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Minimally invasive vein harvesting significantly reduces pain and wound morbidity

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Abstract

Objectives: Minimally invasive saphenous vein harvesting is advocated to reduce wound morbidity. Our early experience with minimally invasive techniques, however, suggested that increased tissue traction and trauma might follow. We aimed to test the hypothesis that minimally invasive harvesting reduces post-operative pain and inflammation. A secondary objective was to determine if minimally invasive harvesting could be performed efficiently. **Methods**: Forty patients were prospectively randomised into minimally invasive harvesting (Minimal, $n = 22$) and traditional open harvesting (Open, $n = 18$). A modified bridging technique was used for minimally invasive harvesting (SaphLITE™, Genzyme Surgical Products, Cambridge, MA, USA). One surgeon performed all operations. Primary end points were signs of impaired healing (a composite score) and pain (visual analogue score). Secondary end-points (operation variables) were also collected. Continuous variables were analysed by Student's *t*-test and categorical variables were analysed by Mann–Whitney *U*-test. **Results**: There were no significant demographic differences between the two groups (height, weight, albumin, diabetes, and peripheral vascular disease). In the early post-operative period, Minimal group had significantly less leg wound pain ($P = 0.04$) and wound sepsis scores ($P = 0.01$). Sternal pain was the same in both groups. After 6 weeks, wound scores and leg pain scores were not significantly different. There were no significant differences in rate of harvest (1.1 cm/min in each group). In Minimal group, 4 cm veins were harvested for each 1 cm skin incision compared with 1 cm in Open group ($P < 0.01$). **Conclusions**: Minimally invasive saphenous vein harvesting significantly reduces early post-operative leg pain and wound sepsis. Our study demonstrates that minimally invasive harvesting can be performed at a satisfactory speed and should be considered to help reduce early post-operative morbidity.

Keywords: Minimally invasive; Coronary artery bypass graft

1. Introduction

Coronary artery bypass graft (CABG) surgery remains widely used for treatment of coronary artery disease [1]. Although arterial grafts are used with increasing frequency, the long saphenous vein remains the most frequently used conduit. Unfortunately, the long incision required for open (traditional) harvest of the saphenous vein is associated with significant morbidity that may dominate post-operative recovery. Impaired leg wound healing occurs in as many as 1–25% of patients [2,3]. Wound infections, haematomas, recurrent cellulitis and saphenous neuropathy can prolong recovery [4], and the requirement for wound dressing and difficulty in mobilisation can impair a patient's quality of life [5,6].

The use of minimally invasive saphenous vein harvesting has been advocated [7–9] in an effort to minimise wound-related problems. Some evidence suggests that these techniques may reduce leg wound complications such as pain and infection [9]. Our previous experience with minimally invasive surgery had left us with some concerns about the lack of control and increased tissue traction that sometimes occurs during these surgical procedures. Consequently we were not sure that minimally invasive saphenous vein harvesting would be better than a traditional single large incision allowing full exposure of all the tissues. We decided to use the SaphLITE™ system (Genzyme Surgical Products, Cambridge, MA, USA).

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2. Materials and methods

Forty patients scheduled for elective CABG surgery, were prospectively randomised into two groups. Patients in Minimal group ($n = 22$) were randomised to have saphenous vein harvested using the SaphLITE™ system. Patients in Open group ($n = 18$) had their long saphenous vein harvested by a traditional open harvesting technique, utilising one continuous incision.

Inclusion into the study required the need for harvest of sufficient long saphenous vein for at least two bypass grafts. The study was approved by the Central Oxford Research Ethics Committee (Ref. C99.082 28/05/99). All patients were counselled, signed informed consent and kept a study information sheet. One surgeon (E.B.) performed all operations in a single institution. All wounds were inspected daily from post-operative day 2 onwards by one research nurse (K.C.). Patients were excluded from this study if they were unable to attend local outpatient follow-up (held 6 weeks after the operation). Patients were not excluded if they had peripheral vascular disease (arterial or venous).

Patient demographics that may be important risk factors for wound healing were collected and are summarised in Table 1. The length of vein harvested, the length of time to harvest the vein, the number of repairs and the total length of the wounds were documented.

