Do residual arteriovenous fistulae after in situ saphenous vein bypass grafting influence patency?

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Purpose: **The purpose of this study was to evaluate the influence on patency of residual arteriovenous fistulae (AVF) after in situ saphenous vein bypass grafting.**
Methods: **Between January 1, 1994, and December 31, 1996, 98 in situ saphenous vein bypass grafting procedures were performed in 94 patients. Patency was evaluated with duplex scanning after operation and at 1, 3, 6, 9, and 12 months.**
Results: **The indications for operation were intermittent claudication in two patients and critical leg ischemia in 92 patients. Two above-knee and 48 below-knee femoropopliteal and 48 femorocrural in situ saphenous vein bypass grafting procedures were performed. The median follow-up period was 9 months (range, 1.5 to 12.5 months). There were no residual AVF in 45 veins (44%; group 1), but 110 residual AVF were found in 53 veins (56%; group 2). In group 2, 36 AVF in 18 veins were surgically or radiologically occluded mainly as a result of a flow velocity decrease distal to the AVF, but the remaining 74 AVF were treated conservatively. The 1-year cumulative primary patency rates were 68% in group 1 and 74% in group 2 (log-rank test, 0.47; degree of freedom = 1; *P* = .52). The 1-year cumulative assisted primary patency rates were 68% in group 1 and 81% in group 2 (log-rank test, 2.19; degree of freedom = 1; *P* = .14).**
Conclusion: **Residual AVF after in situ bypass grafting without influence on bypass graft hemodynamics do not compromise patency and thrombose spontaneously. (J Vasc Surg 1999;30:99-105.)**

Since its introduction in 1962, in situ saphenous vein bypass grafting for leg ischemia has attained widespread acceptance.[1,2] The benefits of the in situ bypass graft include less size disparity between graft and artery, better use of the vein, and no disruption of the nutrient vasa vasorum.[3] The grafting is, however, often necessary to detect, with preoperative vein mapping, intraoperative angioscopy, or angiography, the saphenous vein side branches to occlude them during surgery. Some side branches persist as residual arteriovenous fistulae (AVF) and may influence patency, especially if blood is shunted to the deep venous system.[4-6] Hemodynamically significant AVF necessitate revision, which is a time-consuming and costly procedure.[7] The question therefore is whether it is necessary to occlude all residual AVF after in situ bypass grafting. This is of a particular importance when minimally invasive and semiclosed surgical techniques are used. The purpose of this study was to evaluate the natural history of residual AVF and to investigate the possible hemodynamic significance in relation to in situ saphenous vein bypass graft patency.

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MATERIALS AND METHODS

A surveillance program after femoropopliteal/femorocrural reconstruction has been used at our institution since January 1, 1994. Surveillance data are collected prospectively and entered in a computer-based registry. The data include sex, age, presence of diabetes, type of operation, graft material, indication for operation, time to revision, occlusion, amputation or to death, ankle brachial index, number of residual AVF, and graft hemodynamics. The patients in this study underwent femoropopliteal or femorocrural in situ saphenous vein bypass grafting between January 1, 1994, and December 31, 1996. Preoperative vein mapping was not used on a routine basis.

