

The value of pre-operative ultrasound mapping of the greater saphenous vein prior to 'closed' in situ bypass operations

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Abstract

Objective: The aim of this study was to test pre-operative ultrasound mapping for the detection of duplications and narrow vein segments of the greater saphenous vein (GSV) used as bypass for occlusive arterial disease surgery. **Patients and methods:** In 44 patients pre-operative ultrasound findings of duplications and lumen assessment of the GSV were compared to the per-operative findings. **Results:** In nine patients (20%) the pre-operative ultrasound examination showed a duplication. Pre-operative ultrasound had missed a duplication in two cases but had instead shown a narrow segment in both. The pre-operative ultrasound assessment of lumen diameter showed a narrow lumen segment in 10 of the 44 patients. In one patient a per-operatively narrow lumen had not been seen on pre-operative ultrasound. **Conclusion:** Pre-operative ultrasound mapping of the GSV is a sensitive tool for detection of duplications and narrow vein segments. Since these anatomical variations provide important information for the vascular surgeon, before performing a 'closed' in situ bypass operation, pre-operative vein mapping should be considered when planning such a procedure.

Keywords: Ultrasound studies, saphenous vein; Veins, greater saphenous; Veins, US study; Veins, surgery

1. Introduction

It is generally accepted that autologous vein is the preferred bypass material for surgical arterial reconstruction in the lower extremity since it offers the best patency rates. Usually the greater saphenous vein (GSV) is chosen if it is of sufficient quality to serve as an arterial bypass. The GSV can either be used 'reversed' or 'in situ'. When the reversed technique is chosen, the GSV is removed over the length necessary for the bypass. Subsequently the vein is anastomosed reversed, i.e. the distal end is anastomosed proximally and vice versa. Reversal is necessary because the valves in the vein would otherwise hamper the arterial blood flow. All side branches of the vein are ligated during the removal of the vein. As the name 'in situ' suggests, this technique,

in contrast to the reversed technique, leaves the GSV in its anatomical place. To achieve an adequate bypass, this technique requires that the valves in the vein are rendered insufficient and the side branches of the vein ligated. Usually this technique is performed 'open', i.e. the GSV is exposed over the entire length needed for the bypass. This 'open' technique leads to a high number of post-operative wound complications: Reifsnnyder et al. reported 34% wound complications in a retrospective study [1].

Recently modifications of the 'in situ' bypass technique have been proposed to reduce the length of the skin incision and thereby the number of wound complications [2,3]. Two procedures are necessary for these 'closed' in situ bypass techniques: (1) the blind cutting of the valves of the greater saphenous vein (GSV), and (2) per-operative coil embolisation of the side branches of the GSV. In a previous article, we noted that two anatomical aspects of the GSV in particular are impor-

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Table 1
Patient characteristics and indications for surgery

| Patient characteristics | |
|-----------------------------------|----------|
| Male:female | 29:15 |
| Age (years) | 70 |
| Operation indication ^a | |
| Fontaine II:III:IV | 15:10:19 |
| Diabetes | 18% |
| Smoking | 30% |
| Hypertension | 25% |
| Ischaemic heart disease | 41% |

^aFontaine classification: II, intermittent claudication (in all patients IIb, walking distance <100 m); III, rest pain; IV, ulcer and/or necrosis.

tant determinants for a successful 'closed' in situ bypass procedure, namely, the occurrence of duplications and narrow segments of the GSV [3].

B-mode ultrasound scanning as described by Leopold et al. [4] is considered the best way to perform pre-operative examination of the GSV. The aim of this study was to test the efficacy of pre-operative ultrasound mapping of the GSV for detection of duplications and narrow vein segments.

2. Patients and methods

In 44 patients with arterial obstructive disease, in which a venous bypass with a below knee distal anastomosis was planned, pre-operative ultrasound examination of the GSV was performed less than 1 week prior to surgery. Characteristics and indications for the arterial reconstruction are shown in Table 1. An in situ bypass ('open' or 'closed') was performed. In three patients however a 'semi-closed' procedure was performed, i.e. the side-branches were ligated via separate small skin incisions, because the operator was not yet familiarised with the 'closed' technique. The reversed

Table 2
Types of operative procedures performed

| Types of surgical procedures (N = 44) | |
|--|----|
| In situ femoro-popliteal (N = 22) ^a | |
| "Open" | 12 |
| "Closed" | 9 |
| "Semi-closed" | 1 |
| In situ femoro-crural (N = 13) | |
| "Open" | 9 |
| "Closed" | 2 |
| "Semi-closed" | 2 |
| Reversed femoro-popliteal ^a | 1 |
| Reversed femoro-crural | 2 |
| Prosthetic bypass | 6 |

^aFemoro-popliteal bypasses always with a distal anastomosis below knee joint level.