2.1. Wound assessment

Wounds were graded using the ASEPSIS [10] system (see Appendix A). The name is an acronym for the variables assessed: A, additional treatment required; S, deep tissue separation; E, erythema; P, purulence; S, serous exudate; I, isolation of bacteria; S, prolonged hospital stay. The observer assigned a point score (0–10), based on the proportion of the wound exhibiting the characteristics of serous or purulent exudate, erythema of greater than 5 mm, and separation of the deep tissue. For example, scores of 0, 1, 2, 3, 4 and 5 were given for proportions of 0, 20, 20–39, 40–59, 60–79 and >80% of the wound affected by each variable. Additional points are added for the remaining indicators as they present during the post-operative course. Total score indicates the severity of wound infections. Additionally, the presence and proportion of the limb covered with ecchymosis was noted. The leg was graded according to the proportion of the limb that was covered by ecchymosis using the same scale as in the ASEPSIS scoring (see Appendix A). Wounds were inspected daily during initial in-patient stay and again in the outpatient clinic. Patients were asked to bring details of any interventions that they had needed to the outpatient department.

Table 1
Patient demographics[a]

	Minimal ($n = 22$) mean ± SD	Open ($n = 18$) mean ± SD	*P*
Female (%)	18.2	27.8	0.08
Age (years)	64.2 ± 10.4	62.7 ± 12.1	0.69
NYHA	3.2 ± 1.0	2.2 ± 1.1	0.87
Diabetes (%)	31.8	38.9	0.74
Hb (g/dl)	13.7 ± 1.4	13.4 ± 1.3	0.52
Albumin (g/l)	41.8 ± 2.4	41.4 ± 3.2	0.71
Height (cm)	171.2 ± 9.7	168.7 ± 10.7	0.50
Weight (kg)	78.4 ± 18.8	80.4 ± 13.9	0.74

[a] Patient demographics and pre-operative serum levels of hemoglobin (Hb) and albumin are presented.

2.2. Pain assessment

Leg pain was assessed in this study using a Visual Analog Scale [11,12]. The scale was a 100 mm plain line with descriptive end points of ‘no pain at all’ and ‘worst imaginable pain’. Pain was thus determined as the length (in mm) on the line up to where it had been marked. Importantly, patients were interviewed to determine the severity of the pain from their leg and chest wounds. The patients were asked to complete a pain score on day 2, 3, 4, 5 and again in the outpatient department. A record of all supplemental analgesia used by the patients during their hospital stay once their intravenous analgesia was discontinued (end of day 1) was kept (Table 3).

2.3. Surgical technique

2.3.1. Minimally invasive (Minimal)

The technique used was a modified bridging technique using the SaphLITE™ system. The vein was firstly identified through a longitudinal incision either one hands breadth proximal to the medial malleolus or one hands breadth distal to the groin (randomised). Once the vein had been cleared from the subcutaneous fat and fascia, a plane was cleared anterior and posterior to the vein by a combination of gentle digital dissection and sharp dissection with ordinary Metzenbaum scissors. The blade of the retractor was placed into the wound and with the Genzarm™, the wound was retracted to aid in the visualisation of the vein. Side branches could usually be identified readily and were ligated with Ligaclips™ before dividing them with ordinary scissors. As far as possible the clips on the vein were replaced with silk ties once it had been removed (surgeon’s preference). Once the vein had been dissected free as far as possible the next incision was made as far away along the line of the vein and dissection of the saphenous vein continued. All incisions were closed in layers and a pressure dressing applied immediately, before reversal of heparin (Fig. 1).

2.3.2. Traditional (Open)

The vein was identified either two fingers proximal to the medial malleolus or distal to the skin crease in the groin close to the sapheno-femoral junction (randomised). The skin was incised with a scalpel and the vein was dissected free using Metzenbaum scissors. Dissection was continued along the length of the vein producing one continuous incision, taking care not to traumatise the vein or its branches.

