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Work in progress report - Coronary

Pre-operative long saphenous vein mapping predicts vein anatomy and quality leading to improved post-operative leg morbidity☆

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Abstract

Long saphenous vein harvesting for coronary bypass surgery is associated with significant morbidity. Furthermore, vein quality is often variable sometimes requiring incisions in both legs. This prospective randomised control study assessed the usefulness of pre-operative long saphenous vein mapping in terms of conduit quality and location, incision lengths and post-operative morbidity. The long saphenous vein was assessed and mapped pre-operatively ($n=31$) by venous Doppler ultrasound or not ($n=30$). The size and anatomical distribution of the long saphenous vein was well predicted by the ultrasound study (correlation coefficient=0.87). Intra-operatively, the mean length of leg wound incision per vein graft performed was significantly less in the mapped group [16.8 (4.0) vs. 24.1 (10.4) cm, $P=0.005$]. This translated in a shorter operative time for vein harvesting per length of vein graft needed [36 (13) vs. 47 (17) min, $P=0.04$]. Post-operatively there was a tendency to less leg wound complications in the mapped group ($P=0.08$) and earlier hospital discharge (median length of stay 6.5 days vs. 8.0 days, $P=0.05$). Thus, long saphenous vein mapping pre-operatively predicted the size and anatomy of the vein appropriately. This led to a selective leg wound incision and reduced operative time with the benefit of reduced leg complication post-operatively.

Keywords: Long saphenous vein mapping; Doppler ultrasound

1. Introduction

The long saphenous vein (LSV) remains the most commonly used conduit for coronary artery bypass surgery. However, the morbidity associated with the harvesting of the vein has been reported to be around 40% [1, 2] and includes wound infection, non-infective wound suppuration requiring regular nursing care, leg wound pain, reduced patient's mobility and prolonged in-hospital stay and increased cost. Although minimally invasive techniques for vein harvesting have been have been proven to be better than the open technique [3], its use is still limited to a few centres only despite the availability of re-useable systems and that the overall cost be acceptable as significant leg wound problems are avoided.

Currently, in our Unit, the long saphenous vein is harvested by the open technique, starting from the medial malleolus and proceeding proximally towards the groin. However, there is variability in the calibre and the quality of the vein sometimes requiring incisions in both legs. Segments of the harvested vein, which are of poor quality, have to be discarded.

The aim of this study was to assess the usefulness of pre-operative long saphenous vein mapping in terms of conduit quality and location, incision lengths and post-operative morbidity.

2. Methods

Patients undergoing coronary artery bypass graft (CABG) where the LSV was used as a bypass conduit were recruited in a prospective randomised control trial. Thirty-one patients underwent vein harvesting after the leg had been mapped pre-operatively by venous Doppler assessment while 30 patients who had their LSV harvested from the traditional open technique without mapping were recruited as controls.

The primary end-point of this study was to assess whether LSV anatomy and quality could be evaluated by vein mapping pre-operatively. Secondary end-points included (a) an evaluation of the time differences in harvesting the LSV and closing the wound between the two techniques, (b) leg wound healing as assessed by the ASEPSIS score, (c) the degree of discomfort experienced by the patient as assessed by a visual analogue pain score, (d) patient mobilisation as assessed using a linear scale measure, and (e) the impact on in-hospital stay. The study was powered at 0.9 using an alpha of 0.01.

This study was approved by both the institutional Research and Development Unit and the Local Ethics Research Committee. Patients undergoing CABG were recruited pre-operatively and gave written consent to be part of the study.

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Preoperative variables included patients' age, gender and pre-op incidence of diabetes, peripheral vascular disease, smoking history, ejection fraction, priority of surgery and body surface area, size and anatomical distribution of the long saphenous vein as assessed by venous Doppler ultrasound. Post-operative variables included the ASEPSIS score [4] (Additional treatment, Serous discharge, Erythema, Purulent exudates, Separation of deep tissues, Isolation of bacteria, Stay as patient prolonged over 14 days), patients' comfort as assessed by a visual analog pain scale (score from '0 to 10' with '0' denoting no pain and '10' describing the worse pain experienced) and mobility score post-operatively (score from '0 to 10' with '0' being immobile and '10' being fully mobile) before hospital discharge (Day 6 post op) and at six weeks' follow-up as well as the in-hospital duration of stay. Peri-operative data included the size and anatomical distribution of the long saphenous vein, the lengths of (i) leg wound, (ii) vein harvested, (iii) vein not used and the reason for not using that piece of vein as well as the time duration to harvest and close the leg wound.

