# Part VII

# Surgical treatments

# Reoperative Approaches for Failed Infrainguinal Arterial Bypasses

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Technical advances in both surgical and perioperative treatment of patients suffering from lower extremity ischemia have improved the patency and limb salvage of these patients (1). As the age of the general population and therefore the number of patients with limb-threatening ischemia increases, the need for more advanced vascular reconstructions as well as redo-surgery is also increasing. The patency of vascular reconstructions and limb salvage in older age groups has not been shown to differ from those of younger age groups (2).

The success of infrainguinal bypass surgery for limb ischemia is often limited in time and requires therefore additional endovascular and surgical procedures in the management of failing or failed grafts. Reinterventions constitute an integral part of vascular surgery for chronic limb ischemia due to the nature of the arteriosclerotic disease and to the limitation of the patency of the graft materials. In a 3-year follow-up study on 395 arterial reconstructions to all levels in the leg, Cheshire et al (3). reported an overall rate of graft revision or secondary vascular reconstruction in 44% of all grafts and in 67% of the crural bypasses. The ability to operate on patients at high risk with coronary artery disease, diabetes mellitus and chronic renal failure increases also the frequency of revisional surgery.

The prevalence of diabetes influences the incidence of chronic limb ischemia and the need of revascularisation. In the western world the prevalence of diabetes varies between 2% to 5% (4). Foot ulcers are a major problem in diabetics, affecting about 15% of all diabetics during their lifetime. Chronic ischemia is the major aetiology in 35-50% of diabetic foot ulcers, the rest being either mixed or neuropathic ulcers (5).

Amputation in the presence of reconstructible vessels should be avoided unless the patient is bedridden. Revisional surgery and limb revascularisation is worthwhile not only after failure of the primary graft but in selected cases even after secondary and tertiary graft failure (6) .Successful revascularisation provides a better quality of life, is cost beneficial and provides bipedal ambulatory status (7).

Surgical reintervention deals with regrafting for occluded grafts, corrections of stenosis of the body of the graft by patching, interpositioning of a newly harvested vein, jump-grafting or corrections of the anastomosis, mostly the distal anastomosis. Reinterventions to insure graft patency includes also reconstructions of the native vessels (inflow-PTA, inflow grafting, outflow PTA or jump-grafting) due to progression of the arteriosclerotic disease in the inflow and outflow arteries.

The outcome of redo-surgery for one or more failed primary arterial bypass grafting is shown in numerous reports to be satisfactory with a mean cumulative primary graft patency rates of 40%-60% and secondary patency rates of 60% to 70% at 5 years of follow-up, especially in case if autogenous bypass conduits are used (Table I) (6,8). Bartlett et al. showed a cumulative graft patency of 37% at five years in a series of 284 reoperations including the use of PTFE grafts in 247 cases, composite grafts in 16 cases and vein grafts in only 21 cases (9). Edwards et al. achieved good long-term results with the use of autogenous vein conduits (68 greater saphenous veins, 17 lesser saphenous veins and 31 arm veins) reporting a primary patency rate of 57%, a secondary patency rate of 71% and a leg salvage rate of 90% at five years follow-up (8). The same group reported good results with redo bypass surgery even after multiple failures of infrainguinal bypass grafts. The reintervention frequency is low in aorto-femoral surgery but up to 67% in infrainguinal especially in reconstructive surgery to the crural vessels (1,3).

