Lymph Drainage and the Development of Post-reconstructive Leg Oedema is not Influenced by the Type of Inguinal Incision. A Prospective Randomised Study in Patients Undergoing Femoropopliteal Bypass Surgery

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Introduction

Leg oedema located in the subcutaneous tissue commonly occurs following femoropopliteal bypass surgery.¹² The oedema increases to a maximum at about 1 week postoperatively and then declines gradually.³ This leg oedema may concern the patient and delay rehabilitation following an otherwise successful operation. Impaired lymph drainage⁴⁻¹⁰ and an increased capillary filtration rate¹¹,¹² have been suggested as mechanisms responsible for the post-reconstructive leg oedema formation. The oedema has also been explained as a manifestation of the reperfusion syndrome caused by ischaemic damage to the tissue.¹³,¹⁴ Deep venous thrombosis is uncommon following intrainguinal arterial reconstruction and therefore unlikely to explain postoperative leg oedema formation.¹⁵,¹⁶

Impaired lymph drainage is thought to be caused primarily by lymphatic damage due to surgical dissection. Attention has therefore focused on preservation of the lymphatic network, especially in the inguinal region and in the upper thigh.⁴⁻¹⁰ It has been suggested that modifications of the groin incision, avoiding the major lymphatics, could to some extent prevent postoperative leg oedema.⁵,¹⁷

The primary intention of this prospective investigation was to evaluate whether the type of groin incision; either a lateral incision or a direct medial incision over the femoral vessels, significantly influenced postoperative leg oedema formation. Further-
more, lymphoscintigraphy was used to ascertain whether the type of groin incision affected the degree of lymphatic damage.

**Material and Methods**

Twenty-four patients received a femoropopliteal bypass for either intermittent claudication \( (n = 16) \) or critical lower limb ischaemia \( (n = 8) \). The mean age was 70 years (range 54–84 years) and the series included 14 women and 10 men.

**Surgical procedure**

The patients were randomised before operation to receive either a lateral incision (Group A, \( n = 12 \)) or a direct medial incision over the femoral vessels in the groin (Group B, \( n = 12 \)). The lateral groin incision was made along the medial border of the sartorius muscle which was easily recognised by palpation. With this approach the intention was to avoid lymphatic disruption by lifting the skin and subcutaneous tissue as a flap in the medial direction, thereby giving access to the common femoral artery by a lateral route (Fig. 1A). When using the alternative direct incision no special attention was paid to the lymphatic network (Fig. 1B).

In both groups wound closure was performed with continuous rows of polygiumin 910 (Vicryl\textsuperscript{R}) in the muscular fascia and in the subcutaneous tissue, respectively. In all cases care was taken not to place the subcutaneous suture too deep to avoid inclusion of the lymphatics. Finally, the skin was closed with interrupted polyamide (Ethilone\textsuperscript{R}).

The distal anastomosis was located above the knee level in 15 cases, and below the knee in the remaining cases. In 16 patients autologous greater saphenous vein was used as bypass graft, while the rest of the subjects received externally ring-supported PTFE graft (Goretext\textsuperscript{R}) because the vein was found to be unsuitable.

To improve graft blood flow and as prophylaxis against venous thrombosis, all patients received intravenous dextran 70 (Macrodex\textsuperscript{R}); 500 ml on the day of operation as well as 500 ml on the first postoperative day.\textsuperscript{19} A vacuum drain was routinely placed at each anastomosis until the next postoperative morning. Intravenous cefalotin (Keftin\textsuperscript{R}) 1 g, four times, was administered for 2 days including the day of operation.

Both groups were similar with respect to age and sex ratio, as well as the degree of preoperative ischaemia, level of distal anastomosis and selection of graft material (Table 1).

**Clinical and vascular laboratory assessment**

The ankle-brachial pressure index (ABPI) was measured pre- and postoperatively by the Doppler technique. Leg volume increase was calculated 7 days postoperatively.

<table>
<thead>
<tr>
<th>Preoperative ischaemia</th>
<th>Group A ((n=12))</th>
<th>Group B ((n=12))</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent claudication vs. critical ischaemia</td>
<td>7 : 5</td>
<td>7 : 5</td>
<td>NS</td>
</tr>
<tr>
<td>Distal anastomosis</td>
<td>Above knee vs. below knee</td>
<td>6 : 6</td>
<td>9 : 3</td>
</tr>
<tr>
<td>Graft material</td>
<td>Vein vs. PTFE</td>
<td>8 : 4</td>
<td>8 : 4</td>
</tr>
</tbody>
</table>
postoperatively according to the formula of a truncated cone after measurement of the leg circumference 5–7 cm above the medial malleolus and at the greatest circumference, 25–28 cm proximal to the medial malleolus. The contralateral limb served as control.

Approximately 7 days (range 5–10 days) postoperatively, a screening test for deep venous thrombosis was performed by air plethysmography (Stranden plethysmograph, STR-Teknikk, Oslo, Norway), or by colour-coded Duplex scanning (Vingmed CFM 750, Vingmed Sound, Horten, Norway) using a 7.5 MHz imaging probe and a 6 MHz transducer to receive the Doppler signal.

