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Infrainguinal Arterial Reconstruction with Non-reversed Autologous Vein after Angioscopy Guided Valvulotomy *Ex Situ*

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Aims: *The advantages of* in situ *autologous vein grafts for long infrainguinal arterial reconstructions are the tapered conduit, minimising size mismatch at proximal and distal anastomoses, and the possibility of using small sized veins with good results. Unfortunately, in about 30% of legs the ipsilateral saphenous vein is inadequate rendering* in situ *bypass grafting impossible. To profit from a valveless autologous vein graft in these cases we routinely performed* ex situ *valvulotomy after harvesting the contralateral saphenous vein or good quality segments of the ipsilateral saphenous vein.*

Methods: *The* ex situ *valvulotomy was performed under angioscopic guidance using a flushing-type Mill's valvulotome.*

Results: *Fifty non reversed grafts in 46 patients entered a prospective surveillance program. Primary and primary-assisted patency rates at 2 years were 68% and 82% respectively, early graft thrombosis 2%, late stenosis 8% and major amputation rate with a patent graft 6%. No technique related problems were noticed.*

Conclusion: *Angioscopy guided valvulotomy was safe and simple and allowed good quality control of the veins. The presented results in this study are comparable to other recently reported series of* in situ *bypass. The clinical use of small flexible endoscopes allows a safe and atraumatic valvulotomy and simultaneous quality control of autologous vein grafts.*

Key Words: Infrainguinal bypass; Autologous vein; Vein valves; Angioscopy.

Introduction

There have been numerous reports of excellent results for the *in situ* bypass as an infrainguinal arterial conduit. However, clinical advantages for the *in situ* technique compared to the conventional reversed method could only be demonstrated for small sized veins.[1] Considering the fact that 30–40% of patients do not have an adequate, uninterrupted ipsilateral saphenous vein for *in situ* bypass grafting and to profit from a valveless, tapered conduit we learned to use veins non-reversed.[1] The non-reversed technique combines advantages of the *in situ* technique together with the possibility of using good quality saphenous vein segments from different locations. Vein quality is probably the most important factor in achieving good long term results.[2,3]

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Patients and Methods

All patients undergoing autogenous non-reversed infrainguinal bypass from 1989 to 1992 were reviewed. *In situ* bypasses were excluded from this study. Life-table graft patency was calculated using the criteria of the Ad Hoc Committee on Reporting Standards for Lower Extremity Ischaemia.[4] All patients entered a routine surveillance program after intervention to document problems, using ankle brachial index (ABI) measurements and Duplex imaging of the entire graft length.

We usually used the greater saphenous vein from the ipsi- or contralateral leg. The veins were conventionally harvested using discontinuous longitudinally orientated incisions.

The minimum accepted vein diameter after pressure controlled dilatation was 3 mm. Valve disruption was performed under angioscopic guidance in combination with a modified Mill's valvulotome (Mauch Inc., Loogstrasse, CH-4142 Münchenstein, Switzerland). We used a 2.2 mm or 1.4 mm angioscope without

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flushing channel (Olympus Inc., Zollikon, Switzerland). Imaging was achieved using a video camera with a monitor and Xenon light source. Pressure controlled dilatation of the vein was achieved by connecting the flushing channel of the valvulotome to a simple pressure bag infusion system with a maximum pressure of 180 mmHg. The valvulotome was inserted through the distal end of the harvested vein and was carefully advanced to the proximal end of the vein, where the angioscope was introduced without a sheath. Valvulotomy and inspection of the inner surface of the conduit was achieved from proximal to distal with the tip of the angioscope following the valvulotome.[5]

Fifty bypasses were performed in 46 patients with a mean age of 69.6 years (28–88 years). There were 22 men and 24 women suffering from severe claudication in 19%, ischaemic rest pain in 31% and established tissue loss in 50%. Diabetes was found in 39%, hypertension in 52% and cigarette smoking in 52% of the patients. In 80% of the bypasses the distal anastomosis was below the knee (Table 1). In six patients (six legs, 12%) revision surgery was necessary after previous arterial reconstructions on the ipsilateral leg. All veins were used "non-reversed" and were tunnelled extra-anatomically through subcutaneous tissue with exception of bypasses to the infrageniculate popliteal and proximal anterior tibial artery. In these cases we used an anatomic course of the grafts through the popliteal fossa. Routine outpatient evaluation, including non-invasive laboratory graft surveillance using ABI and Duplex, was scheduled before discharge and at 3, 6, 12, 24, 36, 48 etc. months postoperatively. All grafts at risk were further evaluated by angiography. Stenoses above 80% diameter reduction were generally corrected by an elective surgical procedure or by angioplasty. All procedures to maintain graft patency were performed in patent grafts and were included in the life-table analysis to calculate the primary assisted patency rates.