The mean frequency is 0.8 per reconstruction if autogenous vein is used as graft material and 1.3 per reconstruction if synthetic prosthesis is used (3). Simple thrombectomy and revision of the thrombosed vein grafts results in fairly poor patency rates of 19%-28% at 5-year follow up (10), and even worse patency, 11%, at five years after thrombectomy or thrombolysis of PTFE grafts (11). Early graft failure (<30 days) can also be a sign of aggressive thrombogenity in the patient and therefore the possibility of success in a second attempt of grafting can be considered to be less favourable compared to cases of late graft failure (12). It seems that older vein-grafts have a greater resistance to reoperative measures and thrombolysis compared to grafts failing in the early phase (13). Unless a focal lesion correctable by strait forward revisional surgery is clearly considered to be the reason for early graft failure, some reports recommend complete replacement of the graft, even if the new bypass must be synthetic (14). Secondary distal extension (jump-grafting) after revisional correction of

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**TABLE I**
**Results of repeat bypass surgery for failed infrainguinal grafts.**

| Authors | Patients/ Procedures | Popliteal/ infrapopliteal outflow artery | Reconstruction material | Postoperative morality (%) | Primary Patency (%) | Secondary Patency (%) | Leg salvage (%) | Survival (%) |
|---|---|---|---|---|---|---|---|---|
| Burnham et al. (36) | 17/17 | -/17 | 17 P | ns | ns | 76[a] | ns | ns |
| Kacoyanis et al. (37) | ns/29 | -/29 | 29 V | ns | ns | 22[5] | 69[5] | ns |
| Whittemore et al. (18) | ns/67 | ns | 32 GSV/16 AV/19 P | ns | ns | 47[2]/53[2]/31[2] | ns | ns |
| Brewster et al. (38) | ns/71 | 56/15 | 19 V/52 P | ns | ns | 63[5]/18[5] | 52[5] | ns |
| Green et al. (39) | 52/52 | ns | ns | ns | ns | 421 | ns | ns |
| Harris et al. (40) | ns/21 | ns | 21 VV | ns | ns | 661 | ns | ns |
| Ascer et al. (41) | ns/27 | 10/17 | 9 GSV/6 PV/12P | ns | ns | 48[2]/39[2b] | ns | ns |
| Bartlett et al. (9) | ns/284 | 55/229 | 21 GSV/16 PV/247 P | ns | ns | 37[5] | 59[5] | 80[5] |
| Dennis et al. (42) | ns/26 | 2/24 | 26 P | 7.3 | ns | 30[2] | ns | ns |
| Edwards et al. (8) | 100/103 | 36/67 | 68 GSV/17 LSV/ 31 AV | ns | 57[5] | 71[5] | 90[5] | 12[5] |
| Paty et al. (43) | 16/16 | 1/15 | 14 P[c]/2 PV[c] | 0 | 67 | 67[1] | 75[1] | ns |
| Silverman et al. (44) | 35/39 | -/39 | 18 V/17 PV/ 4 P | 0 | ns | 72[2]/24[2]/25[2] | 52[2] | |
| Yang et al. (45) | 64/73 | 69/4 | 73 P | 2.7 | 38[4] | 55[4] | 74[4] | ns |
| Morris et al. (12) | ns/109 | -/109 | 109 Pd | ns | 20[3] | ns | 42[3] | ns |
| Schweiger et al. (46) | ns/103 | -/103 | 103 P | ns | 14[4] | ns | 50[5] | ns |
| Berkowitz et al. (26) | ns/89 | 44/45 | 51 GSV/13 AV or VV/ 25 P | ns | ns | 52[5] | ns | ns |
| George et al. (47) | 16/23 e | 1/15 | 3 GSV/12 VV/6 P/1 PV/ 1 Cr | ns | 32[3] | ns | 32[3] | 62[2] |
| Belkin et al. (30) | ns/213 | 73/140 | 133 GSV/46 AV/34 LSV | (0.3) | 43[5] | 51[5] | 59[5] | 73[5] |
| Fichelle et al. (48) | 19/19 | -/19 | 8 PV/4 P/7 Pd | ns | 44[4] | ns | ns | ns |
| Morasch et al. (49) | 19/19 | ns/ns | 19 P[a] | ns | 22[2] | ns | ns | ns |
| Rebane et al. (50) | ns/41 | ns | ns | ns | ns | 10[5] | ns | ns |
| Jakobsen et al. (51) | ns/21 | ns/ns | 21 P f | ns | 38[2] | ns | ns | ns |
| Biancari et al. (34) | 45/51 | -/51 | 30 V/19 P/ 2 PV | 6 | 42[2] | 43[2] | 67[2] | 77[2] |

