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LEADING ARTICLE

Refinements of the *In Situ* Vein Bypass: Towards a More "Closed" Technique

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Autologous greater saphenous vein is considered to be the best bypass material for below knee femoropopliteal and femorocrural arterial reconstructions. Although the patency rates of *in situ* bypasses are no better than reversed bypasses,[1] the *in situ* technique is the preferred technique in many clinics.

Two mandatory procedures during the *in situ* bypass operation are the closure of side branches and the cutting of the valves. These procedures are often performed under direct vision, necessitating a complete exposure of the greater saphenous vein. A disadvantage of this technique is the high incidence of postoperative wound complications. In two retrospective studies dealing with postoperative wound complications after *in situ* bypasses the incidences were 33% and 44%.[2,3] A logical step to reduce wound complications was the development of operating techniques with a reduced skin incision length. To allow selective ligation of side branches, via separate small incisions, the valvulotomy procedure must first be performed either "blindly" or under endoscopic control. The endoscopically controlled valvulotomy offers the advantage of direct visualisation of the effectiveness of the valvulotomy procedure. However Clair *et al.* showed in a randomised trial,[4] that endoscopically assisted *in situ* bypass grafting did not result in a better bypass performance.

Angiography, a Doppler device or a Duplex scanner can be used peroperatively to identify and selectively ligate the side branches.[5,6] Another option is to locate the side branches endoscopically. With this "semi-closed" technique the need for one long skin incision is obviated, but several small skin incisions, beside the incisions necessary for the anastomoses, remain.

The final step to a more "closed" technique, with less skin incision length, necessitates the closure of the side branches of the vein from the inside. Rosenthal *et al.* were the first to describe a series of these "closed" *in situ* bypasses.[7] They used an electronically steerable nitinol catheter system, to selectively, catheterise and coil-embolise the side branches of the vein. Peroperative coil-embolisation was performed under angioscopic and fluoroscopic control. In 46 patients a total number of 84 side branches (< 2 per bypass) were peroperatively coil embolised. In 39 patients extra small skin incisions were necessary to ligate or clip side branches that could not be coil embolised. The occurrence of postoperative residual arteriovenous fistulae was not mentioned in this preliminary report. Wound complications occurred in only 6% of the patients, but no details about the severity of the wound complications were available. The one year patency rate (13 grafts at risk), was 84%. The authors did not mention if this was primary or secondary patency.

Cikrit *et al.* used the same electronically steerable nitinol catheter system in a series of 30 patients (31 limbs).[8] After the first 16 operations they abandoned the angioscopic control during valvulotomy and coil embolisation. Valvulotomy was then performed blindly and the peroperative coil-embolisation was performed under fluoroscopic control only. In 31 operations a total number of 97 side branches were coil embolised. During seven operations an extra skin incision was necessary to ligate side branches that

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could not be embolised. In 39% of the cases residual arteriovenous fistulae were treated postoperatively. In 13% of the patients postoperative wound complications were reported. Early graft failure (within 30 days of the operation) was 6%. One year patency rates were not reported. Chervu *et al.* described their initial experience in three patients.[9] In two patients wound complications occurred. Residual AV-fistulae were seen in two patients. The operation time was significantly prolonged (1–5 h increase) by the endovascular coil embolisation procedure.

Wittens *et al.* describe a pilot series of 14 patients (16 limbs: 12 below knee femoropopliteal and 4 femorocrural).[10] They used a variable valvecutter for "blind" valvulotomy and a coaxial catheter system for the peroperative coil embolisation of the side branches. Fluoroscopic control was used during the coil embolisation procedure. In 16 operations 122 side branches were peroperatively coil-embolised. In four patients (25%) postoperative residual arteriovenous fistulae were treated. In two patients (13%) a major wound complication occurred. One year primary patency was 81% for the femoropopliteal and 50% for the femorocrural bypasses. Following this pilot study, a randomised multi-centre trial was performed.[11] Forty-seven "closed" *in situ* bypass procedures were compared to 50 "open" procedures. In the 47 "closed" procedures 272 side branches were coil embolised. In three of these patients additional skin incisions were necessary for ligation of side branches that could not be coil embolised. In two patients all side branches were ligated via skin incisions because of failure of the peroperative coil embolisation. All five were due to the small diameter of the vein of less than 3mm. In 42% of the "closed" procedures residual AV fistulae were treated compared to 8% in the "open" group. Total wound complication rates were 36% in the "closed" group compared to 72% in the "open" group. One year primary patency rates were similar for both patient groups.

Peroperative endovascular obliteration of side branches during *in situ* bypass procedures now appears feasible. However as pointed out very clearly by Chervu *et al.*[9] it is a costly and time consuming procedure especially when learning the technique. Successful embolisation-catheter manipulation requires a well trained operating team and optimal fluoroscopy for visualisation of the embolisation procedure. Since the quality of the greater saphenous vein is one of the factors influencing the outcome of an *in situ* bypass[12,13] and a diameter > 3mm and a normal anatomy are obligatory for a "closed" procedure, preoperative assessment of the vein is recommended. Currently ultrasound seems the best tool for this preoperative vein mapping.[14,15]

The "closed" *in situ* bypass technique reduces the wound complication rates significantly compared to the "open" technique.[11] Since the "closed" *in situ* bypass operation is more expensive, other patient treatment costs have to be less, to make the "closed" *in situ* bypass procedure worthwhile in a pure economic perspective. The reduction of wound complication rates could lead to a shortened hospital stay and reduced outpatient or community care. However in the study of Van Dijk *et al.*,[11] no significant reduction in hospital stay was seen, due to concommitant disease. By including outpatient care, a significant reduction in wound healing time was found, namely 18 days for the closed technique *vs.* 42 days for the open technique. A cost-effectiveness study comparing the financial as well as the medical consequences of the different operating technique is needed to answer the important question whether this new technique is acceptable in countries with a financially restricted health-care system.

A serious problem of the "closed" technique seems to be the high percentage of postoperative residual arteriovenous fistulae. Cikrit *et al.* reported that 39% and Van Dijk *et al.* that 42% of the patients received treatment for postoperative residual AV fistulae after a "closed" *in situ* bypass procedure. Treatment of these residual AV fistulae can be performed operatively or by percutaneous coil-embolisation.[16,17] Currently no generally accepted treatment criteria for residual AV fistulae are available. Since Chang *et al.*[18] have shown that in the majority of residual AV fistulae do not affect distal bypass flow and patency, it is possible that in the above mentioned studies, too many AV fistulae were treated postoperatively.

In conclusion we can state that the "closed" *in situ* bypass technique, using peroperative endovascular obliteration of the side branches is a promising new technique and potentially the new standard for *in situ* bypasses. The first encouraging results have to be corroborated by other studies, the problems of residual postoperative AV fistulae have to be solved and cost-effectiveness studies are needed to establish the role of this technique in the future.

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