Examination of Difference in the Proximal Anastomotic Site for Crus, Ankle Bypass: Common Femoral Artery vs Below the Knee Popliteal Artery

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Objective: We evaluated the outcomes of bypass surgery for revascularization in cases of critical limb ischemia with the distal anastomotic site at or below the ankle; we focused on the differences in outcomes between 2 groups having different proximal anastomotic sites.

Patients and Methods: Out of 270 cases diagnosed with critical limb ischemia from January 2003 to October 2009, bypass surgeries with the distal anastomotic site at or below the ankle were performed on the limbs of 69 patients (75 limbs). These cases were classified on the basis of the proximal anastomotic sites: group F (n = 50) where the common femoral artery was the proximal anastomotic site and group P (n = 25) where the below-knee popliteal artery was the site.

Results: The 5-year cumulative primary/secondary patency rates were 69.3%/81.8% for group F and 68.7%/84.9% for group P. The 5-year cumulative limb salvage rate was 97.9% in group F and 80.3% in group P.

Conclusion: Among the cases reviewed, results were comparable between cases with the proximal anastomotic site at the below-knee popliteal artery and those with the site at the common femoral artery.

Keywords: peripheral arterial disease, critical limb ischemia, femoral to distal bypass, popliteal to distal bypass, peripheral obstructive arterial disease

INTRODUCTION

Incidence of chronic arterial occlusion disease continues to rise, with increased life expectancy and changing lifestyles. As a result, opportunities to perform surgical lower-limb revascularization procedures like bypass surgeries with the distal anastomotic site in the leg or at or below the ankle are increasing. In this study, we evaluated the outcome of bypass surgery with the distal anastomotic site at or below the ankle; we primarily focused on differences in outcomes between 2 groups having different proximal anastomotic sites.

Subjects and Methods

Of 270 cases of critical limb ischemia diagnosed between January 2003 and October 2009, surgical revascularization was considered feasible and performed in 259 instances. Of these, bypass surgery with the distal anastomotic site in the ankle region was performed on the limbs of 69 patients (75 limbs). These cases were classified on the basis of the proximal anastomotic sites into a femoral artery group (F) and a below-knee popliteal artery group (P). The patency rates for these 2 groups were examined and compared.

Selection of the operative procedure: The proximal anastomotic site was determined using computed tomography angiography (CTA) and duplex scans. In instances
where no significant lesions were seen in the superficial femoral artery (SFA) as well as the proximal popliteal artery, the below-knee popliteal artery was considered the anastomotic site. The final decision was made by confirming the intraoperative blood flow in the post-anastomotic segment, confirmed beats of the popliteal artery with palpation.

Selection of grafts: Venous autografts were used for every surgery and their properties were evaluated using the duplex scan. The most important factors determining the selection of an operative procedure were the venous properties of each case; where there were no differences in venous properties, the less invasive operative procedure was chosen.

After vascular clamping, 100 U/kg of heparin was intravenously administered. Oral anti-platelet drugs and warfarin were given, and the prothrombin time-international normalized ratio was maintained at 1.5–2.5. After the operation, we started the patients on oral administrations of these drugs. Following surgery, follow-up of the patients was done using duplex scans at intervals of 1 month, 3 months, and every 3 or 4 months thereafter. When suspected stenoses were confirmed, their origins were traced by CTA and additional treatment was provided in cases with significant lesions.

The study included 69 patients (48 men, 21 women) with a mean age of 70 years (range, 24–88 years). A total of 75 limbs were treated. Table 1 details the preoperative characteristics of the patients and their lesions, including coexisting diseases and the Fontaine and TransAtlantic InterSociety Consensus (TASC) status. Table 2 provides information regarding the grafts.

The Kaplan–Meier analysis was used to assess primary and secondary graft patency, as well as limb salvage on the basis of the selection of proximal anastomotic sites. Cox hazard testing was used to compare results between the 2 groups. \( P < 0.05 \) was considered significant. All analyses were conducted using JMP software (version 8.0, SAS Institute, Cary, NC, USA).

**RESULTS**

In 1 case of SFA stenting, the proximal anastomotic site determined by the preoperative CTA changed from the below-knee popliteal artery to the common femoral artery on the basis of confirmation of intraoperative blood flow.

<table>
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<tr>
<th>Table 1 Patient characteristics</th>
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<tr>
<td><strong>Group F</strong></td>
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<tr>
<td>No. of patients/leg (including cases belonging to both groups)</td>
</tr>
<tr>
<td>Age (mean)</td>
</tr>
<tr>
<td>Gender (M/F) (including cases belonging to both groups)</td>
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<tr>
<td>Disease related with CLI (ASO/TAO)</td>
</tr>
<tr>
<td>Fontaine grade III</td>
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<tr>
<td>Fontaine grade IV</td>
</tr>
<tr>
<td>DM</td>
</tr>
<tr>
<td>CRF</td>
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<tr>
<td>MI</td>
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<td>CI</td>
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DM: diabetes mellitus; CRF: chronic renal failure; MI: myocardial infarction; CI: cerebrovascular infarction; CLI: critical limb ischemia; ASO: arteriosclerosis obliterans; TAO: thromboangitis obliterans

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<tr>
<th>Table 2 Graft material</th>
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<tr>
<td><strong>No</strong></td>
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<tr>
<td>in situ bypass</td>
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<tr>
<td>Non reversed vein bypass</td>
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<tr>
<td>Reversed vein bypass</td>
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<td>Spliced vein graft</td>
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The mean operative time and the mean blood loss were 298 min and 449.7 ml in group F, and 243 min and 324 ml in group P, respectively.