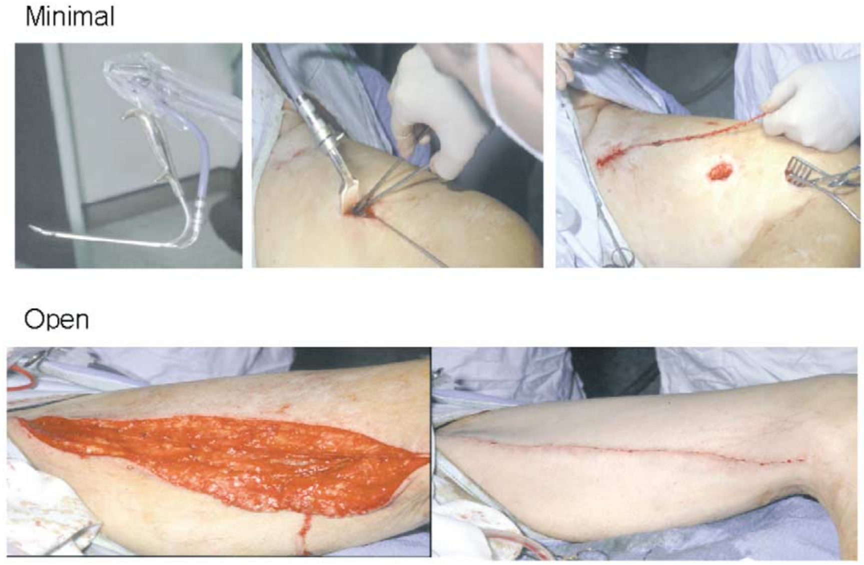

Fig. 1. Operative techniques.

Side branches were ligated with 4.0 silk on the vein side and a Ligaclips™ on the patient's side. The leg wound was closed in layers and a full-length pressure dressing applied before reversal of heparin (Fig. 1).

Routine pre-operative and post-operative care was not otherwise changed for these study patients. Legs were shaved the night before surgery, followed by a shower with Chlorhexidine antiseptic. The legs were painted with iodine-based antiseptic at the time of surgery and the groins were excluded with drapes. All patients received prophylactic gentamicin and flucloxacillin for 24 h. In both groups dressings were left in place until the second post-operative day when they were removed and the wounds left open to air.

2.4. Statistical analysis

Continuous variables were analysed by Student's *t*-test and categorical variables were analysed by Mann–Whitney *U*-test.

3. Results

3.1. Patient demographics

Patient populations were well matched for variables likely to influence wound healing (diabetes, serum albumin, serum Hb, height weight, see Table 1). Both patient populations had peripheral venous disease (varicosities, pigmentation, old ulcers) 23% in Minimal and 27% in Open. A history of intermittent claudication was present in 9 and 11% of the two groups, respectively.

3.2. Vein harvest variables

In all cases sufficient vein was harvested for all the required grafts. Four patients from Minimal crossed over to Open. In three of these patients, vein harvested firstly by minimally invasive technique was severely diseased and unusable (calcified, sclerotic, varicose). The rest of the vein was removed via an open incision allowing greater inspection of the vein prior to removal. In the other converted case, the minimally invasive technique took too long and was changed to expedite the harvest. Data was collected and analysed for both types of wounds.

Both patient populations had a similar number of bypass grafts (3.3 ± 0.7 in the Minimal group and 3.2 ± 0.7 in the Open group, $P = \text{NS}$) and spent a similar length of time on cardio-pulmonary bypass (Table 2). The length of undistended vein harvested in the Minimal group, 48 ± 19 cm, was a little longer than in the Open, 40 ± 12 cm ($P = 0.12$). The mean harvest times were 46 ± 18 min versus 35 ± 9 min, respectively ($P = 0.02$). The calculated harvest rate (cm/min) was not significantly different between both groups, 1.1 and 1.2 cm/min, respectively ($P = 0.25$). The

Table 2
Operative details for minimally invasive (Minimal) and open (Open) saphenous vein harvesting[a]

	Minimal ($n = 22$) median (IQR)	Open ($n = 22$) median (IQR)	P
No. of incisions	3 (3–5)	1 (1–1)	<0.01
Incision length (cm)	11 (8–16)	37 (34–39)	<0.01
Vein length (cm)	43 (37–58)	37 (34–42)	0.12
Repairs	2 (2–4)	1 (0–1)	<0.01
Length/min (cm/min)	1.1 (1.0–1.2)	1.1 (0.9–1.6)	0.25
Vein/incision (cm/cm)	4 (3.5–4.6)	1 (1–1)	<0.01

[a] Operative details for both minimally invasive and traditional/open harvesting (Minimal and Open groups, respectively) were collected prospectively. Results are presented as median (inter-quartile range). Four patients had both types of wound and are recorded in each column.

