, 14 percutaneous transluminal angioplasty procedures and 19 surgical revisions, were required in 28 (9%) patients (p = 0.004 compared to group I).

The overall secondary bypass patency for all 335 patients was 82% compared to 38% in group I ($p < 0.00001$) (Fig. 2) and the 12 months bypass patency for the 295 patients at risk at 1 month was 87% compared to 57% in group I (p = 0.0003).

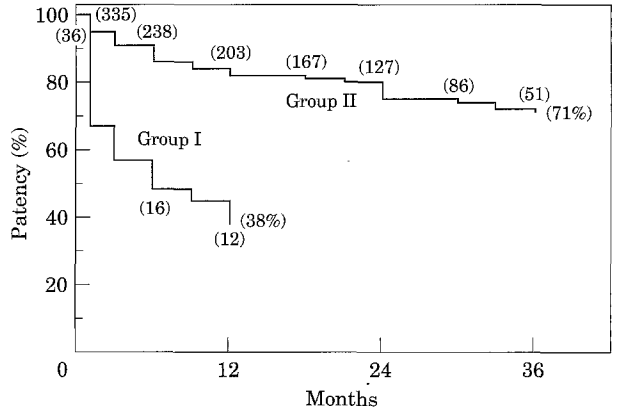

Fig. 2. Cumulative bypass patency in 36 patients with vein bypasses which were thrombectomised within 30 days after surgery (group I) and in 335 patients not subjected to early thrombectomy (group II). Log-rank test p = < 0.00001.

Discussion

Graft stenoses are considered to be the most common cause of reconstruction failure within 1–2 years after infrainguinal vein bypass surgery.[4,5,7,14,15] Histopathologically vein graft stenoses are characterised by myointimal hyperplasia.[7] The initiating event is assumed to be intraoperative endothelial injury caused by the surgical preparation of the saphenous vein. This injury induces a healing response which involves platelet aggregation, smooth muscle cell proliferation and subsequently leads to intimal thickening.[16] In a prospective study, however, sites of valve disruption, tributary ligation and clamping have shown no correlation to the postoperative development of stenoses.[17] Since the extent and depth of vessel injury strongly correlate with the degree of myointimal hyperplasia[16] more extensive injury may be necessary to induce significant stenosis. In support of this hypothesis, endoluminal passage of a valvulotome through veins causes marked damage of the endothelial cells.[18] Furthermore, stenoses due to myointimal hyperplasia have been recognised as a delayed complication after thromboembolectomy of arteries.[10]

The present finding of an increased risk of bypass stenoses after successful thrombectomy indicates that intraoperative endothelial injury induced by the balloon catheter may be an aetiological factor in the development of vein bypass stenoses. Besides surgical handling, flow abnormalities are assumed to play a role in the perioperative vein injury.[7,19] In three of the nine patients who developed stenoses following early bypass thrombectomy the lesions were located in the anastomotic region. In these turbulent flow might have been a causative factor. The six patients with intrinsic graft stenoses, however, had normal duplex findings at 1 week and therefore flow disturbances seem an unlikely cause. Morphological changes in the saphenous vein, as identified by histological examination of pre-bypass vein segments, are associated with increased risk of both early and late bypass failure.[20–22] Vein histology was not evaluated in the present study, but the presence of minor venous disease not detectable by intraoperative gross examination may have contributed to the development of stenoses. Early bypass failures have been attributed to inadequate patient selection, technical problems and coagulation abnormalities.[14,15,23] In this study patient selection was based on preoperative arteriography and ultrasound duplex mapping of the greater saphenous vein. More conservative patient selection might have limited the number of failures but not improved

the overall results in the group of patients considered for infrainguinal arterial reconstruction.

In accordance with the findings of Donaldson *et al.*[14] technical errors or overlooked stenoses were identified in approximately half of the recanalised bypasses. Our results were no better following secondary correction of assumed contributory causes of failure than after restoration of flow by thrombectomy alone. Thus meticulous intraoperative assessment and early postoperative monitoring followed by correction of technical errors before occlusion occurs seem to be essential in preventing early failures. In this series intraoperative assessment consisted of Doppler examination and when a technical error was suspected, angiography. The accuracy of ultrasound B-mode imaging in detecting minor defects is superior to that of arteriography.[24] Duplex scanning, which combines B-mode imaging and pulsed Doppler flow analysis, is presumably the best extraluminal modality for intraoperative assessment.[25] Intravascular ultrasound (IVUS) and angioscopy may identify technical defects missed by angiography.[26,27] No report on the effect of IVUS on vein bypass patency is yet available. A randomised study of 59 patients failed to show any impact of the use of angioscopy on long term bypass patency.[28]

Though improved per- and postoperative monitoring may reduce the number of technical errors, early failures cannot be completely eliminated. Therefore restoration of flow should be performed as carefully as possible to minimise the risk of vein injury. In theory, medical thrombolysis is less traumatic than surgical thrombectomy. In a retrospective non-randomised study of 60 patients 30 day patency was higher after thrombolysis by rt-PA than after thrombectomy but long-term results were similar in the two groups.[29] Angioscopically guided graft thrombectomy may facilitate complete thrombus removal,[30] which is a major determinant for graft patency.[31] Whether passage of the scope contributes to the endothelial injury is unknown.

The present 12 months patency of 38% after reopening of occluded grafts is in accordance with the findings of others.[29,32] Long-term results for below-knee prosthetic bypasses are equally disappointing.[33] Single centre reports on the use of prosthetic grafts with interpositioned vein cuffs or patches, however, have been promising.[34] If these results are confirmed in further studies insertion of a modified prosthesis may be a better option than repeated bypass revisions in patients with poor quality veins or vein grafts failing early.

In conclusion, early vein bypass thrombectomy is associated with an increased risk of graft related stenoses and a reduced long term bypass patency. Meticulous intraoperative assessment and postoperative monitoring to identify technical defects prior to occlusion may reduce the risk of early bypass failure.

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