ns: not stated; GSV: great saphenous vein; LSV: lesser saphenous vein; AV: arm vein; VV: composite vein; P: prosthesis; PV: composite prosthesis-vein graft; V: vein; Cr: cryopreserved vein; [a]: at 26-month follow-up; [b]: below-knee popliteal bypasses/infrapopliteal bypasses; [c]: with adjuvant arteriovenous fistulas; [d]: with distal vein cuff or patch; [e]: 12 graft failures and 4 failing grafts included; [f]: some adjuvant arteriovenous fistula included in the study; [1]: at 1-year follow-up; [2]: at 2-year follow-up; [3]: at 3-year follow-up; [4]: at 4-year follow-up; [5]: at 5-year follow-up

the primary graft is also supported in appropriate cases with good results (15). It has been suggested that thrombolysis is mostly effective in prosthetic grafts (16), in those vein grafts that failed later than the first postoperative year (13), and when it is attempted within 2 weeks of presentation (17).

## Terminology

The terminology is essential to be clear when dealing with reoperative bypass surgery. Primary patency is considered when the graft has not been subject to any intervention after initial bypass and is still open. Primary assisted patency is considered when the graft needs revision (PTA, patch angioplasty or reanastomosis) while still patent. Secondary patency is considered the patency of occluded grafts (failed grafts) after thrombectomy or thrombolysis and patching or revision. It is a question of secondary patency also if a major part (>50%) of the initial graft has been changed or revised while still patent. This is not to be confused with primary patency derived from secondary or reoperative procedures.

## Aetiology of early graft failure

The cause of graft failure differs according to weather the graft fails in the immediate, intermediate or late postoperative phase. The clinical signs vary from almost no signs at all to severe ischemia with loss of the sense and motor function of the leg. Whittemore et al (18). identified three aetiological categories of femoropopliteal thrombosis (Figure 1). Failure within 30 days of surgery results of technical (dissection of atheromatous plaque within the proximal or distal anastomosis, a retained valve, lesion of the venous wall) or judgemental errors. Especially in crural and pedal bypasses the distal anastomosis is the crucial point and needs to be done meticulously in order to guarantee good patency. Poor runoff score in the vascular bed is clearly also attributable to graft failure also in the immediate outcome (19). A dominating second group of failures during the first year is development of graft stenosis. This can be due to neointimal hyperplasia, clamp injury or poor quality of the vein. The third group most commonly failed a year or more after surgery due to progression of the arteriosclerotic disease. Patients with hypercoagulable thrombophilia are also risking graft failure within the first 30 days.

Thrombophilic risk factors for arterial thrombosis in patients subjected to reconstructive vascular surgery are high (20). About 60-75% of the patients are reported to carry a thrombophilic state. These include resistance to activated protein-C due to a mutation in the coagulation factor V, prothrombin gene mutation leading to elevated prothrombin levels, lack of natural anticoagulants, antithrombin III, protein C and S, hyperhomocysteinemia and phospholipid antibody syndrome which is a