The 5-year cumulative primary/secondary patency rate was 69.3%/81.8% for group F and 68.7%/84.9% for group P (Figs. 1 and 2).

Endovascular repair of SFA was performed simultaneously for 4 group P patients, all of which were TASC A cases who obtained patency during the observation period.

There were no intraoperative deaths; however, occlusion occurred in 11 limbs: 8 (16%) in group F and 3 (12%) in group P. Following occlusion, 8 limbs were Fontaine stage III or below: 6 limbs in group F and 2 limbs in group P. One limb in group F was stage IV, and major amputation from the ankle to the center was performed on 2 limbs (1 limb [2%] in group F and 1 limb [4%] in group P).

In addition, amputation due to infection in spite of graft patency was performed on 3 limbs in group P, all of which were either of patients with diabetes or chronic renal failure. The 5-year cumulative limb salvage rate was 97.9% in group F and 80.3% in group P (Fig. 3). There is no statistically significant difference in primary and secondary patency, as well as in the limb salvage rate, between groups F and P.

**DISCUSSION**

With an increase in the incidence of diabetes and cases of chronic renal failure,1 instances of bypass surgery with the distal anastomotic site at or below the ankle have also increased.2 Securing adequate blood flow at the proximal anastomotic site is fundamental to the bypass procedure. Therefore, in many cases the common femoral artery is chosen as the proximal anastomotic site despite the fact that significant vein harvesting of bypass material is required to cover the entire lower limb. Operative procedures using the popliteal artery site have been reported in Europe and America.3–7) In Japan, since target lesions of lower limb ischemia localize mostly in the femoral and popliteal arteries, most operative procedures involve the common femoral artery. However, simultaneous to the increase in cases of diabetes and chronic renal failure, situations where lesions in the legs play a main role in the disease pathology have also increased. Due to these changes, the frequency of performing bypass procedures involving the popliteal artery, which was rarely selected
Fig. 2  Secondary patency rates comparing group F to group P. The secondary patency rate is 81.8% for group F and 84.9% for group P after bypass surgery.

Fig. 3  Limb salvage rates comparing group F to group P. The limb salvage rate is 97.9% for group F and 80.3% for group P after bypass surgery. In addition, amputation due to infection, in spite of graft patency, was performed on 3 limbs in group P, all of which were either of patients with diabetes or chronic renal failure.
before, is increasing.\(^8\)

The most important factor in the criteria that sets the proximal anastomotic site as the below-knee popliteal artery is the absence of a significant lesion in SFA. Palpable beats of the popliteal artery and absence of significant stenosis on diagnostic imaging were previously reported adaptation conditions.\(^9\) In the present study, absence of significant lesions on CTA in SFA or the popliteal artery and confirmation of intraoperative blood flow in the below-knee popliteal artery are the adaptation conditions. However, an intraoperative decision taken in 1 case changed the proximal anastomotic site to the common femoral artery. Although, palpable beats of the popliteal artery is somewhat subjective, there is considered reasonable for this study.

Development of lesions in SFA postoperatively is an interesting finding. This phenomenon does not occur very often when the proximal anastomotic site is the below-knee popliteal artery.\(^10\) Similarly, in our study, significant development of proximal lesions was not seen in the 3 cases with occlusion in group P. Furthermore, no case in group P required additional treatment for proximal SFA lesions during the postoperative observation period. When considering the grafts used, cases with spliced vein grafts totaled 36% in group F, whereas there was only 1 (4%) case in group P. Bypass surgeries in all other cases were performed using a single-vein graft. In addition, in-situ bypasses were also feasible for 24% of group P, a finding similar to that previously reported.\(^11\) Furthermore, operative time and blood loss tended to be less in group P than in group F. These results support the usage of the below-knee popliteal artery as a proximal anastomotic site, the advantages being a shorter graft length that reduces the amount of vein harvested, simplification of the operative procedure, and reduction in operative time and blood loss. Due to recent developments in endovascular repair procedures, there is an increase in the number of reports on results for TASC A and B lesions in the femoral artery region.\(^12\) There are also reports on combination endovascular repair for TASC A lesions in the SFA region and bypass surgery in the leg.\(^13,14\) In this study, endovascular repair was performed in 4 cases of TASC A with similar outcomes. Hence, good results with endovascular repair in the femoral artery region are additional incentives to encourage the use of this bypass design.

Although a previous report had concluded that patency rates are higher when the proximal anastomotic site is at the above-knee popliteal artery than at the below-knee popliteal artery,\(^15\) the primary and secondary five-year patency rates in our study showed no differences for groups F and P. The results obtained in this study indicate that if neither SFA nor the popliteal artery have significant lesions, the outcome of a bypass surgery using below-knee popliteal artery as the proximal anastomotic site is comparable to that where the common femoral artery is used. Furthermore, there may be an advanced possibility that endovascular repair of SFA to secure inflow may also be established on the basis of strict adaptation.\(^16\)

**Conclusion**

Bypass surgery cases around the ankle with the absence of lesions in SFA as well as the popliteal artery, and with the proximal anastomotic site at the below-knee popliteal artery shows results comparable to cases with the site at the common femoral artery.

**References**