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Major Leg Wound Complications After Saphenous Vein Harvest for Coronary Revascularization

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***Background*. Major leg wound complications after coronary artery bypass graft procedures are infrequent and few are reported in the literature. We present our experience in treating 23 patients with major leg wound complications after coronary revascularization procedures.**

***Methods*. A retrospective review of 3,525 bypass procedures with saphenous vein grafts performed over a 10-year period was conducted. Ten potential risk factors for those who developed major leg wound complications were analyzed and compared with the entire cohort of patients undergoing similar bypass procedures during the same period.**

***Results*. Lower extremity wound complications occurred in 145 patients (4.1%), 23 of whom (0.65%) required additional surgical interventions (62 total). There were 32 wound debridements, 8 skin grafts, 11 vascular procedures, 5 amputations, 3 fasciotomies, 2 free tissue transfers, and 1 fasciocutaneous flap. Of ten variables evaluated by multivariate analysis, female gender, peripheral vascular disease, and postoperative intraaortic balloon pump use were identified as significant independent predictors of major leg wound complications ($p <$ 0.0001).**

***Conclusions*. The causes of major leg wound complications after saphenous vein harvest for coronary artery bypass graft procedures are multifactorial. To minimize these complications, we recommend vascular evaluations before saphenous vein harvest, attention to proper surgical technique, and careful harvest site selection.**

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Coronary atherosclerosis is most prevalent among males, diabetics, smokers, and those with obesity, hyperlipidemia, and hypertension. It affects more than 13 million Americans today and has resulted in more than 573,000 coronary artery bypass graft (CABG) operations performed in the United States in 1995 [1]. Despite increased use of arterial grafts, the greater saphenous vein (GSV) still remains the most frequently employed conduit in coronary revascularization since its introduction in 1968. Although a considerable amount has been written concerning sternal wound infections after CABG, little information has appeared in the literature regarding lower extremity morbidity.

The reported incidence of leg wound complications after GSV harvest ranges from 1% to 24% [2–5], with one series as high as 43.8% [6]. Commonly reported leg wound complications include dermatitis, cellulitis, greater saphenous neuropathy, chronic nonhealing wounds, and lymphocoele [6–9]. These complications rarely require surgical intervention and represent minor concerns in most CABG procedures. However, major leg wound complications at the GSV harvest site can cause significant patient morbidity resulting in greater length of stay, increased hospital cost, and additional surgical procedures with associated deformities and limb loss.

The purpose of this study is to review our experience in treating 23 patients with major leg wound complications after CABG procedures over a 10-year period and identify potential associated risk factors.

Material and Methods

Between November 1988 and August 1997, 3,525 CABG procedures using GSV with or without internal mammary artery (IMA) grafts were performed at our institution. One hundred forty-five patients were identified as having lower extremity wound complications, 23 of whom were referred to the Division of Plastic Surgery for management of major leg wound complications.

Major leg wound complication was defined as a leg wound that had failed to respond to conservative treatment and required subsequent surgical intervention (Figs 1, 2). Surgical interventions included debridement, amputation, fasciotomy, thromboembolectomy with or without vascular bypass, delayed wound closure with skin graft or local rotational flap, and free tissue transfer for limb salvage.

Demographic information, leg wound management protocol, and surgical procedures performed in all 23 patients were obtained through retrospective chart review. Ten perioperative risk factors associated with leg wound complications among these 23 patients were an-

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Fig 1. Right leg wound necrosis developed in a 62-year-old woman after three-vessel saphenous vein bypass. Balloon angioplasty and arterial bypasses were attempted to improve lower extremity inflow. Unfortunately, postoperative complications and bypass graft failure resulted in above-knee amputation.