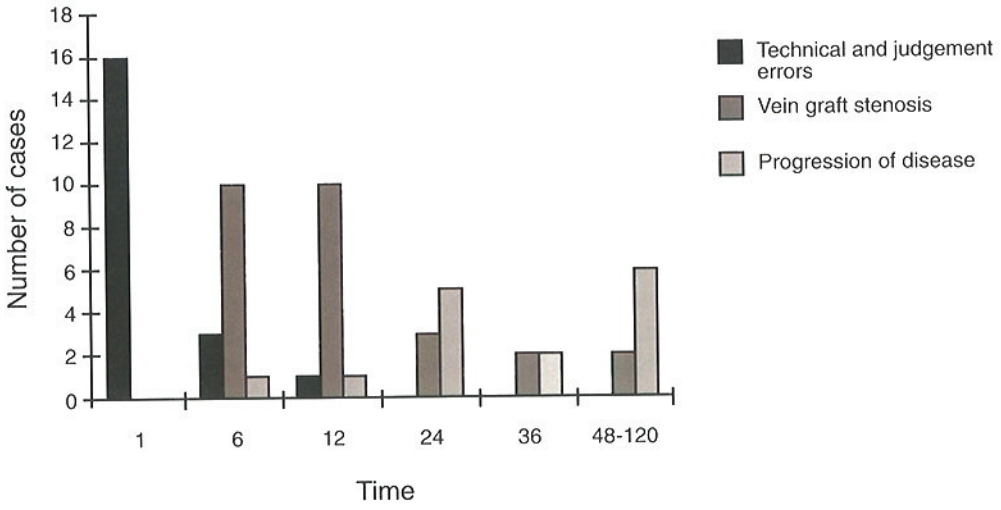


**FIGURE 1**

*The temporal distribution of the three most frequent failure modes in 78 limbs with an identified cause of graft occlusion. The technical and judgement errors include compromised runoff at the time of the primary operation (Whittemore et al 1981, with permission)*

highly thrombogenic condition, often manifesting itself with both venous and arterial thrombosis. Myeloproliferative diseases such as polycythemia vera and essential thrombosytosis are also associated with high risk of thrombosis. Preoperative screening of these thrombophilic risk factors helps to target meticulous antithrombotic treatment for the postoperative period and secondary prevention. Considering both thrombophilic risks, technical and judgmental errors, the risk of early thrombosis is around 15-20%. In a series of 2058 autogenous vein in situ bypass with 1271 crural bypasses and 152 pedal bypasses the 30-day occlusion rate was 7% (21), as in a series of 109 pedal bypasses of which 70 were in situ vein and 29 transposed vein bypasses and 10 prosthetic bypasses (mainly PTFE), 21% failed within 30 days post-operatively (22).

## Aetiology of late graft failure

Vein graft failures months post-operatively are often due to neointimal hyperplasia within the anastomotic region, usually at the distal outflow anastomosis. The distal anastomosis is due to its inferior calibre more prone to the narrowing effect of the neointimal hyperplasia compared to the inflow anastomosis. The neointimal thickening can also be found along the body of the graft. Graft thrombosis beyond 12-18 months is usually a cause of progression of the atherosclerosis in the outflow vascular bed along with the neointimal hyperplasia of the graft. Clearly there are numerous pathogenic processes that cause graft occlusion at different time periods after vascular surgery, and a strict classification according to these factors is therefore difficult to make.

## Clinical signs of graft failure

The clinical signs of failed or failing graft varies range from total lack of subjective symptoms to severe limb threatening ischemia. Routine surveillance program of arterial bypasses by duplex-doppler can detect high grade graft stenosis without any clear clinical signs, whereas reappearance of claudication or delayed ulcer healing can be a sign of earlier total graft thrombosis. Clinical signs of critical limb ischemia prior to the initial bypass operation do not necessarily reappear at the time of late graft occlusion. In 10-25% of the patients the original ischaemic lesion may have healed in the interval between primary operation and occlusion and signs of ischemia do not necessarily reappear (1). It seems that in these cases the perfusion is adequate to keep skin intact though it was not enough to enable healing of the ischaemic lesion. On the other hand reappearing of critical limb ischemia can sometimes be severe with signs of paresthesia or paralysis in the foot. This can be due to the division of the collaterals during the initial operation or by physiological reduction of their flow during successful graft function and also to thrombosis of either the outflow or inflow vessels.