All patients received identical medical, surgical and nursing intervention. All patients had the skin preparation using iodine solution and sterile drapes to isolate the sterile operative field. Antibiotic prophylaxis consisted of cefuroxime 1500 mg and teicoplanin 400 mg, at the time of induction and two further doses of cefuroxime (750 mg each) at 8 and 16 h post op. The wound dressing and leg bandaging were identical for the two groups.

The ultrasound equipment used was a Toshiba Aplio colour flow ultrasound system (Toshiba Medical Systems, Tochigi, Japan) with a PLT1204AX linear array transducer (Toshiba Medical Systems, Tochigi, Japan). Patients were mapped while lying supine i.e. in the same operative position. During the mapping process, the entire length of the LSV of both legs was assessed, and marked using a water-proof skin marking pen. The findings were documented in the patient's medical records (Fig. 1a,b). It took, on average, 10 min to fully map each leg.

The vein was harvested and prepared as per our usual routine. However, for the group of patients who have been randomised to the vein mapping pre-operatively, the incision was only along the externally marked line. The wound was closed after haemostasis using 2/0 biosyn (Synecture, TycoHealthcare, Norwalk, Connecticut, USA) for the subcutaneous layer and 3/0 biosyn (Synecture, TycoHealthcare, Norwalk, CT, USA) for the subcuticular layer and the leg bandaged as per usual practice.

3. Results

Thirty-one patients were recruited to the 'mapped' group and the 'non-mapped' group had 30 patients. The pre-operative characteristics of the study groups are shown in Table 1. Illustrations of the mapping are shown in Fig. 1a,b.

There was no significant difference between the two groups in terms of age, gender and pre-op incidence of diabetes, peripheral vascular disease, smoking history, ejection fraction, priority of surgery and body surface area (Table 1). None of the patients recruited had a history of deep vein thrombosis in the past.

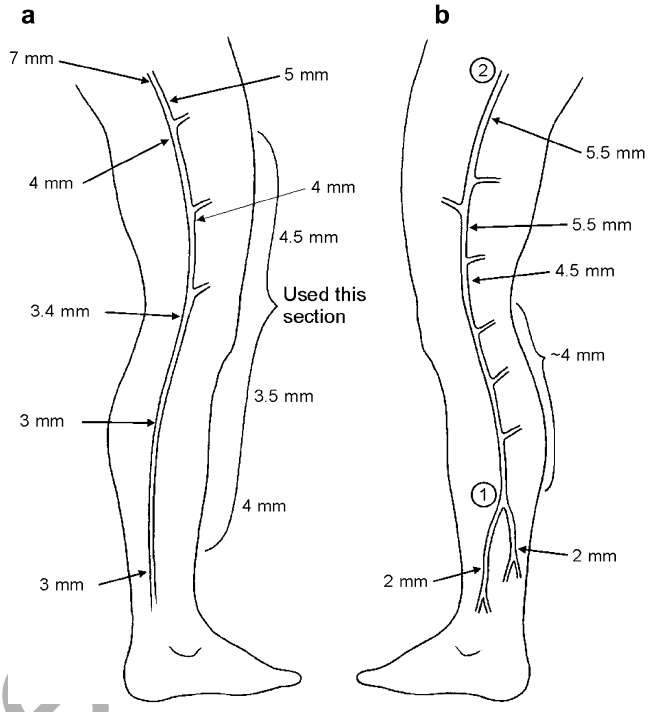

Fig. 1. (a) Pre-operative mapping of the left long saphenous vein using the Doppler ultrasound depicting good calibre vein from medial malleolus to the thigh, including some of the major side branches. (b) Pre-operative mapping of the right long saphenous vein showing bifid LSV from medial malleolus to mid-calf. Thus, vein was harvested from point (1) to (2).

The anatomical distribution of the long saphenous vein was well predicted by the ultrasound study in 100% of the patients. The size of the distended vein correlated well with the pre-operative size measurement (correlation coefficient = 0.87, Fig. 2). Following distension, the vein size was, on average, 1 mm larger than that obtained during mapping.