Table 3
Compound wound scores (ASEPSIS) and pain scores on day 4 and 6 weeks after surgery[a]

	Minimal $n = 22$ Median (IQR)	Open $n = 18$ Median (IQR)	P
Day 4 ASEPSIS	1 (0–3)	4.5 (3–6)	<0.01
Day 4 Ecchymosis	8 (4–10)	5.5 (3.5–7)	0.17
Day 4 Leg pain	11 (4–24)	22 (13–40)	0.04
Day 4 Sternal pain	12 (3–59)	34 (26–48)	0.18
6 Week ASEPSIS	0 (0–0)	0 (0–10)	0.18
6 Week ecchymosis	0 (0–0)	0 (0–0)	1.00
6 Week leg pain	4 (0–10)	4 (0–13)	0.56
6 Week sternal pain	13 (0–24)	17 (10–55)	0.12

[a] The wounds from minimally invasive (Minimal) and traditionally (Open) harvested groups were inspected daily. Cumulative scores on day 4 and scores at 6 weeks are presented as median (inter-quartile range). Wounds were graded for signs of infection and ecchymosis (see ASEPSIS and ecchymosis scores Appendix A) and pain was assessed with 100 mm Visual Analogue Scale (0–100). Four patients had both types of wound and are recorded in each column.

harvest rate did not demonstrate a consistent improvement in performance with case.

3.3. Pain measurement

Early leg pain was significantly less in those patients in the Minimal group compared with the Open patients ($P < 0.01$). Early chest pain was not significantly different between the two groups (Table 3). We found no significant difference in the amount of analgesia taken by the patients in each harvesting group. No pain assessment was possible on two Minimal patients (one death, one sedated and ventilated for respiratory problems) and one Open patient (confused). There were no differences in the pain felt in either the leg wounds or the chest wounds at the 6-week follow-up.

3.4. Wound assessment

The median ASEPSIS score on post-operative day 4 was significantly lower in the Minimal patients, 1 versus 6 and $P < 0.01$ (Table 3). There was no evidence of active infection in either group at the 6-week outpatient examination. However, one Minimal and five Open harvested patients had visited their primary physician since discharge from hospital and received a course of oral antibiotics. Some of the patients in the Minimal group had painless ecchymosis. The ecchymosis scores were 13 versus 8, $P = 0.17$ for Minimal and Open, respectively. The ecchymosis had resolved in all cases by the time patients were examined at the 6-week clinic. Examples of high and low scoring wounds from both groups at day 4 and 6 week are shown in Fig. 2.

Early pain from the sternal incision was greater than the leg wound pain in the Minimal patients only. By 6 weeks, chest pain was greater than the leg pain regardless of the harvest technique (Table 3).

4. Discussion

Concern about wound morbidity associated with the traditional/open technique of saphenous vein harvesting has led to a variety of minimally invasive or less invasive techniques. These range from totally endoscopic techniques [7,8] to the use of non-specialist and cheap equipment to aid the harvesting of the saphenous vein via smaller incisions [13,14] Modern management of CABG surgery patients emphasises an early return to 'normal' activity [15]. Mobility is an important aspect of this process of normalisation, benefiting respiratory function and allowing independence. Wound pain, wound discharge and infection all impact negatively on a patient's quality of life after surgery. The incidence of major wound problems is fortunately low, but less severe complications; inflammation, serous discharge, haematoma formation, separation of the tissues and pain are probably underestimated.