Thrombosis prophylaxis with one daily subcutaneous injection of 40 mg of Enoxaparin (Rhone-Poulenc Rohrer, Collegville, Pa) was started the day before surgery and continued for the duration of the hospital stay. The patients underwent a three-dose antibiotic prophylaxis treatment with 2 g intravenously of cloxacillin sodium (ASTRA, Stockholm, Sweden) with a 12-hour interval beginning at the commencement of surgery. The surgery was performed without angioscopy or semi-closed AVF ligature. The saphenous vein was divided at the deep femoral junction. Before arterial clamping, sodium heparin (5000 units; Pharmacia-Upjohn, Stockholm, Sweden) was given intravenously. The proximal anastomosis was made end to side at the origin of the deep femoral artery with a running CV 6 Gore-Tex suture (WL Gore Associates Inc, Flagstaff, Ariz). After the completion of the proximal anastomosis restoration of blood flow, a LeMaitre, (Vascutech Inc, Burlington, Mass) 2.5-mm to 4-mm fixed diameter valvulotome was introduced through the distal vein end for valve disruption. When a pulsatile flow through the vein was accomplished, the distal anastomosis was completed end to side with a CV 7 Gore-Tex running suture. AVF that were detected during operation were ligated. The fistulae were identified with flow measurements with a transit time ultrasound volume flow meter Transonic TC 107 (Transonic Inc, Ithaca, NY) or a Cardiomed CM-1005 (Cardiomed A/S, Horten, Norway). After restoration of blood flow, a 5-mm or 6-mm flow probe was placed over the saphenous vein at the proximal anastomosis along the length axis of the vein. To achieve a good ultrasound signal, the space between the probe and the vein was filled with heparinized saline solution. The vein distal to the probe was occluded with digital compression. Flow through the vein was unaffected or only slightly reduced when an AVF was present between the site of the compression and the probe but was decreased to zero when no AVF was present. The site of the AVF was marked, a small incision was made, and the AVF was ligated. Fistulae with flows of less than 10 mL/min were not ligated. Completion angiography was used to detect missed AVF and to assess patency, the anastomoses, and the outflow tract before wound closure.

Bypass graft function was followed through the surveillance program. The patients underwent evaluation at the vascular clinic with a duplex scan at 1 or 2 days after surgery and at 1, 3, 6, 9, and 12 months thereafter.

The duplex scan examinations were performed with an Acuson 128 XP/10 duplex scanner (Acuson Inc, Mountain View, Calif) that was equipped with a real-time linear array multifrequency sector transducer with 3.5-MHz and 5-MHz settings to generate a B-mode image of the vessels and the pulsed Doppler scan signals. The Doppler scan signals were analyzed under a Doppler angle set as near as possible to 60 degrees. For any area in which stenosis was suspected, Doppler scan spectra were recorded proximal to, at, and just distal to the stenosis. The whole length of the graft, including the anastomoses, was examined. Residual AVF were identified, and the peak flow velocity proximal and distal to the AVF was recorded. The Doppler scan signal parameters recorded were the peak systolic flow velocity (PSV; in cm/s), the PSV ratio (PSV proximal to the AVF divided by PSV distal to the AVF), and the spectral waveform. Spectral analysis was made with visual interpretation of the Doppler scan velocity spectrum. A PSV of more than 2 m/s or a ratio more than 2.0 was defined as a stenosis >50%.[8,9] A similar index was used for residual AVF. An AVF/PSV ratio (PSV proximal/PSV distal to the AVF) of more than 1 proximal was considered to indicate an AVF that adversely influenced in situ vein hemodynamics through a shunting of blood to the deep venous system.[10] Occlusive superficial phlebitis as a result of an unligated branch was not found to be an indication for ligature. In addition to the duplex scan, the ankle brachial ratio (ABI) was calculated and a clinical assessment of graft function was made. The bypass grafts thereafter were divided in two groups on the basis of the presence or the absence of residual AVF at the postoperative duplex scan control, without AVF (group 1) or with one or more residual AVF (group 2). A failing graft was suspected during follow-up provided that duplex scanning indicated a graft or anastomosis stenosis of more than 50% or if the ABI decreased more than 0.15 between two controls. The diagnosis was verified with control angiography.

Primary patency rates (uninterrupted patency without intervention) and assisted primary patency rates (uninterrupted patency with bypass graft revision) were calculated for both groups. Patency was defined according to the Society for Vascular Surgery and International Society for Cardiovascular Surgery criteria.[11] Values were median and interquartile range. A StatView 4.5 statistics program for Macintosh (SAS Institute, Cary, NC) was used for the statistical analyses. The Kaplan-Meier method and log-rank tests were used for the analysis of the survival data. The Mann-Whitney test was

