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Risk Factors for Leg Wound Complications Following Endoscopic Versus Traditional Saphenous Vein Harvesting

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ABSTRACT

Background: Risk factors for leg wound complications following traditional saphenectomy have included: obesity, diabetes, female gender, anemia, age, and peripheral vascular disease. Use of an endoscopic saphenectomy technique may modify the risk factor profile associated with a traditional longitudinal incision.

Methods: From September 1996 to May 1999, 276 consecutive patients who underwent elective isolated coronary artery bypass grafting performed by a single surgeon (K.B.A.) had their greater saphenous vein harvested endoscopically. During the period from January 1999 to May 1999, the surgical records of 643 patients who underwent the same operation and had a traditional longitudinal saphenectomy were reviewed for postoperative leg wound complications. Group demographics were similar regarding preoperative risk stratification and traditionally identified wound complication risk factors (diabetes, gender, obesity, preoperative anemia, and peripheral vascular disease). Leg wound complications were defined as: hematoma, dehiscence, cellulitis, necrosis, or abscess requiring dressing changes, antibiotics and/or debridement prior to complete epithelialization. Follow-up was 100% at six weeks.

Results: Leg wound complications following endoscopic harvest occurred in 3% (9/276) of patients versus 17% (110/643) of traditional harvest patients (p<0.0001). No univariate risk factors for wound complications were associated with endoscopic saphenectomy. Univariate predictors of wound complications following traditional saphenectomy included: diabetes (p=0.001), obesity (p=0.0005), and female gender (p=0.005). Multivariable risk factors for leg wound complications following saphenectomy were traditional harvest technique (OR 7.56, CI 3.8–17.2, p<0.0001), diabetes (OR 2.10, CI 1.4–3.2, p=0.0006) and obesity (OR 1.82, CI 1.2–2.8, p=0.007).

Conclusions: Traditional longitudinal saphenectomy is a multivariable risk factor for development of leg wound complications. Endoscopic saphenectomy modifies the risk factor profile for wound complications and should be the standard of care, particularly for obese and/or diabetic patients who require venous conduit during coronary artery bypass grafting.

INTRODUCTION

Despite increased use of arterial grafts, the greater saphenous vein (SV) remains the most commonly used conduit for coronary artery bypass grafting (CABG). While traditional longitudinal SV harvesting infrequently results in major complications such as sepsis or amputation, minor wound complications are common. Saphenectomy wound complications, depending on definition, have a reported incidence of 1% to 44% [Delaria 1981, Lavee 1989, Utley 1989, Wipke-Tevis 1996, Allen 1998]. Reports have described the increased use of endoscopic vein harvest (EVH) of the SV for both cardiac [Allen 1997, Cable 1997, Allen 1998] and peripheral vascular procedures [Lumsden 1996] in order to reduce wound complications. A recent prospective randomized trial compared endoscopic and traditional longitudinal SV harvest for coronary procedures and demonstrated a significant reduction in leg wound complications following endoscopic saphenectomy [Allen 1998]. The larger retro-

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Table 1. Preoperative demographics

Characteristic	Endoscopic (n=276)	Traditional (n=643)	p-value[a]
Age (years)	63.8 ± 8.2[b]	63.2 ± 8.4	0.91
Female	78 (28%)	176 (27%)	0.78
Diabetes Mellitus	87 (31%)	163 (25%)	0.07
Obesity[c]	59 (21%)	146 (23%)	0.66
Pre-operative Anemia[d]	108 (39%)	290 (45%)	0.09
Peripheral Vascular Disease[e]	55 (20%)	100 (16%)	0.10
Parsonnet Score [Parsonnet 1989]	3.8 ± 3.0	4.3 ± 3.8	0.17
Cleveland Clinic Score [Higgins 1992]	3.8 ± 3.0	4.2 ± 3.5	0.06

[a]Continuous variables compared using a t-test and categorical values compared using Pearson's method of analysis

[b]Mean ± standard deviation

[c]> 1.5x ideal body weight, Metropolitan Life Insurance Height and Weight Table, 1980

[d]Hematocrit < 34%

[e]Claudication, previous vascular surgery, aortic aneurysm

Figure 1. Leg photographed 6 weeks postoperatively following endoscopic harvest of the saphenous vein from groin to just below the knee in a morbidly obese, diabetic female.

spective study presented here further defines clinical risk factors for wound complications associated with endoscopic and traditional saphenectomy techniques.