**Lymphoscintigraphy**

At an average of 7 days (range 5–10 days) postoperatively all patients were examined by lymphoscintigraphy with $^{99m}$Tc labelled human serum albumin ($^{99m}$Tc HSA) of both limbs with the non-operated side serving as control. Approximately 200 MBq $^{99m}$Tc HSA in 0.2 ml saline (IFE, Kjeller, Norway) was injected intradermally between the first and second toe using a 27 gauge needle. During the investigation, all patients were placed in a supine relaxed position for examination with a gamma camera having a 54 × 40 cm field of view (Elscint Apex SP-6, Elscint Ltd., Haifa, Israel) connected to a nuclear medicine computer (Elscint Apex SP-1, Elscint Ltd., Haifa, Israel). Dynamic acquisition was performed by taking sequential images of a field, reaching from the knee level of both limbs distally and including the pelvis proximally, every 2 min for a period of 40 min. Sequential images were grouped to give a summary image of the investigation period.

The images showing radioisotope transport and uptake through lymphatic vessels and lymph nodes of the operated limb was compared with the contralateral limb of each patient. Lymphatic damage could be demonstrated by the following morphologic abnormalities in the lymphoscintigrams: lymphatic interruption, lymph cysts, extravasation of radioactivity or collateral pathways. Lymphatic interruption, defined as abrupt loss of radioactive visualisation along the lymphatic trunks or delayed appearance of radioisotope in the groin, was used as the main parameter of lymphatic damage. Lymph cyst formation was defined as radioactivity appearing as a shape with regular margins outside the lymphatic trunks. Extravasation of radioactivity appears in the lymphoscintigraphic images as diffuse interstitial activity in the thigh and the inguinal region.

**Statistics**

The statistical calculations were based on the Student's t-test for paired data, the Student's t-test for independent samples and the chi-square test. The summary statistics are given as mean and S.D.. The level of significance was set to 0.05.

**Results**

The ABPI increased from 0.51 (0.16) preoperatively to 0.85 (0.13) postoperatively in the operated limb of the pooled group of patients ($p = 0.001$). The increase was similar in both groups. No change of ABPI was detected in the contralateral control limb, neither in the total group of patients nor in the two subgroups. No cases of DVT were detected postoperatively.

On the seventh postoperative day the average leg volume increase in the total group of patients was 23.9 (12.0)%$. The leg volume increase was of the same magnitude whether the surgical approach was lateral or direct over the femoral vessels in the groin; 24.5 (15.5)% in Group A vs. 23.3 (7.9)% in Group B (N.S.).

The lymphoscintigraphic investigation revealed interruption of the lymphatics in five patients of Group A and in three patients of Group B. Lymphatic obstruction was observed in the groin ($n = 5$) (Fig. 2), thigh ($n = 1$) and at or below the knee level ($n = 2$) (Table 2). Signs of collateral lymphatic pathways in three patients were associated with lymphatic interruption (Fig. 3). Two patients had lymph cysts in the inguinal region. Eight patients presented with extravasation of radioactivity in the thigh on the operated side, two of these had simultaneous lymphatic interruption. The occurrence of lymphatic obstruction, lymph cyst or extravasation of radioactivity did not differ between the two groups of patients (Table 3). In one patient no images were obtained due to difficulties with the isotope injection procedure. In the remaining seven patients no lymphatic lesion was observed (Fig. 4). Lymphatic lesions were not found in any of the contralateral non-operated limbs.

In the operated limbs the leg volume increase was 20.6 (7.0)% in patients with normal lymphatics ($n = 7$), 16.6 (7.0)% with extravasation of radioactive lymph ($n = 6$), 24.9 (0.8)% with lymph cysts ($n = 2$) and 31.2 (16.6)% with lymphatic interruption ($n = 8$). There was no difference in the magnitude of the postoperative

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Fig. 2. Lymphoscintigraphy of the lower extremities with $^{99m}$Tc labelled human serum albumin. Lymphatic interruption is easily observed in the groin on the operated left limb (arrowed).

leg swelling in the operated limb of the patients with normal lymphoscintigraphy vs. the patients with lymphatic interruption, lymph cyst or extravasation of radioactivity, when comparing the single groups with each other (NS). On the other hand, there was a larger leg volume increase on the operated side of the patients with lymphatic interruption ($n=8$) compared to the rest of the patients with no or minor lymphatic lesions ($n=15$) found by lymphoscintigraphy ($p<0.05$) (Table 4).