Table I. Risk factors, indication for surgery, and type of reconstruction

	Group 1	*Group 2*
	No AVF (n = 45)	*≥1 AVF (n = 53)*
Sex	28 M, 17 F	33 M, 20 F
Median age (years)	76 (range, 70 to 81)	76 (range, 70 to 83)
Diabetes	15 (34%)	21 (39%)
Intermittent claudication	1	1
Rest pain	14	22
Ischemic ulcer	18	16
Gangrene	9	12
Popliteal aneurysm	3	2
Fempop AK	2	0
Fempop BK	26	22
Femorocrural	17	31
Preoperative ABI	0.54 (range, 0.17 to 0.67)	0.36 (range, 0.1 to 0.5)
Postoperative ABI	0.73 (range, 0.61 to 0.96)	0.86 (range, 0.69 to 1)

AVF, Arteriovenous fistulae; *AK,* above knee; *BK,* below knee; *ABI,* ankle brachial ratio.
The groups were similar with regard to risk factors and indication. There were numerically more femorocrural reconstructions in group 2 as compared with group 1.

used for the comparison between the groups. A *P* value of less than .05 was considered significant.

RESULTS

From January 1, 1994, through December 31, 1996, 94 patients underwent 98 femoropopliteal or femorocrural in situ saphenous vein bypass grafting procedures. There were 59 men, and the median age was 76 years (range, 70 to 82 years). Diabetes, type 1 or 2, was present in 34 patients (36%). Indication was critical leg ischemia in all the patients but two (intermittent claudication, one in each group). There were 50 femoropopliteal (two above-knee and 48 below-knee) reconstructions and 48 femorocrural reconstructions. There were no differences with regard to sex distribution, age, presence of diabetes, indication for surgery, and type of reconstruction between the groups, although the portion of femorocrural reconstructions in group 2 was higher as compared with group 1 (Table I). The 30-day mortality rate was 4.4% (four patients). Eight veins occluded during the 30-day postoperative period. The median follow-up period was 9 months (range, 1.5 to 12.5 months). No AVF were detected in 45 veins (group 1). At the 1-month follow-up examination, one residual AVF was identified in three of these 45 veins (7%). These AVF thrombosed spontaneously.

A total of 110 residual AVF were found in 53 veins (group 2). There were 36 ligatures or coilings made on 46 identified AVF in 18 of the 53 veins (Table II). AVF in four veins had to be ligated in two separate procedures. The indication for revision was an AVF/PSV ratio that exceeded 1 in 14 veins. Residual AVF (n = 9) in four veins were revised, although blood flow velocity was unaffected and no leg swelling was present. This was done at the discretion of the surgeon. ABI was unaffected in all but one of the 18 veins where the postoperative ABI was low in spite of a patent graft. In addition to an AVF/PSV ratio, more than one low ABI was perceived as a steal phenomenon from a significant AVF. After AVF ligation, ABI was doubled. A notable leg edema occurred in four extremities where residual AVF were ligated. Of the remaining 74 AVF, 73 thrombosed spontaneously within 12 months (Tables III and IV). Seven of the veins in group 2 and three of the veins in group 1 necessitated additional revisions as a result of stenosis of the inflow vessel (n = 1), the proximal anastomosis (n = 2), the distal anastomosis (n = 4), the saphenous vein (n = 2), and the residual valve leaflets (n = 1). One patient in group 2 did not want to participate in the surveillance program after discharge and was considered lost to follow-up examination.

The 1-year cumulative primary patency rates were 68% for group 1 and 74% for group 2 (log-rank test, 0.52; degree of freedom = 1; $P = .52$). The 1-year assisted primary patency rates were 68% for group 1 and 81% for group 2 (log-rank test, 2.19; degree of freedom = 1; $P = .14$; Fig 1).

DISCUSSION

Since the introduction of the in situ bypass graft, controversy has surrounded the issue of whether or not residual AVF influence graft patency.[12] Residual AVF may divert blood from the bypass graft to the