## Reoperative approaches of failed grafts in cases of recurrent ischemia

The correct management in any particular patient varies with the functional status of the patient, the actual alteration of life quality and the clinical status of the affected extremity. The interval between grafting and occlusion affects also the decision. It is clear that within the immediate post-operative period (hours-10 days), thrombolysis is out of question because of risks of bleeding and development of a haematoma at the wound site and therefore surgery is the only possibility. In case of early thrombosis of a vein graft the revascularisation of the vasa vasorum is not fulfilled yet and the graft-wall gets ischaemic due to the obliteration of the existing nourishing vasa vasorum vessels (23). This damages the quality of the vein graft rapidly, increases the adherence of the thrombus to the graft wall, provokes migration of the thrombosis to the outflow vessels and renders the graft thrombogenic and later unusable.

## Reoperative approaches for early graft failure

In case of immediate graft failure the patient should be returned as soon as possible back to the operating room. In very selected cases, the initial operation reveals clinical facts not known prior to the operation (poor run-off vascular status, poor graft quality, patient deterioration during the operation) in a way that an immediate reoperation in case of graft thrombosis is not justified. In the absolute majority of the cases, an aggressive reoperative policy is mandatory. The reason for failure is usually technical. Torsion of the graft is possible with synthetic bypass grafts and bypasses using reversed or transposed vein grafts. The in situ technique protects at least a major part of the vein graft from torsion, but the very distal part of the vein, which is freed for anastomosis, can be kinking. In case of torsion of the graft, the graft should be cut in two after heparinisation at the site of the torsion and the thrombus gently removed with a balloon catheter. It is important to be very gentle during the thrombectomy of failed grafts, because especially if the graft is a few days old its wall tends to be oedematic and fragile and the balloon catheter can easily cause a rupture of the graft wall. The reanastomosis is done end-to end with 7-0 interrupted monofilament sutures. This ensures the maintenance of the calibre of the

lumen. Usually torsion occludes the graft within hours. Sometimes a bleeding in the site of the harvested vein can provoke external compression on the graft leading to thrombosis. In case of thrombosis without torsion of the graft, the proximal and distal end of the graft should be exposed and the proximal and distal hoods of the grafts are opened. This way both anastomoses can be visualized for possible technical errors. Gentle thrombectomy with a balloon catheter with the same precautions as mentioned above is done in combination with an irrigation of heparinized saline or preferentially heparinized warm blood. The feeling of hindrance in extraction of the balloon catheter can sometimes lead the way to the problem (stenosis, retained valve). The proximal site is closed by patch angioplasty if needed and the flow is opened. If re-valvulotomy is needed it should be performed meticulously. Intact valve cusps are often present after valvulotomy of in situ saphenous grafts. Unligated collaterals should be suspected and explored if persisting flow in the graft is detected in the flow-recorder despite the distal clamping of the graft. Post trombectomy angioscopy of the entire femoro-distal conduit and inflow vessel is useful in finding retained valve cusps, retained thrombus or intimal lesions. All major defects are corrected by angioplasties, replacement of defectuous segments by newly harvested vein and by reanastomosis. The distal outflow vascular bed can be irrigated in selected cases with a solution of 10 mg recombinant tissue-type plasminogene activator (r-tPA) (Actilyse®) acting as local trombolysis. This will not have a clinically significant systemic effect when given in situ and when the proximal inflow vessel is clamped. The lysis of the distal run-off vessels can lead to improved patency (25). The result of this reoperation and the quality of the graft and the outflow vessels is controlled by an intraoperative angiography. This can lead to further exploration of the arterial tree. A reoperation in the immediate post-operative period seldom leads to total regrafting, especially if the primary graft is a vein. The replacement of an occluded synthetic graft by a vein can on the other hand be done in selected cases.