Table 1. Distal anastomosis (*n* = 50)

Receiving arteries	*n* (%)
Suprageniculate popliteal artery	10 (20%)
Infrageniculate popliteal artery	18 (36%)
Tibial arteries	14 (28%)
Pedal arteries	8 (16%)

Results

Fifty operations were performed in 46 patients. There were no intraoperative complications. The average time of the *ex situ* venous preparation was 15 min (7–25 min). Two patients died within 30 days of surgery (4%). One bypass failed on the third postoperative day requiring immediate reoperation. The cause of failure was a technical problem at the distal anastomosis. No significant graft infection was noted. Intraoperatively no technical problems related to the described angioscopy guided technique were noted. Angioscopically detected intraluminal venous defects like webs and strands resulted in removal of venous segments in four of 50 saphenous veins (8%).

Postoperative measurements of ABI showed significant improvement (> 0.15) in all legs with ablation or marked improvement in symptoms. During follow up, five of 50 grafts (10%) developed significant stenoses requiring to be corrected. One tight stenosis was found to be related to an end to end anastomosis of two vein segments and required surgical correction. Major amputation was necessary in three legs (6%) with patent grafts due to severe infection of the foot (Table 2). Primary graft patency rates at 1 and 2 years were 74 and 68% respectively (Fig. 1). Primary assisted patency rates after one and two years were 86 and 81% respectively (Fig. 2).

Table 2. Outcome of non reversed bypass (*n* = 50)

Outcome	*n* (%)
Operative mortality (30 days)	2 (4%)
Secondary procedures	5 (10%)
Wound complications	3 (6%)
Major amputation (parent graft)	3 (6%)
Early graft thrombosis (< 30 days)	1 (2%)

Discussion

A major disadvantage of *in situ* bypass grafting is the dependence on a good quality ipsilateral saphenous vein. Vein quality is one of the most important factors influencing graft patency.[2,3,6,7] The saphenous vein can be interrupted or totally absent especially after previous arterial surgery, varicose vein surgery or coronary artery bypass grafting. Thirty to forty percent of our patients do not have a good quality ipsilateral saphenous vein, making *in situ* bypass grafting impossible. An advantage of the *in situ* bypass is the tapered conduit, minimising size disparities at proximal and distal anastomoses. It is possible to achieve excellent results even with small diameter veins.[1] More theoretical advantages are a

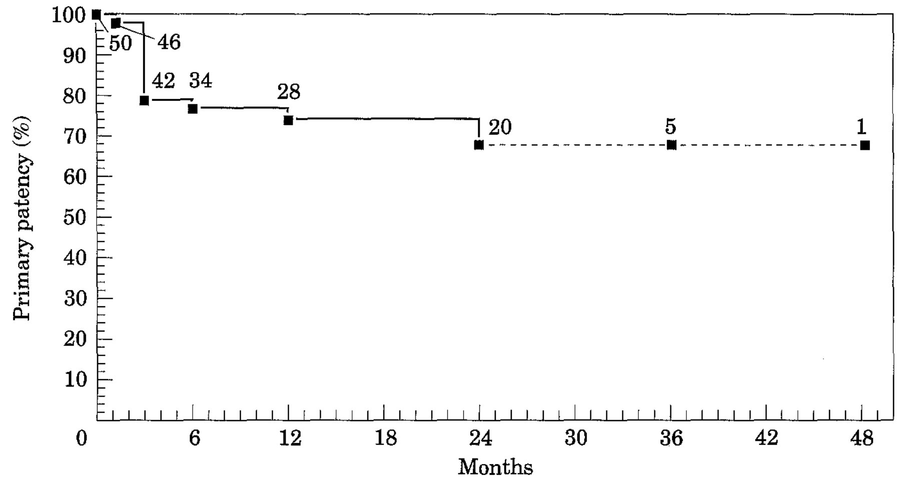

Fig. 1. Primary cumulative patency rates in 50 non-reversed bypasses. The number of grafts at risk at each time interval are shown above the graph. (– – –) S.E. >10%.