Table II. Revised AVF

Patient no.	*Procedure*	*Time to AVF ligature/ coiling (days)*	*Assisted primary patency (days)*	*PSV (m/s) proximal to AVF*	*PSV ratio*	*No. of AVF (revised)*	*Comment*
1	crural	3+16	722	2	2	5 (4)	ligature
2	crural	5	413	2.5	1.4	2 (1)	ligature
3	crural	6	361	3	3	4 (1)	ligature
4	below knee	7	34	1	1	2 (2)	ligature
5	crural	7	813	0.8	1.6	1 (1)	ligature, ABI increase 0.4 to 0.75
6	below knee	7	26 (occluded)	2.6	5.3	2 (1)	ligature
7	below knee	7	368	1.1	2.1	2 (2)	ligature
8	crural	8	46	4	1	3 (3)	ligature, PTA distal anastomosis
9	crural	13+103	1024	3	3	3 (3)	coiling, PTA graft stenosis
10	crural	35	368	1	1	3 (1)	ligature
11	below knee	36	508	1.8	4.2	2 (1)	ligature
12	crural	51+227	389	2.8	2	4 (4)	ligature, PTA proximal anastomosis
13	crural	56	371	0.6	1.5	3 (3)	ligature
14	below knee	71+296	368	1	1	4 (3)	ligature
15	below knee	78	392	2	2	1 (1)	coiling, PTA proximal anastomosis
16	below knee	191	464	0.7	1.5	2 (2)	coiling, PTA and stent iliac artery
17	crural	211	1677	1.9	1.9	2 (2)	ligature, patch distal anastomosis, PTA × 3
18	crural	306	1162	2	1.8	1 (1)	ligature, resection of valve leaflets
Median (range)		12 (7-78)	380 (361-469)	1.9 (1.0-3.0)	1.8 (1.5-3.0)	2 (2) (1-2[3])	

AVF, Arteriovenous fistulae; *PSV,* peak systolic flow velocity; *ABI,* ankle brachial ratio; *PTA,* percutaneous transluminal angioplasty. The largest proportion of revisions were made during the first 30 postoperative days. Residual arteriovenous fistulae in four veins were ligated/coiled in two separate procedures.

deep venous system, thus diminishing the amount that reaches the distal arterial bed, which could influence patency.[6]

In the present study, neither primary nor assisted primary patency rates differed between the groups. This was even more notable because the portion of femorocrural reconstructions was higher in group 2 as compared with group 1.

To identify AVF during operation, we used ultrasound volume blood flow measurements and completion angiography. Flow measurements, either with a volume flow meter or duplex scanning, allowed an estimation of the flow through the AVF, thus verifying a hemodynamically significant lesion.[12]

This method was discovered to be equally effective as the "closed" in situ bypass grafting technique, in which perioperative angiography was used.[13] A further advantage of the method was its lack of complexity, which almost eliminated the learning curve.

Angioscopy with endovascular side branch occlusion during in situ bypass grafting has been successfully used to occlude AVF.[14] The technique allows the surgeon to occlude AVF from within the saphenous vein without making separate skin incisions, thereby reducing the risk for wound complications.[15] The hemodynamic significance of a potential AVF cannot, however, be estimated with angioscopy, and an unnecessarily high number of AVF may, as a consequence, be occluded.

Our data did not support the belief that all residual AVF should be ligated.[16] In patients in group 2, residual AVF without influence on flow velocity thrombosed spontaneously within 1 year. It is, however, of interest to note that, in three bypass grafts (7%) with no detected AVF at the postoperative control, one AVF was found after 1 month. These AVF thrombosed spontaneously during the follow-up period. Small AVF that remained closed during operation apparently opened during the first postoperative month, possibly as the result of an increase in peripheral resistance. This increase may lead to a diversion of blood through AVF seen at the 1-