## Reopeartive measures in the intermediate phase

When the thrombosis occurs one month beyond the immediate perioperative period and the symptoms are not risking the viability of the leg, an attempt of thrombolysis should be done. As thrombolysis is time consuming it is not recommended if the viability of the leg is at risk. In this case the patient should immediately be transported to the operating room for intraoperative angiography and prompt surgical revascularisation. The operative strategy is identical to the approach described for immediate graft failure. A permanent loss of sensomotoric function may appear within a few hours and therefore the revascularisation is to be made surgically.

The main attraction of thrombolysis is to rescue the thrombosed grafts and to minimize the need for surgical intervention, especially in cases where good vein material is no longer available. Usually graft revision is needed after thrombolysis to correct the underlying cause that lead to graft failure. Good long-term patency rates with a five-year patency of 45% with vein grafts of 10 months or older compared to 21% patency for younger vein grafts is reported (26). The time of approximately ten to twelve moths is needed for the vein graft to incorporate in the surrounding tissue and to gain more resistance for thrombolytic agents and graft wall ischemia. A selective good quality angiography needs to be done before thrombolysis. The catheter should be inserted all the way to the distal part of the thrombosed segment and an initial pulse-spray instillation of 10 mg of recombinant tissue plasminogene activator (r-tPA) (Actilyse®) is injected into the thrombus while withdrawing the catheter slowly in order to start the thrombolytic activity along the whole continuity of the segment ("lacing"). Thereafter a continuous low dose (0.5-1 mg/h) thrombolytic therapy for 24 - 48 hours is administered inside the thrombus. Streptokinase and urokinase can be used as well. In case the guidewire runs smoothly through the thrombus out to the run off vessels, the lytic therapy has good chances of success. Intravenous application of the thrombolytic drug is ineffective because it does not reach the actual thrombus, and the required dosage is much higher and this increases the risk of haemorrhage. The patient needs to be observed carefully during thrombolysis because of risks of bleeding. It is of outmost importance to rule out contraindications for thrombolytic therapy before making the decision of lytic therapy. Patients with a malignancy, active gastric or duodenal ulcer, pregnancy, recent cerebral infarction or history of cerebral haemorrhage are not suitable for thrombolysis. Thrombolysis of occluded grafts is successful in up to 60-70% of the cases (14), especially in recent thromboses but can be tempted in older thrombosis (2-3 months) as well. A randomised multicenter study (Stile study) showed in a subgroup of 124 patients with recent graft thrombosis (<14 days) that restored patency after successful catheter insertion was observed in 82% of autogenous vein grafts and in 85% of synthetic grafts (27). This study also showed better results of catheter-derived thrombolysis in recent thrombosis (<14 days) and better results of surgical intervention in thrombosis with chronic (>14 days) graft occlusion. Usually prosthetic graft occlusions can be successfully thrombolysed even after longer times of occlusion than 14 days, sometimes even after 4-6 weeks of occlusion. Low molecular weight heparin (1 mg/kg enoxiparine or dalteparine 100 U/kg) and 250 mg of ASA should be

given prior to the thrombolythic therapy. Especially in the midterm occlusions the progression of arteriosclerosis in the native inflow vessels needs PTA, endarterectomies or inflow-bypass grafting. Corrections of the graft itself can be done by PTA in short stenosis (<2 cm) with fairly good long-term results (28,29). Longer stenotic segments within the body of the graft or within the distal anastomosis should be treated with angioplasty or preferably with interposition grafting or jump grafting. In case of unsuccessful thrombolysis the patient has to be considered for regrafting.

Reoperative bypass surgery with autogenous venous conduits has been shown to achieve satisfactory long-term results. (6,30) De Frang et al. (6). reported a primary patency of 79,8% and a limb salvage rate of 69.6% at 4-years follow-up in patients with repeat leg bypass after multiple prior bypass failures. Their material of 85 infrainguinal bypass procedures after two or more failures contained 57 vein grafts and only 14 prosthetic bypass grafts and 4 composite conduits of vein and prosthesis.