higher flow rate in valvulotomised small sized veins and the potential of reversed flow during diastole allowing continuous motion of blood.[8,9] Angioscopy guided valvulotomy and quality control of the saphenous vein seem to influence outcome of infrainguinal arterial reconstructions. Miller *et al.* demonstrated advantages for angioscopy guided *in situ* bypass grafts in a randomised study.[10] Sales reported a high sensitivity for angioscopy to detect intraluminal defects, making vascular endoscopy a perfect instrument for intraluminal quality control.[11] A prospective study by Gilbertson *et al.* showed advantages in the detection of residual valve leaflets after valvulotomy in comparison to angiography and Duplex sonography.[12] We gained experience with an angioscopically guided technique in *in situ* bypass grafting using a flushing type Mill's valvulotome.[5] Matsumoto *et al.* were the first to report *ex situ* valvulotomy using an angioscope in combination with a Mill's valvulotome in 1987.[13] They used the prepared veins non-reversed. To combine the advantages of a valvulotomised vein in combination with angioscopy guided quality control we developed the described technique of *ex situ* vein preparation.

A disadvantage of venous valve ablation is the necessity for endoluminal manipulations with the potential for endothelial trauma. Vaentinnen *et al.* reported a rather disappointing patency rate of 58% after 12 months in a series of 63 non-reversed grafts.[14] For valvulotomy he turned his grafts inside out to get visual control for valve excision. This cumbersome technique possibly caused structural damage to the vein wall. Beard published results of 85 fully mobilised, non-reversed grafts with patency rates similar to

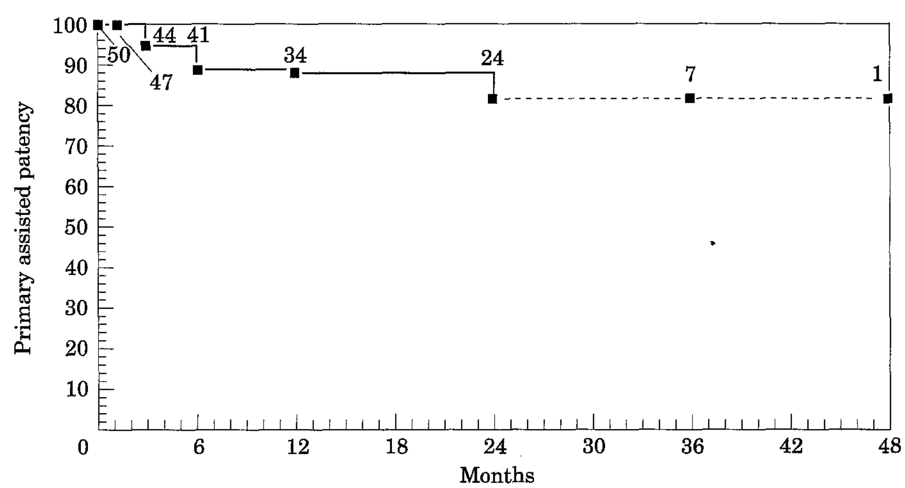

Fig. 2. Primary assisted patency rates in 50 non-reversed bypasses. The number of grafts at risk at each time interval are shown above the graph. (– – –) S.E. >10%.

those of modern *in situ* series, using a Hall valve stripper for blind valvulotomy.[15] We combined small sized angioscopes with an atraumatic modified Mill's flushing valvulotome. In our experience the 1.4 mm angioscope was the instrument of choice as the 2.2 mm instrument seemed to be too large, especially for small diameter veins. All *ex situ* prepared veins were used non reversed to achieve optimal size-match at the anastomoses. The presented primary and primary assisted patency rates are comparable to other recently reported series of *in situ* bypass grafting,[16] as were the early graft thrombosis and subsequent graft stenosis rates.

In conclusion, angioscopically guided *"ex situ"* vein preparation allows the creation of a valveless conduit that can be used either reversed or non-reversed. The procedure permits a high vein utilisation rate. Visual control of the valvulotomy improves quality control, reduces the learning curve and ameliorates the "teaching effect" during bypass surgery.

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