Table III. Conservative treatment of residual AVF, group 2

Patient no.	*Procedure*	*Time to revision (days)*	*Assisted primary patency (days)*	*PSV (m/s)*	*PSV ratio*	*No. of AVF*	*Comment*
1	crural	1 (occluded)	1	0.3	1	1	
2	crural	1	697	1.9	1.6	1	Patch distal anastomosis
3	crural	6 (occluded)	6	1.2	4	1	
4	below knee	6	6	1	1	2	Lost to follow-up
5	crural	19	19	1	1	2	
6	crural	22	22	2.1	1	2	
7	crural	33	33	1	1	3	
8	crural	49	49	0.7	1	1	
9	crural	51	51	1	1	3	
10	crural	77	77	1.6	1	1	
11	crural	79	79	1	10	1	
12	crural	89	89	2.2	1	1	
13	crural	130	130	0.3	3	4	
14	below knee	140	274	2.8	1	1	Revision with ePTFE
15	crural	188	188	1	1	1	
16	below knee	190	1100	1	1	1	PTA distal anastomosis
17	crural	248	248	1	1	1	
18	crural	272	272	4	1	4	
19	crural	274	274	1	1	2	
20	crural	342	342	2.5	1	2	
21	below knee	360	360	1	0.7	3	
22	below knee	363	363	1.6	3.8	2	
23	below knee	363	363	1.3	1	3	
24	below knee	365	365	1	1	1	
25	below knee	374	374	1.8	1	3	
26	below knee	379	379	1.1	1.6	1	
27	below knee	381	381	1.2	1	2	
28	below knee	384	384	1	1	1	
29	below knee	392	392	2.2	1	2	
30	crural	397	397	2	1	1	
31	below knee	454	454	1.7	1	3	
32	crural	586	762	1	1.3	1	PTA of graft stenosis
33	below knee	750	750	1	1	2	
34	below knee	771	771	1	1	2	
35	below knee	783	783	0.6	1	2	
Median		274 (57-381)	342 (78-391)	1.0 (1.0-1.8)	1.0 (1.0-1.0)	2 (1-2)	

PSV, Peak systolic flow velocity; *AVF,* arteriovenous fistulae; *ePTFE,* expanded polytetrafluoroethylene; *PTA,* percutaneous transluminal angioplasty.
One patient was lost to follow-up examination.

Table IV. Veins with residual AVF during follow-up, group 2

Postoperative	*1 month*	*3 months*	*6 months*	*9 months*	*12 months*
53/53 (100%)	27/47 (57%)	14/39 (36%)	7/38 (18%)	3/36 (8%)	1/27 (4%)

After 1 year, all but one of the not ligated/coiled AVF thrombosed spontaneously. Percentage of veins with patent residual AVF during follow-up, group 2.

month control but not in the immediate postoperative period.[17-19]

Operative intervention for residual AVF in our study occurred in 18 of 98 patent grafts (18%). The revision rate was similar to that reported by van Dijk et al[20] (20%) but higher than that reported by Rosenthal et al[21] (6%). The difference seems to be a result of the use of intraoperative angioscopy, which allows better identification of all venous side branches and thus their occlusion.