While immediate or early postoperative graft failures are indications to reoperative procedures, in connection to intermediate or late postoperative failures, a number of additional considerations takes place before a decision to reoperate can be made. Poor life expectancy, non-ambulatory patients, high-risk patients with severe coronary disease, severe renal insufficiency or recent cerebro-vascular events should be considered as contraindications to reoperative measures. A major consideration is also the degree of ischemia and the alteration of the patient's life quality due to the failed graft. In case of reappearance of critical limb ischemia and if the patient has no other contraindications for surgery an attempt of bypass grafting or thrombolysis with or without revision is done. As a rule a new angiography is needed before reoperative surgery is done for failed grafts over 4 - 6 months of age. At this stage the most probable reason for graft failure is neointimal hyperplasia associated with progression of the arteriosclerosis that can change the bypass strategy compared to the previous angiography. The availability of vein material for the bypass is also to be considered. If the primary operation is done with synthetic graft material, as usually is the case for above knee bypass surgery and if no previous surgery for varicose veins is done, then there is no difficulty in performing saphenous vein bypass grafting. Previous surgery for varicose veins does not always mean total lack of veins. Vein mapping with Duplex can find saphenous vein duplicates and ectopic veins. If the other leg is not ischaemic the controlateral saphenous vein can be used. The ischaemic state of the controlateral leg should be evaluated by clinical examination, ankle brachial index pressure and toe pressure in diabetics. The proximal part of the saphenous vein can be harvested even in patients with ankle brachial index of 0.5-0.4, but the use of the distal part saphenous vein may be hazardous. It should be kept in mind that controlateral chronic limb ischemia appears in 30-50% of the cases within 3-5 years (3).

The cephalic and basilar arm veins may be available for bypass surgery. The length of the cephalic vein from the root of the thumb to the apex of the shoulder is often sufficient for bypassing. The basilar vein from the medial side of the arm can be anastomosed end to end with the cephalic, or used in a continuous U-form, in order to get sufficient length to the bypass. Harvesting of the superficial veins does seldomly lead to swelling of the arm. The use of the basilar and cephalic veins as bypass material results in good long-term results. Andros et al. (31) reported a 57% secondary patency rate at 5 years of follow up in a series with 88 arm veins. Harward et al. (32) reported in a series of arm veins as bypass grafts, a primary graft patency 67% at one year, and 49% at three years, and secondary patency of 66% at three years after revision of graftstenosis detected in six patients during the follow up. It is clear that a full length saphenous bypass available for revisional bypass surgery is the best option, but alternatively the use of arm veins, lesser saphenous veins or composite grafts such as combinations of different alternative conduits with meticulous end to end anastomosis have also acceptable patency rates (20,35). It seems that fairly good results are obtained, even in cases where spliced grafts composed of 2-3 different segments (arm vein/ectopic vein/lesser saphenous vein) are used. In long term follow up however, the resistance of the arm vein wall to arterial pressure can lead to elongation or dilatation (32).

Due to previous surgery, varicose vein surgery, coronary bypass-surgery, earlier infrainguinal reconstructions and possibly revisional surgery, the lack of vein material can be sometimes be absolute. Also previous trombophlebitis and repeated insertions of iv-lines during previous hospitalisations contributes to arm vein thrombosis and can lead to a serious lack of veins. The superficial femoral vein can in selected cases be used as a conduit. The dissection is quite cumbersome due to its deep location. The part of the superficial vein below the bifurcation of the deep femoral vein can be harvested for bypass purposes.

The radial artery, if not harvested for coronary surgery, can in selected cases be used in crural jump grafting. The use of PTFE grafts preferably with a distal vein-cuff is recommended in provisional surgery if autologous vein is not available (12,33,35). It should be kept in mind also that aggressive revisional surgery has its limits, and that the tolerance of the patient can be limited. Sometimes the patient is in a situation where the mobility is already severely restricted, and the amputation is not expected to significantly worsen the situation.