The mean length of leg wound per vein graft performed was significantly less in the mapped group [16.8 (4.0) vs. 24.1 (10.4) cm, $P = 0.005$]. This translated in a shorter operative time for vein harvesting per length of vein graft needed [36 (13) vs. 47 (17) min, $P = 0.04$].

Post-operatively there was a tendency to less leg wound complications in the mapped group [median (IQR) 10 (8.20) vs. 25 (10.26), $P = 0.08$] but there was no significant difference in the pain VAS and mobility (Table 2).

Table 1
Pre-operative data for the patients in the two groups

	Mapped	Non-mapped	*P*-value
n	31	30	
Age (years)*	64.5	66.9	0.26
Male (%)	77	73	0.71
Diabetes (%)	20	30	0.33
PVD (%)	10	20	0.22
Smoking (%)	71	67	0.72
Impaired LV function (%)	45	33	0.34
Elective (%)	58	56	0.91
BSA*	1.93	1.87	0.16

*Data expressed as mean; PVD, peripheral vascular disease; LV, left ventricular.

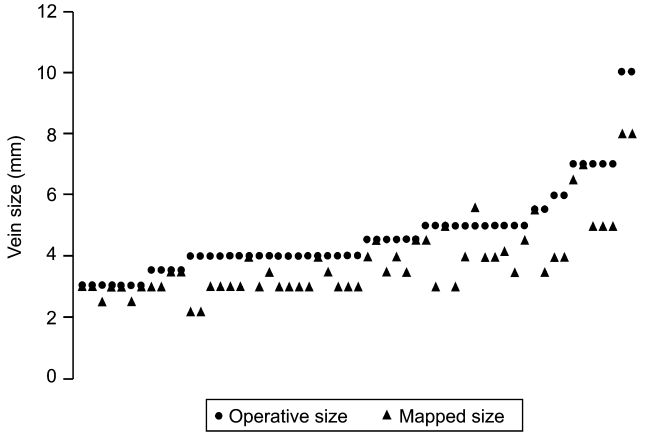

Fig. 2. Scatter plot of the sizes of the various vein segments as measured by mapping and during surgery (correlation coefficient = 0.87).

Patients in the 'mapped' group had a shorter median (IQR) in-hospital stay at 6.5 (5.8, 8.5) days compared to 8.0 (6.0, 11.8) days for the 'non-mapped' group ($P = 0.05$).

4. Discussion

Currently, the long saphenous vein is assessed pre-operatively by most surgeons using a crude physical examination. Unfortunately, the lack of pre-operative information concerning the vein anatomy and morphology can lead to excessive dissection, significant soft tissue trauma and creation of tissue flaps with the potential of significant leg wound morbidity.

The burden of leg wound complications post CABG is enormous on the healthcare system. It is reported that up to 40% of patients who had open LSV harvesting by the traditional method would develop a complication [2]. This translated in an increase in the in-hospital stay, increased need for nursing care and increased cost [5].

In the past, the LSV had been assessed using venography [6]. However, although this method provided excellent information concerning the anatomical distribution of the vein, it was inaccurate in predicting the vein size and it was also a source of confusion, as both the superficial and deep venous systems would be delineated.

The use of high resolution real-time B-mode ultrasonic imaging to assess the LSV provides a better way to evaluate this conduit and was initially described in the 1980s [7]. In that study, 15 patients were assessed and the imaging provided excellent assessment of the calibre and abnormalities of the LSV.

In a non-randomised study, Head and Brown [8] demonstrated that the pre-operative vein diameter, as assessed by high resolution real-time ultrasonic imaging, was 1.5 mm smaller in diameter when compared to its distended size.

Optimising the LSV harvest site by using venous duplex ultrasound scanning was also reported by Cohn and Korver [9]. In their non-randomised study of 58 patients, they showed that this allowed optimal surgical site selection, avoiding unnecessary surgical dissection during blind exploration for vein conduit, time delays, vein wastage and potential for wound complications.

In the randomised control study described above, the use of Doppler venous mapping for the LSV confirmed a very good correlation with surgical anatomical and morphological findings. This translated into shorter leg wound incisions, less vein wastage, a tendency to less leg wound infection and a shorter in-hospital stay.

Even in the minimally invasive technique for LSV harvesting, a 10% morbidity rate is quoted in the literature [3, 5]. This could be reduced further if this technique is combined with pre-operative LSV mapping.