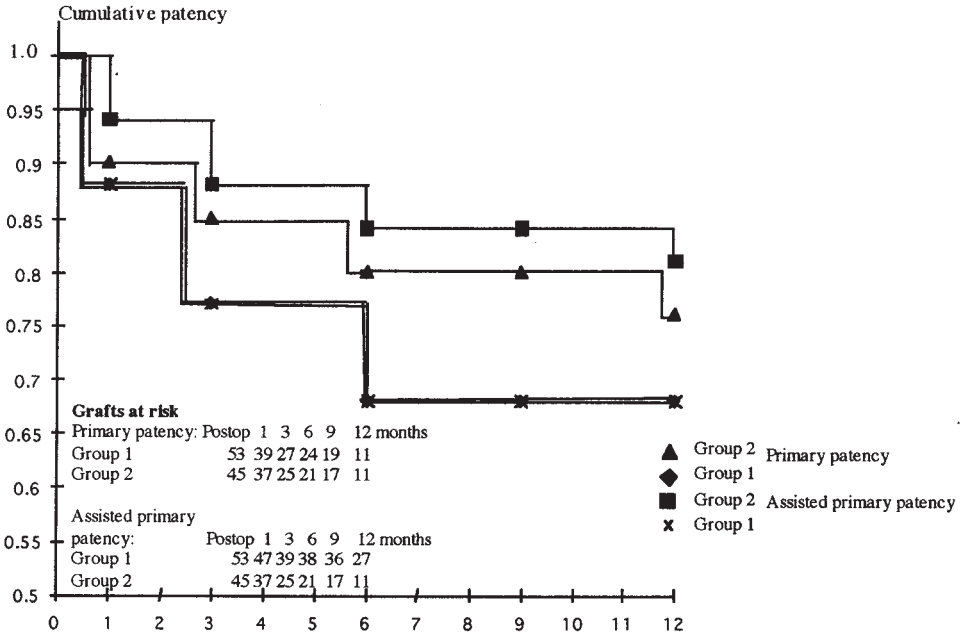

Fig 1. Cumulative patency rates did not differ between the two groups. The 1-year cumulative primary patency rates were 68% for group 1 and 76% for group 2 (log-rank test, 0.71; degree of freedom = 1; $P = .40$). The 1-year assisted primary patency rates were 68% for group 1 and 83% for group 2 (log-rank test, 1.69; degree of freedom = 1; $P = .19$).

A weakness of the study was that not all residual AVF were treated conservatively. Furthermore, nine residual AVF in four veins were ligated in spite of the fact that our criteria for a hemodynamically significant AVF were not met. Those AVF would probably have thrombosed spontaneously had they been treated conservatively. Whether or not a noninterventional approach would have led to a spontaneous thrombosis of all residual AVF, including those that severely influenced graft hemodynamics, cannot be answered by this study. We may have set the cut-off points for intervention for the flow velocity ratio too low, thus revising an unnecessarily high number of veins.[22]

There is, however, no generally accepted criteria for defining a hemodynamically significant AVF. We used the ratio between the flow velocity immediately proximal and distal to the AVF. If it can be assumed that the diameter of the vein is equal proximal and distal to the AVF, a flow velocity reduction distal to the AVF would indicate that blood is shunted to the deep venous system. Whether or not this also leads to a decrease in peripheral perfusion is uncertain. It seems logical that residual AVF impair distal flow when flow velocity is reduced distal to the AVF.

It could be argued, however, that most residual AVF did not influence peripheral perfusion in spite of the reduction in flow velocity distal to the AVF seen by the nonexistent influence on ABI.[23-25] This was only seen, however, in one patient in whom the postoperative ABI was found to be unexpectedly low in spite of a patent graft. The important issue therefore is to select a suitable cut-off limit. In our study, we used any flow velocity reduction seen as a ratio of more than 1 as the criteria for a significant AVF. Under the condition that ABI is not affected, the limit could perhaps be set at 2 to 2.5 without compromising patency in accordance with findings regarding vein graft stenoses.[26]

A prospective study that investigates this question has been designed at our institution. Until the results are available, our data support the position that only AVF that affect in situ bypass graft hemodynamics, seen as a decrease in flow velocity distal to the AVF, should be occluded. The indication for ligature is strengthened when the postoperative ABI is low in spite of a patent graft. Small AVF identified after operation, which do not influence the hemodynamics of the bypass graft, will likely occlude during the first postoperative year.