The patients life expectancy an also be low due to a concomitant disease. Although loss of a leg is considered an untoward event by the patient, rehabilitation and restoration of the walking ability can be quite successful among younger patients after amputation, especially after below knee amputations (34).

## Conclusions

Early graft failure postoperatively needs always to be treated with prompt surgery, thrombectomy, intraoperative angioscopy or angiography and correction of the cause of failure.

If 2- 4 weeks has passed since primary surgery, and whenever after this time period, thrombolysis is recommended as primary treatment in case of graft thrombosis. The lytic therapy is likely to be successful if the insertion of the catheter is successfully inside the thrombus and the time between thrombosis and diagnosis does not exceed 24 - 48 hours in vein grafts over 10 months of age, or if the graft material is PTFE.

If time between thrombosis and diagnosis is longer, thrombolysis is not recommended for venous grafts but PTFE grafts can still be opened with thrombolysis. Revascularisation with a new vein graft is recommended as first option, if the signs of critical ischemia are fulfilled, and the patient is suitable for redo-surgery. In lack of veins, or composite vein alternative, redo-surgery should be done preferentially using PTFE with a vein cuff to the crural level (35), and Dacron or PTFE to the above knee position (Figure 2).

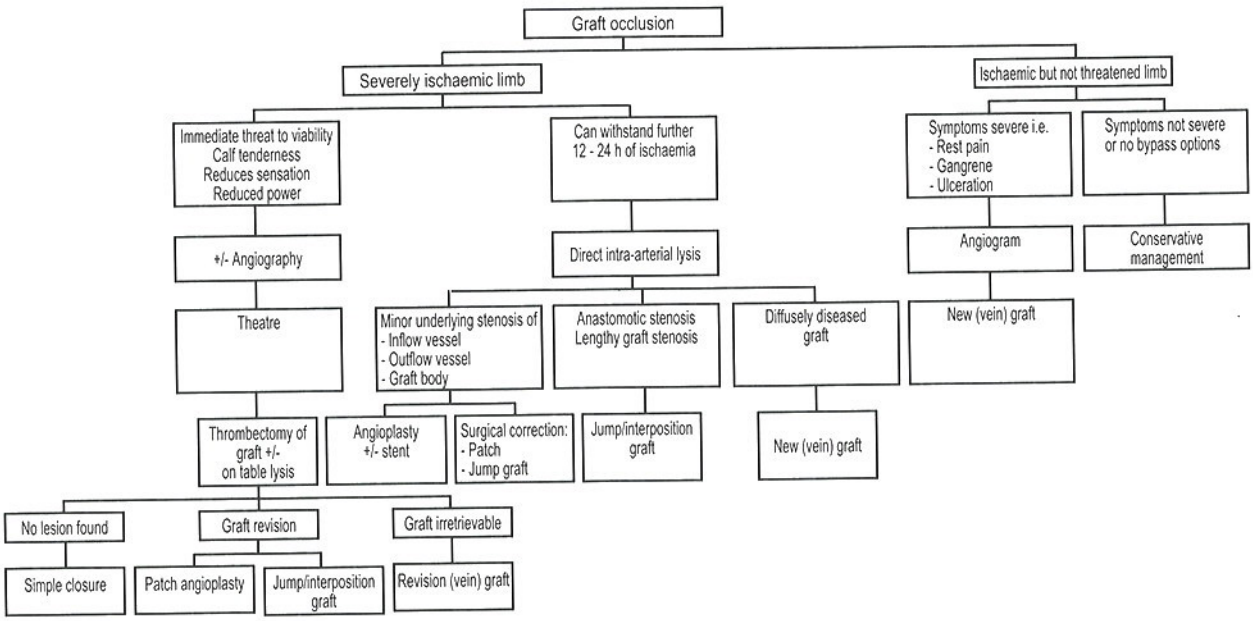


**FIGURE 2**

*Algorithm outlining the management of the occluded infrainguinal graft (Mireskandari - 2000 with permission)*

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