MATERIALS AND METHODS

Patient Population

From September 1996 to May 1999, 281 consecutive patients underwent elective, isolated CABG performed by a single surgeon (K.B.A.). Two hundred seventy-six patients had their greater SV harvested endoscopically (Ethicon Endosurgery, Cincinnati, OH). Five of 281 patients (1.9%) were unable to undergo EVH (two patients because of equipment problems, one patient because of a subdermal vein, and two patients because of the presence of a dual venous system) and were excluded from analysis. From January 1999 to May 1999, 643 consecutive patients underwent elective isolated CABG using a traditional longitudinal saphenectomy. Both groups were demographically similar with regard to age, preoperative risk stratification and traditionally identified risk factors for development of leg wound complications (Table 1, ◉). Thirty patient variables (Appendix A) recorded in the Heartbase Data System at the Indiana Heart Institute were reviewed for identification of preoperative variables associated with postoperative leg wound complications. Leg wound complications were defined as: hematoma, dehiscence, cellulitis, necrosis, or abscess requiring dressing changes, antibiotics and/or debridement prior to complete epithelialization [Utley 1989]. Follow-up was 100% for both patient groups and included a six-week postoperative clinic visit and a six-month postoperative telephone interview. The harvest groups included 51 and 58 patients, respectively, who had been part of a previously reported prospective randomized trial that compared endoscopic and traditional longitudinal SV harvest techniques [Allen 1998].

Surgical Techniques

Both groups received the same perioperative antibiotic prophylaxis. The endoscopic harvest patients had their greater SV harvested using an endoscopic vein harvest system (Ethicon Endo-Surgery, Inc., Cincinnati, OH). Technical aspects of that endoscopic system have been previously described [Allen 1997, Allen 1998]. Briefly, SV location is accomplished through one or two transverse incisions made above and/or below the knee. Intraoperative venous mapping using a portable ultra-sound device (Site Rite, Dymax Corp., Pittsburgh, PA) aids in the location of the SV and reduces the initial learning curve with EVH [Allen 2000a]. Early in our experience, SV side branches were endoscopically clipped and divided with endoscopic scissors. More recently, reusable bipolar scissors (Powerstar, Ethicon Endo-Surgery, Inc., Cincinnati, OH) have been used to divide venous side branches and decrease endoscopic harvest time. The endoscopic dissection tunnel is loosely packed with an antibiotic-soaked laparotomy pad until heparin is reversed; incisions are subsequently closed in layers with a subcuticular skin closure (Figure 1, ◉).

Traditional SV harvest patients had their greater SV harvested through a longitudinal incision without skin bridges. After vein removal the wound is irrigated with normal saline followed by layered closure with absorbable sutures. Either subcuticular closure or skin clips approximate the skin. Closed suction drains are not used in either technique and donor legs of both groups are wrapped with an elastic wrap.