Table 3
Duplications (N = 44) of the greater saphenous vein. Pre-operative ultrasound vein mapping findings compared to per-operative findings

| Pre-operative | During operation | |
|---------------|------------------|-------------|
| | Normal | Duplication |
| Normal | 33 | 2 |
| Duplication | 3 | 6 |

GSV technique was used if the ipsilateral GSV was not available or considered inadequate per-operatively and the contralateral GSV was acceptable. A prosthetic bypass was used if no adequate GSV was available at all. Veins of other parts of the body were not used. Also no composed grafts were used in this study. Table 2 shows the numbers of the different operative procedures.

The pre-operative ultrasound vein mapping was performed with a Dornier AI 3200 B-mode ultrasound scanner. A 7.5-mHz linear array transducer was used. Patients were examined with the leg in a vertical position: standing or sitting on a high chair with the examined leg dangling. If the ipsilateral vein was considered not suitable for a bypass, the contralateral GSV was also examined. The pre-operative ultrasound and per-operative visual aspects of the GSV were described as follows: (1) the occurrence of duplications was scored; (2) the diameter of the vein was assessed for stenoses.

The pre-operative ultrasound criterion for a narrow segment was if the smallest venous lumen diameter <2.0 mm. The per-operative criterion was a subjective judgement of narrowness by the surgeon, without the use of a caliper or other measurement since only outer diameter and not lumen diameter was assessed per-operatively.

The ultrasound findings were pre-operatively available to the surgeon. There was an agreement that the findings on ultrasound were not to be considered a reason for not using the vein as a bypass without per-operative inspection of the vein.

3. Results

In nine patients (20%) the pre-operative ultrasound examination showed a duplication of the GSV (Table 3).

Table 4
Diameter assessment (N = 44) of the greater saphenous vein. Pre-operative ultrasound vein mapping findings compared to subjective per-operative findings

| Pre-operative | During operation | |
|----------------|------------------|--------|
| | Normal | Narrow |
| Normal | 33 | 1 |
| Narrow (<2 mm) | 4 | 6 |

Pre-operative ultrasound had missed a duplication in two cases but had instead shown a narrow segment with a lumen <2 mm in both.

The pre-operative ultrasound assessment of lumen diameter showed a narrow lumen segment in 10 of the 44 patients (Table 4).

4. Discussion

Pre-operative ultrasound mapping of the GSV allows visualisation of duplications and narrow segments of the GSV. With pre-operative vein mapping duplications of the GSV were observed in 20%. Two duplications were missed with pre-operative ultrasound. In both patients pre-operative ultrasound had only shown a narrow vein segment, possibly one half of the duplicated segment. In three patients in which pre-operative ultrasound showed a duplication, this was not visualised per-operatively, possibly due to the fact that the duplicated part of the GSV was not explored totally and therefore the duplication could have been interpreted as being a side branch. If the pre-operatively and per-operatively demonstrated duplications are added, a total of 11 duplications in 44 legs (25%) were seen. This figure lies between the 42% seen by Leopold et al. [5] and the 18% found by Ruoff et al. [6]. Both however only recorded the number of duplications seen with pre-operative ultrasound vein mapping and did not mention any 'missed' duplications encountered per-operatively.

When planning per-operative coil embolisation for a 'closed' in situ bypass technique, requiring endovascular catheter manipulation, an accurate pre-operative diameter assessment is essential since a lumen diameter of ≥ 3 mm is preferred [7,8]. The coil embolisation catheter we use has a 7-F (2.1 mm) diameter, therefore we consider a venous lumen diameter <2 mm to be an absolute contra-indication for a closed in situ bypass. The pre-operative assessment showed a venous lumen with the smallest diameter <2 mm in 10 patients. Only in one patient a per-operatively found narrow venous lumen was not anticipated pre-operatively with ultrasound. In four patients a narrow vein anticipated pre-operatively was not considered to be narrow during the operation. The diameter of the GSV was examined with the patients leg in a vertical position. This may explain the apparent overestimation of the occurrence of narrow segments, since Blebea et al. showed that the optimal position for venous mapping, leading to the largest

measured vein diameters, is not the vertical position but supine in combination with the use of a high-thigh tourniquet [9].

Pre-operative ultrasound vein mapping is a relatively inexpensive and unharmed investigation which can provide useful information when planning lower extremity vein bypass surgery. We have shown that the pre-operative ultrasound mapping is a sensitive tool for the detection of duplications and narrow segments of the GSV. Therefore this safe and inexpensive investigation should be considered before planning a 'closed' in situ bypass procedure. Pre-operative vein mapping can be performed with the leg in a vertical position as we did, but the supine position with use of a high-thigh tourniquet is to be preferred [9].

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