Discussion

The intraoperative damage of the lymphatics during

<table>
<thead>
<tr>
<th>Level of lymphatic interruption</th>
<th>Group A ($n=12$)</th>
<th>Group B ($n=12$)</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groin</td>
<td>2</td>
<td>3</td>
<td>NS</td>
</tr>
<tr>
<td>Thigh</td>
<td>1</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td>Knee</td>
<td>2</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>3</td>
<td>NS</td>
</tr>
</tbody>
</table>

vascular reconstructions was described by Vaughan et al. Several studies using contrast lymphangiography have indicated a relationship between the degree of post-reconstructive leg oedema and the number of damaged lymphatic channels. Lymphatic damage has been found along most of the areas of surgical dissection, especially at the medial aspect of the knee where the lymphatics are confluencing, in the mid-thigh region and in the groin. Lymphangiography has been the definitive method for evaluation of the lymphatic system. However, this method is invasive and may have certain side effects. In addition it

<table>
<thead>
<tr>
<th>Lymphatic lesion</th>
<th>Group A ($n=11$)</th>
<th>Group B ($n=12$)</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lymphatic interruption</td>
<td>5</td>
<td>3</td>
<td>NS</td>
</tr>
<tr>
<td>Lymph cyst</td>
<td>0</td>
<td>2</td>
<td>NS</td>
</tr>
<tr>
<td>Extravasation of lymph</td>
<td>3</td>
<td>5</td>
<td>NS</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>10</td>
<td>NS</td>
</tr>
</tbody>
</table>
Fig. 4. Lymphoscintigraphy of the lower extremities with $^{99m}$Tc labelled human serum albumin. There is normal, symmetrical transport of the radioisotope in both limbs without any lymphatic damage on the operated right limb (left side of the picture).

gives little information on the function of the lymphatics. During recent years lymphoscintigraphy has developed as an alternative and simpler method for morphologic and functional assessment of the lymphatic tissue. The method is especially important for the diagnosis of chronic lymphoedema. However, in some investigations lymphoscintigraphy has also shown a good agreement with lymphangiography in the diagnosis of lymphatic damage following infrainguinal bypass surgery.

Dynamic studies with quantitation of radioactivity giving time-activity curves may be valuable in the investigation of the lymphatic tissue, especially in chronic lymphoedema. However, this technique is easily disturbed if isotope escapes into the venous system. Furthermore, surgical tissue trauma and motion artifacts are known to interfere with the results. The interpretation of quantitative lymphoscintigraphy would therefore have been difficult in patients undergoing vascular surgery and was not found applicable in our study. In the present investigation lymphoscintigraphy was instead performed by dynamic acquisition, using $^{99m}$Tc HSA, which gave sequential images of the lymphatic vascular morphology. By injecting the isotope on the dorsal aspect of the foot, as recommended by Ohtake et al., the main lymphatic trunks in the thigh and the inguinal region of both limbs could be visualised. Because of a high clearance rate of the radioactive human serum albumin from the peripheral tissue, the investigation could be completed in a relatively short time and without discomfort or adverse effects for the patients.

By performing superficial lymphoscintigraphy with injection of the radioisotope in the first digital interspace, lymphatic lesions located to the thigh and groin were observed in a majority of the patients. If the study had been extended by an investigation of the deep lymphatics, perhaps even more lymphatic damage might have been revealed. However, this would have required repeated investigations in all of the patients, which we did not think was justified.

Visual interpretation of the lymphoscintigraphic images was based on three main lymphatic patterns: interruption, lymph cysts and diffuse extravasation of radioactivity outside the lymphatics. As shown by other reports, we found that interruption of the lymphatics was the main indicator of lymphatic damage, whereas lymph cysts and extravasation are both considered to represent minor lesions of the lymphatic tissue. Extravasation may even be found in healthy subjects, whereas collateral pathways were in all cases seen in association with lymphatic interruption as shown in Fig. 3.

No difference was observed in the occurrence of lymphatic obstruction between the two groups of patients with respect to groin incision. Furthermore, the extent of lymphatic interruption was similar whether a reversed saphenous vein or a PTFE graft was used. In most patients the lymphatic interruption occurred in the groin or in the thigh. The study shows that lymphatic disruption may occur even with a
lateral groin incision. A possibility is that during application of the subcutaneous suture, lymphatics could have inadvertently been included in the sutured tissue. Furthermore, the function of the lymphatics is sometimes reduced because of adjacent tissue trauma. Lymphatic damage could possibly be avoided if the lymphatic vessels had been visualised by preoperative injection of a coloured dye in the foot.6,10

As indicated by earlier investigations, lymphoedema is a possible mechanism for post-reconstruction leg oedema.2-10 Stranden4,12 has shown that an increased transcapillary fluid filtration is generally found in the limbs developing post-reconstructive leg oedema. However, the mechanism of lymphatic propulsion is still intact.31 In this study a statistically significant relationship is shown towards increased leg volume postoperatively following infrainguinal bypass surgery.

In conclusion, following femoropopliteal bypass surgery, the same degree of leg oedema formation and the same occurrence of lymphatic lesions was observed regardless of whether the groin incision was placed laterally or directly over the femoral vessels. There was an increased leg volume postoperatively in patients with lymphatic interruption, shown by lymphoscintigraphy. This indicates that lymphatic obstruction causing acute lymphoedema is a part of a multifactorial mechanism leading to post-reconstruction leg oedema.

References


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