Statistical Analysis

Statistical analysis was done with the PC JMP® Statistical Discovery Software (SAS Institute, Cary, NC). Categorical data were analyzed using the Pearson's method. Continuous data were analyzed using one-way analysis of variance to determine population homogeneity, and mean differences were determined using Student's t-test. Wound

Table 2. Leg wound complications following traditional and endoscopic saphenous vein harvesting categorized by type and treatment

	Traditional (n=110)	Endoscopic (n=9)
Cellulitis/abscess; hospitalization/IV antibiotics	12	1
Cellulitis/abscess; outpatient/oral antibiotics	34	1
Cellulitis/dehiscence; outpatient local wound care/oral antibiotics	22	4
Local dehiscence; local wound care without antibiotics	40	1
Hematoma/no treatment	2	2
TOTAL	17% (110/643)	3% (9/276)*

* p<0.0001 determined using Pearson's method of analysis.

complication risk factors were identified by univariate analysis for each harvest method as well as for the total population. Multivariable analysis by logistic regression was carried out on the entire patient population using the methodology of Cox. Variables were selected for inclusion in the multivariable analysis if their univariate p-values were less than 0.25. Odds ratios and their 95% confidence limits were calculated. Continuous and categorical values were considered statistically significant with a probability value of < 0.05 after two-tailed testing.

RESULTS

Wound complications occurred in 3% (9/276) of patients who underwent EVH as compared to 17% (110/643) of patients having a traditional longitudinal incision (p<0.0001). Types of leg wound complications observed in both groups and treatments they required are summarized in Table 2 (◎). Univariate analysis of the entire patient population identified traditional harvest (p<0.0001), diabetes (p=0.0004), and obesity (p=0.0006) as risk factors for leg wound complications (Table 3, ◎). Wound complication risk factors associated with each harvest technique are summarized in Table 4 (◎). No univariate risk factors for leg wound complications were associated with endoscopic saphenectomy. Multivariable correlates (Table 5, ◎) for wound complications following saphenectomy based on an analysis of the entire population were traditional harvest technique (p<0.0001), diabetes (p=0.0006) and morbid obesity (p=0.007). Wound complications, regardless of harvest technique, were not correlated with operative risk (Cleveland Clinic or Modified Parsonnet Scores), individual surgeons or surgical assistants.

DISCUSSION

Minor leg wound complications following SV harvesting for CABG occur in 1% to 44% of patients [Delaria 1981, Lavee 1989, Utley 1989, Wipke-Tevis 1996, Allen 1998]. Factors contributing to such a wide range include differences in wound complication definition, reporting of retrospective and prospective studies, and underestimation of wound complication rates which often occur when surgeons report their own patients' complications [Taylor 1990]. In two prospective studies evaluating wound complications following longitudinal saphenectomy after CABG, Utley (1989) and Allen (1998) reported wound complication rates of 24% and 19%, respectively. These studies utilized identical wound complication definitions and independent, non-surgeon identification of leg wound complications. This larger retrospective study confirms the conclusion of our smaller prospective randomized trial [Allen 1998] that the traditional longitudinal harvest technique is an independent risk factor for postoperative leg wound complications. Further, this larger study suggests that traditionally identified risk factors for wound complications can be modified through use of an endoscopic technique.

Less invasive surgical techniques improve patient outcomes by reducing the influence of risk factors on postoperative complications. In our previous prospective randomized trial comparing endoscopic and traditional saphenectomy, multivariable analysis identified the tradi-

Table 3. Univariate analysis of wound complications following saphenectomy

Risk Factor	Wound Complications	p-value[a]
Method		
EVH	3% (9/276)	<0.0001
Traditional	17% (110/643)	
Diabetes		
Yes	20% (49/249)	0.0004
No	10% (70/670)	
Obesity[b]		
Yes	20% (42/205)	0.0006
No	11% (77/714)	
Gender		
Female	18% (45/254)	0.01
Male	1% (74/665)	
Preoperative Anemia[c]		
Yes	14% (56/398)	0.36
No	12% (61/507)	
Peripheral Vascular Disease[d]		
Yes	13% (21/161)	0.97
No	13% (98/757)	
Hypercholesterolemia[e]		
Yes	12% (75/632)	0.15
No	15% (44/287)	

[a]Categorical values compared using Pearson's method of analysis

[b]> 1.5x ideal body weight, Metropolitan Life Insurance Height and Weight Table, 1980