We found that minimally invasive vein harvest reduces post-operative morbidity. There is a significant reduction in the signs of wound inflammation with minimally invasive harvesting ($P = 0.01$, Table 3). Furthermore we found that there is a significant reduction in the pain perception during the early period of recovery ($P = 0.04$, Table 3). In our study, four Minimal patients crossed over to Open harvesting during the operation (three cases due to calcification/

Fig. 2. Wounds at day 4 (A) and 6 weeks later (B) demonstrating low (top row) and high (bottom row) ASEPSIS score wounds.

small size of the vein). Interestingly, in these cases, two patients had additional antibiotics prescribed by their General Practitioner for problems with their open harvest wounds only.

We had a greater need to repair the vein in the Minimal group. This was as a result that occasionally it was not possible to clip a branch due to poor vision or difficulty in using an ordinary Ligaclip™ applicator. Then the vein was repaired once it had been removed from the leg.

We chose to use a modified bridging technique. This requires little extra equipment and is consequently relatively cheap and does not occupy valuable space in the operating theatre. Hovarth et al.'s [16] non-randomised comparison of bridging with endoscopic harvest recorded a lower incidence of wound complications with the bridging technique. Most of these complications in the endoscopic group were haematomas (we would perhaps have defined these haematomas as ecchymosis). In his study, there was an average of five incisions required to harvest 48 cm of vein in the bridging group. Utilising the SaphLITE™ system, we had an average of four incisions (median three, Table 2), to harvest the same length of vein in the same time. Tevaearai [17] compared minimally invasive harvest using an alternative modified bridging technique with open harvesting. In this study the length of harvested vein was three times as long as the total incision length, compared with our study where the vein was four times as long as the incision length. Thus we think that our technique was at least comparable with other techniques.

Puskas et al. [18] compared traditional or open harvest with endoscopic harvest technique. Whilst the endoscopic group had less drainage through the wounds, as in our study, they found a higher incidence of ecchymosis in the minimally invasive group. They interestingly found no difference in the post-operative pain (possibly due to the large incision length used in the endoscopic group). This paper implies that any benefit of minimally invasive harvesting is rather limited. The very long harvest times (62 min) may deter some centres from attempting this method. Conversely Allen et al. [19] recorded a faster harvest rate in the endoscopic harvest group (0.9 ± 0.4 versus 1.2 ± 0.5 cm/min, $P < 0.02$). They found that there was no difference in the patients' perception of pain at day 2, discharge or at 6 weeks. Interestingly pain perception did not change with time.

We used the ASEPSIS scoring method for grading wounds for infection [10]. This previously validated system is a composite score of several variables (Appendix A). In our study the most common problem with the leg wounds was a serous discharge. Ecchymosis was a common early feature in the minimally invasive group. This may be due to the fact that unlike other published studies, we elected to close wounds whilst the patient was on CPB rather than waiting until heparin reversal. No patients from either group required a prolonged hospital stay due to leg wound problems.

Wound pain is difficult to measure. The visual analogue scale (VAS) has been used for some time and is thought to be reasonably reliable especially when measuring pain levels within subjects [11,12]. To supplement the VAS, we also asked patients to record the pain from the sternal incisions (thus providing a control wound) and recorded the total amount of supplemental analgesia used by each patient.

We found that patients in the minimally invasive group had significantly less pain throughout their hospital stay (Fig. 2) and pain diminished with time. We have found that by employing a modification of the bridging technique using specially designed equipment (SaphLITE™, Genzyme Surgical Products), less invasive vein harvesting reduces post-operative leg morbidity. Specifically, patients have significantly less pain while they are in hospital and significantly reduced signs of wound sepsis.

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Appendix A. ASEPSIS scoring method

Wound characteristic	Proportion of wound affected (%)					
	0	<20	20–39	40–59	60–79	>80
Serous exudate	0	1	2	3	4	5
Erythema	0	1	2	3	4	5
Purulent exudate	0	2	4	6	8	10
Deep separation	0	2	4	6	8	10
Ecchymosis	0	1	2	3	4	5

Criterion	Points
Additional antibiotics	10
Drainage under local anesthesia	5
Drainage under general anesthesia	10
Isolation of bacteria	10
ASEPSIS	0–30 daily
Ecchymosis	0–5 daily
Length of stay for wounds >14 days	5

Wounds were graded according to a modified version of the ASEPSIS composite wound scoring system. Wounds were graded for each variable and a final summated score given to reflect the total wound morbidity.