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REFERENCES

1. Leather RP, Powers RP, Karmody AM. A reappraisal of the in situ saphenous vein bypass. Surgery 1979;86:453-60.
2. Hall KV. The great saphenous vein used in-situ as an arterial shunt after extirpation of the vein valves: a preliminary report. Surgery 1962;51:492-5.
3. Leather RP, Powers RP, Karmody AM. Infrapopliteal arterial bypass for limb salvage. Increased patency and better utilisation of the saphenous vein in situ. Surgery 1981;290:1000-8.
4. Wilson YG, Davies AH, Currie IC, McGrath C, Morgan M, Sheffield E, et al. Angioscopy for quality control of saphenous vein during bypass grafting. Eur J Vasc Endovasc Surg 1996;11:12-8.
5. van Dijk LC, Wittens CH, Pieterman H, van Urk H. The value of pre-operative ultrasound mapping of the greater saphenous vein prior to 'closed' in situ bypass operations. Eur J Radiol 1996;23:235-7.
6. Chang BB, Leopold PW, Krupinsk AM, Kaufman JL, Leather RP, Shah DM. In situ bypass haemodynamics. The effect of residual AVF. J Cardiovasc Surg 1989;30:843-7.
7. Dundas P. The in situ vein bypass. J Cardiovasc Surg 1970; 11:450-3.
8. Buth J, Disselhoff B, Sommeling C, Stam L. Color-flow duplex criteria for grading stenosis in infrainguinal vein grafts. J Vasc Surg 1991;14:716-28.
9. Cossman DV, Ellison JE, Wagner WH, Carrol RM, Treiman RL, Foran RF, et al. Comparison of contrast arteriography to arterial mapping with color-flow duplex imaging in the lower extremities. J Vasc Surg 1989:10:522-29.
10. Shearman CP, Gannon MX, Gwynn BR, Simms MH. A clinical method for the detection of arteriovenous fistulas during in situ great saphenous vein bypass. J Vasc Surg 1986;4: 578-81.
11. Rutherford RB, Baker JD, Ernst C, Johnston KW, Porter JM, Ahn S, et al. Recommended standards for reports dealing with lower extremity ischemia: revised version. J Vasc Surg 1997;26:517-38.
12. Rordam P, Jensen LP, Schroeder T, Lorentzen JE, Bagi P. The effect of arteriovenous fistulas on in situ saphenous vein bypasses. Ann Vasc Surg 1991;5:419-23.
13. Wittens CHA, van Diijk LC, Du Bois NAJJ, van Urk H. A new "closed" in situ vein bypass technique. Eur J Vasc Endovasc Surg 1994;8:166-70.
14. Rosenthal D. Angioscopy in vascular surgery. Cardiovasc Surg 1997;5:245-55.
15. Rosenthal D, Tucker JG, Atkins CP, Walters AS, Newman CL, Lamis PA, et al. Extraluminal endoscopic-assisted ligation of venous tributaries for infrainguinal in situ saphenous vein bypass: a preliminary report. Cardiovasc Surg 1996;4: 512-4.
16. Gwynn BR, Shearman CP, Simms MH. The influence of patent branches on in situ vein graft haemodynamics. Eur J Vasc Surg 1987;1:169-72.
17. Parvin SD, Bentley S, Asher MJ, Prytherch DR, Evans DH, Bell PR. Haemodynamics of the adjunctive arteriovenous fistula in femorodistal bypass grafting: an experimental study. Br J Surg 1984;71:502-5.
18. Smith FC, Shearman CP. Pharmacological manipulation of peripheral resistance during distal vascular reconstruction. Vasa Suppl 1992;36:55-7.
19. Hickey NC, Wilkes MP, Howes D, Watt J, Shearman CP. The effect of epidural anaesthesia on peripheral resistance and graft flow following femorodistal reconstruction. Eur J Vasc Endovasc Surg 1995;9:93-6.
20. van Dijk LC, van Urk H, Lameris JS, Wittens CHA. Residual arteriovenous fistulae after closed in situ bypass grafting: an overrated problem. Eur J Vasc Endovasc Surg 1997;13: 439-42.
21. Rosenthal D, Dickson C, Rodriguez FJ, Blackshear WM Jr, Clark MD, Lamis PA, et al. Infrainguinal endovascular in situ saphenous vein bypass: ongoing results. J Vasc Surg 1994; 20:389-95.
22. Papanicolaou G, Zierler RE, Beach KW, Isaacson JA, Strandness DE Jr. Hemodynamic parameters of failing infrainguinal bypass grafts. Am J Surg 1995;169:238-44.
23. Lundell A, Lindblad B, Bergqvist D, Hansen F. Femoropopliteo-crural graft patency is improved by an intensive surveillance program: a prospective randomised study. J Vasc Surg 1995;21:26-34.
24. Tittley JG, Sniderman KW, Kalman PG. Radiological intervention for the failing in situ vein bypass. Ann Vasc Surg 1992;6:25-30.
25. Papanicolau G, Beach KW, Zierler RE, Strandness DE Jr. The relationship between arm-ankle pressure difference and peak systolic velocity in patients with stenotic lower extremity vein grafts. Ann Vasc Surg 1995;9:554-60.
26. Idu MM, Buth J, Hop WCJ, Cuypers P, van de Pavoordt EDWM, Tordoir JHM. Vein graft surveillance: is graft revision without angiography justified and what criteria should be used? J Vasc Surg 1998;27:399-413.

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