[c]Hematocrit <34%

[d]Claudication, previous vascular surgery, aortic aneurysm

[e]Serum cholesterol >200 mg/dl

Table 4. Univariate analysis of risk factors for leg wound complications based on harvest methods

Risk Factor	Traditional Method	p-value[a]	EVH Method	p-value[b]
	% Leg Wound Complications		% Leg Wound Complications	
Diabetes				
Yes	28% (46/163)	p<0.001	3% (3/86)	p=0.89
No	13% (64/480)		3% (6/190)	
Obesity[c]				
Yes	27% (39/146)	p=0.0005	5% (3/59)	p=0.37
No	14% (71/497)		3% (6/217)	
Gender				
Female	24% (42/176)	p=0.005	4% (3/78)	p=0.73
Male	15% (68/467)		3% (6/198)	
Anemia[d]				
Yes	18% (51/290)	p=0.80	5% (5/108)	p=0.31
No	17% (59/350)		2% (4/168)	
Peripheral vascular disease[e]				
Yes	19% (19/100)	p=0.58	4% (2/55)	p=0.86
No	17% (91/542)		3% (7/221)	
Hypercholesterolemia[f]				
Yes	16% (70/134)	p=0.34	3% (5/198)	p=0.27
No	19% (40/209)		5% (4/78)	

[a,b]Significances determined by Pearson's chi square and Fisher's exact test, respectively

[c]> 1.5x ideal body weight, Metropolitan Life Insurance Height and Weight Table, 1980

[d]Hematocrit <34%

[e]Claudication, previous vascular surgery, aortic aneurysm

[f]Serum cholesterol >200 mg/dl

Table 5. Multivariable risk factors for leg wound complications following endoscopic (n=276) and traditional (n=643) saphenectomy

Variables	Odds Ratio	95% Confidence Limits Lower	95% Confidence Limits Upper	p value[a]
Traditional Harvest Technique	7.56	3.8	17.2	<0.0001
Diabetes	2.10	1.4	3.2	0.0006
Obesity[b]	1.82	1.2	2.8	0.007
Female Gender	1.43	0.9	2.2	0.11

[a]Significance of odd ratios determined using the methods described in the JMP® software

[b]1.5x ideal body weight, Metropolitan Life Insurance Height and Weight Table, 1980

tional harvest technique as a possible risk factor for leg wound complications (p=0.03). However, conclusive evidence was limited due to the small patient population [Allen 1998]. This larger study supports the conclusion that traditional harvest (p<0.0001) is the most influential multivariable predictor for leg wound complications.

The mechanism by which EVH reduces wound complications in cardiac surgery is unknown. Shing et al. [Shing 1997] found a positive correlation between incision length and infection rate. Reports from peripheral vascular procedures may clarify this issue. To minimize complications associated with long incisions following in situ lower extremity bypasses, Wittens et al. [Wittens 1994] developed a "closed" technique for in situ SV bypass, thus avoiding multiple or long leg incisions. In a prospective randomized trial, wound complications were reduced by more than 50% in patients who underwent the closed technique compared to patients who underwent the same procedure using the open technique [van Dijk 1995]. Furthermore, in a prospective, non-randomized, multi-center study, wound complications decreased from 24% to 4% when an endoscopic technique was compared to the classic in situ bypass technique [Rosenthal 1989]. The common denominator for these less invasive techniques is minimization of length and number of leg incisions.

Harvesting the SV using a bridging technique through multiple small leg incisions can also reduce saphenectomy wound complications [Clair 1994, Tevaearai 1997]. Whether the bridging technique is as efficacious as the endoscopic technique with respect to wound complications has yet to be determined. In a prospective randomized trial comparing in situ lower extremity bypass via bridging incisions versus a standard continuous incision, wound complication rates were similar [Clair 1994]. Minimizing the number of incisions on an edematous leg with obstructed lymphatics may be the most important determinant for the subsequent development of leg wound complications following saphenectomy.