There was a tendency to less leg wound infection but there was no significant difference in the pain VAS and mobility scores. This may be due to the small number of patients recruited in this study, as the study was powered to assess the anatomical and morphological correlations between venous Doppler mapping and surgical findings.

Table 2
Post-operative assessment of the ASEPSIS, pain and mobility scores

	Mapped	Non-mapped	*P*-value
n	31	30	
ASEPSIS score			
At day 6 post-op	10	25	0.08
At 4 weeks post-op	1.0	2.0	0.65
VAS pain score			
At day 6 post-op	1.0	0.0	0.79
At 4 weeks post-op	0.0	0.0	0.23
Mobility score			
At day 6 post-op	10.0	10.0	0.21
At 4 weeks post-op	10.0	10.0	0.56

Data expressed as median.

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Conference discussion

Dr. F. Beyersdorf (*Freiburg, Germany*): I think that you describe a potential solution to a clinically relevant problem, i.e. the unknown quality and anatomy of the long saphenous vein before harvesting this conduit for coronary artery bypass grafting. You have assessed the usefulness of preoperative long saphenous vein mapping and assessment by venous Doppler ultrasound, and the prospective randomized control trial in your 61 patients revealed clear and probably expected results.

You report that the size and anatomical distribution can be well predicted by the ultrasound study, and the mean length of the wound incision per vein graft performed was significantly less in the mapped group. This again correlated with a shorter time for vein harvesting per length of vein graft needed. And also expectedly there were less wound complications in the mapped group. So, this is a well performed study dealing with an important clinical entity, and I have three questions for you.

1. Can you give us some data about the time and personnel needed for routine assessment and mapping by the venous Doppler ultrasound?
2. What is the percentage of inappropriate prediction of size, quality and anatomy despite the ultrasound assessment?
3. In our center as well as in others, minimally invasive endoscopic harvesting of the vein is routinely done. Do you have some information about the usefulness of venous Doppler ultrasound when minimally invasive harvesting of the vein is routinely performed?

Mr. Luckraz *(Cardiff, UK)*: First of all, it takes about 10 min to actually do the mapping. Initially the mapping was done by Dr. Pugh, who is our venous ultrasonographer consultant, but I actually myself went down and actually learned the technique off him, and that is why we are planning to move to an intraoperative more or less mapping in the anesthetic room. It is a technique that is not very difficult to learn. Obviously you have, with everything else in surgery, a learning curve, but it is easily learned by anybody who is involved with assessing the veins.

In terms of the anatomy, I have to say wherever the line was, that is where we found the vein. The size, there was a slight discrepancy, and that size discrepancy was accentuated if the vein when it was mapped was of a big caliber. I am not too sure what sort of technique you use to dilate your vein, but we just use gentle pressure, and we found that if the vein was above 6 mm in diameter, when you dilate it you will get a vein of about 8 mm in diameter, which is quite a significant size.

And finally in terms of looking at endoscopic harvesting, I think it would be a very good way, because if you know exactly where the vein is running, because this study and from our previous experience with the mapping, we know that the anatomy will be as predicted by the Doppler ultrasound. I don't have any experience with endoscopic harvesting at our center, but I think if you know where the vein is running with the endoscope, you can just make your cuts just there and then avoid any dissection. As you are probably aware, a lot of the time we know as surgeons where the vein would be and what usually the general sort of size that the vein will be, but very commonly you will find a vein that starts very nicely at the ankle and then divides into two branches and then rejoin again higher up near the knee. So then you avoid having to dissect a bit around the calf area if you know already beforehand that that vein is not going to be of any use to you.

Dr. T. Sioris (*Helsinki, Finland*): I have two questions. Were there any patients who had clinically varicose vein disease that you could see before you started the ultrasound mapping? And the second question is, were there any criteria, which made you not to harvest the vein when you examined it by the ultrasound?

Mr. Luckraz: The whole study stemmed from our previous experience in patients who we assessed preoperatively and we think there is a bit of varicosities in their leg, and that is how we started off. And anybody who we were not too sure about their conduits, we used to send them down for the mapping, and we got excellent results from that, because then you avoid all the varicoses, and the ultrasonographer will just map a bit either in the thigh or wherever it will be worthwhile to take just for your graft. So we do have experience with that. That was not part of this study. And if you want to assess varicosities with the ultrasound Doppler, it is very, very easy.