Although endoscopic saphenectomy has resulted in fewer leg wound complications in both randomized [Allen 1998, Puskas 1999] and non-randomized studies [Allen 1997, Crouch 1999], important criticisms that have impeded its adoption by cardiac surgeons have included: 1) additional operative time; 2) increased cost due to disposable instruments; and 3) the potential for conduit trauma during harvest which may result in premature graft failure when compared to a traditional harvest technique.

The need for additional operative time and the higher expense for endoscopic instrumentation can be balanced against reduced patient morbidity and improved patient satisfaction. Although an economic analysis was not part of this study, outpatient resource utilization for the care of leg wound complications following EVH was found to be reduced when compared to traditional longitudinal saphenectomy [Allen 1999]. In addition, further refinement of endoscopic equipment, harvest technique [Allen 2000a], and postoperative care [Allen 2000b] continues to improve outcomes following endoscopic saphenectomy.

The potential for increased SV trauma during endoscopic harvest compared to the traditional longitudinal technique is an important issue. Complications related to premature graft failure, which might be attributed to a new SV harvest technique, have been addressed. As previously reported [Allen 1998], acute perioperative events associated with gross conduit trauma are similar between harvest techniques. In a

subsequent blind histologic comparison of endoscopically and traditionally harvested SV, minor histologic alterations were observed with both harvest techniques, but no significant differences were noted between groups [Griffith 2000]. Likewise, 18-month event free survival (freedom from myocardial infarction, recurrence of angina or congestive heart failure) was similar between patients randomized to endoscopic versus traditional harvest [Allen 1999].

CONCLUSION

Traditional longitudinal saphenectomy is an important multivariable risk factor for development of leg wound complications. Endoscopic vein harvest results in a significant reduction of leg wound complications and should be the standard of care, especially in obese and/or diabetic patients.

REFERENCES

1. Allen KB, Shaar CJ. Endoscopic saphenous vein harvesting. Ann Thorac Surg 64:265–6, 1997.
2. Allen KB, Griffith GL, Heimansohn DA, et al. Endoscopic versus traditional saphenous vein harvesting: a prospective randomized trial. Ann Thorac Surg 66:26–32, 1998.
3. Allen KB, Heimansohn DA, Griffith GL, et al. Endoscopic versus traditional saphenous vein harvesting: a prospective, randomized trial with 18-month follow-up. American Heart Association 72nd Scientific Sessions,. Atlanta, GA, November 10, 1999 AHA.
4. Allen KB, Heimansohn DA, Griffith GL, et al. Facile location of the saphenous vein during endoscopic vessel harvest. Ann Thorac Surg 69:295–7, 2000.
5. Allen KB, Fitzgerald EB, Heimansohn DA, et al. Management of closed space infections associated with endoscopic vein harvest. Ann Thorac Surg 69:960–1, 2000.
6. Cable DG, Dearani JA. Endoscopic saphenous vein harvesting: minimally invasive video-assisted saphenectomy. Ann Thorac Surg 64:1183–5, 1997.
7. Clair DG, Golden MA, Mannick JA, et al. Randomized prospective study of angioscopically assisted in situ saphenous vein grafting. J Vasc Surg 19(6):992–1000, 1994.
8. Crouch JD, O'Hair DP, Keuler JP, et al. Open versus endoscopic saphenous vein harvesting: wound complications and vein quality. Ann Thorac Surg 68:1513–6, 1999.
9. Davis Z, Jacobs HK, Zhang M, et al. Endoscopic vein harvest for coronary artery bypass grafting: technique and outcomes. J Thorac Cardiovasc Surg 116:228–35, 1998.
10. Delaria GA, Hunter JA, Goldin MD, et al. Leg wound complications with coronary revascularization. J Thorac Cardiovasc Surg 81:403–7, 1981.
11. Griffith GL, Allen KB, Waller BD, et al. Endoscopic and traditional saphenous vein harvest: a histologic comparison. Ann Thorac Surg 69:520–3, 2000.
12. Hayward TZ, Hey LA, Newman LL, et al. Endoscopic versus open saphenous vein harvest: the effect on postoperative outcomes. Ann Thorac Surg 68:2107–11, 1999.
13. Higgins LH, Estafanous FG, Loop FD, et al. Stratification of morbidity and mortality outcome by preoperative risk factors in coronary artery bypass patients: a clinical severity score. JAMA 267:2344–5, 1992.
14. Lavee J, Schneiderman J, Yorav S, et al. Complications of saphenous vein harvesting following coronary artery bypass surgery. J Cardiovasc Surg 30:989–91, 1989.
15. Lumsden AB, Eaves FF, Ofenloch JC, et al. Subcutaneous, video-assisted saphenous vein harvest: report of the first 30 cases. Cardiovasc Surg 4(6):771–6, 1996.
16. Parsonnet V, Dean D, Bernstein AD. A method of uniform stratification of risk for evaluating the results of surgery in acquired adult heart disease. Circulation 79(suppl I):I-3–I-12, 1989.
17. Puskas JD, Wright CE, Miller PK, et al. A randomized trial of endoscopic versus open saphenous vein harvest in coronary bypass surgery. Ann Thorac Surg 68:1509–12, 1999.
18. Rosenthal D. Endoscopic in situ bypass. Surg Clin North Am 74(5):703–13, 1995.
19. Shing WW, Fernando D, Grant P. Leg wound infections associated with coronary revascularization. Aust, NZ J Surg 67:689–91, 1997.
20. Slaughter MS, Gerchar DC, Pappas PS. Modified minimally invasive technique for greater saphenous vein harvesting. Ann Thorac Surg 65:571–2, 1998.
21. Taylor G, McKenzie M, Kirkland T, et al. Effect of surgeon's diagnosis on surgical wound infection rates. Am J Infect Control 18:295–9, 1990.
22. Tevaearai HT, Mueller XM, von Segesser LK. Minimally invasive harvest of the saphenous vein for coronary artery bypass grafting. Ann Thorac Surg 63:S119–21, 1997.
23. Utley JR, Thomason ME, Wallace DJ, et al. Preoperative correlates of impaired wound healing after saphenous vein excision. J Thorac Cardiovasc Surg 98:147–9, 1989.
24. van Dijk JC, van Urk H, du Bois NAJJ, et al. A new "closed" in situ vein bypass technique results in a reduced wound complication rate. Eur J Vasc Endovasc Surg 10:162–7, 1995.
25. Wipke-Tevis DD, Stotts NA, Skov P, et al. Frequency, manifestations, and correlates of impaired healing of saphenous vein harvest incisions. Heart Lung 25:108–16, 1996.
26. Wittens CHA, van Dijk LC, Du Bois NAJJ, et al. A new "closed" in situ vein bypass technique. Eur J Vasc Surg 8:166–-70, 1994.

APPENDIX

Heartbase Variables

Patient characteristics recorded in the Heartbase Data System of the Indiana Heart Institute and reviewed for identification of preoperative variables associated with postoperative leg wound complications.

Traditional SV harvest
Endoscopic SV harvest
Obesity
Diabetes
Gender
Hematocrit

Peripheral vascular disease
Prior peripheral vascular surgery
Other vascular surgery
Claudication
Age
History of smoking
Current smoker
Renal insufficiency
Hypertension
Congestive heart failure
Prior percutaneous transluminal coronary angioplasty
Prior CABG
Carotid disease
History of stroke
Ejection fraction
White blood cell count
Procedure status (elective, urgent, emergent)
Valvular heart disease
Angina class
Current myocardial infarction
Prior myocardial infarction
Hypercholesterolemia
Cardiomyopathy
Concomitant procedures