alyzed and compared with the entire cohort of patients undergoing CABG during this same interval. Risk factors examined in this study included age, body mass index (BMI), gender, diabetes mellitus, peripheral vascular disease (PVD), cardiopulmonary bypass time, aortic cross-clamp time, the use of IMA as bypass conduit, the number of GSV grafts, and postoperative intraaortic balloon pump (IABP) use. BMI was determined by patient's body weight in kilograms (kg) divided by height in meters squared (m^2) [BMI = weight (kg)/height (m^2)]. All data were analyzed using StatView for Windows Version 5.01 (SAS Institute Inc, Cary, NC). Statistical analysis consisted of a χ^2 contingency analysis or Fisher's exact test for discrete variables and unpaired *t* test for continuous variables. A value of *p* less than 0.05 was considered significant, whereas *p* less than 0.10 and *p* greater than 0.05 were considered marginally significant. Both significant and marginally significant variables were entered into multivariate stepwise regression analysis to identify significant independent predictors of major leg wound complications.

Fig 2. A 61-year-old woman presented with nonhealing wound/ulcer of the left leg after four-vessel bypass. Postoperative segmental Doppler pressure study revealed no significant arterial insufficiency in either lower extremity. The wound was treated successfully with debridements and skin graft.

Results

During the interval of this study, a total of 3,525 CABG procedures with GSV harvesting were performed. Lower extremity wound complications were identified in 145 patients (4.1%), 122 of whom were treated successfully with nonoperative management. The remaining 23 patients (0.65%) required one or more additional surgical procedures to treat their major leg wound complication. There were 9 men and 14 women, with a mean age of 68 years (range, 46 to 82 years). The patient demographics, complications, and surgical procedures performed are summarized in Table 1.

The most frequent complication in our study was nonhealing wounds or ulcers (13 patients) and wound necrosis (8 patients). Cellulitis occurred in 6 patients and epidermolysis was noted in 1 patient. These complications resulted in 62 additional surgical procedures performed. The most common operations were debridement and skin grafts (32 and 8, respectively). Eight patients required multiple (total of 11) vascular procedures due to lower extremity ischemia or impaired wound healing secondary to vascular insufficiency. Three of the 8 patients eventually required lower extremity amputation. Two patients had amputation of their lower extremities without any prior vascular intervention. Fasciotomy was performed in 3 patients for compartment syndrome of their lower extremity as a result of arterial thrombosis. Delayed wound closure using a local fasciocutaneous flap was successful in 1 patient, whereas free tissue transfers for limb salvage were performed in 2 patients. One patient died before any surgical intervention.

Sixteen of the 23 patients with major leg wound complications had PVD. Among them, 4 patients had documented noninvasive vascular evaluations before their cardiac operation. Their preoperative ankle-brachial pressure index (ABI) of the affected limbs ranged from 0.67 to 0.91. The ABI obtained postoperatively to evaluate their nonhealing leg wounds ranged from 0.26 to 0.53. Three of the 4 patients subsequently required revascularization procedures to achieve complete wound healing.

IABP was required in 10 of 23 patients with major leg wound complications, 5 of whom experienced limb ischemia. Three of the 5 patients had preexisting PVD but none had vascular evaluation of their lower extremities before their myocardial revascularization. Two patients eventually required limb amputations. The remaining 3 patients had IABP removal with thrombectomy to achieve limb salvage.

Of 10 variables evaluated by univariate analysis, female gender, PVD, diabetes, and postoperative IABP use were identified as significant risk factors for development of major leg wound complications (Table 2). Statistically significant variables were entered into a multivariate stepwise regression analysis model which identified female gender, PVD, and IABP use as independent predic-

Table 1. Patient Demographics

Patient No.	Age (y)	Sex	DM	PVD	CABG	IABP	Preoperative ABI	Postoperative ABI	Complication	Surgical Procedure
1	54	F	Y	Y	IMA, R SVG	Y (R leg)	N	N	Wound necrosis, R leg compartment syndrome, R leg ischemia	Debridement, thrombectomy (vein patch)
2	72	F	N	Y	L SVG	Y (L leg)	N	N	Wound necrosis, L leg compartment syndrome, L leg ischemia	Anterior compartment fasciotomy, L iliofemoral thrombectomy and angioplasty, debridement × 2, latissimus dorsi free flap and STSG
3	63	M	N	N	LIMA, L SVG	Y (L leg)	N	N	Nonhealing wound L leg	Debridement, STSG L leg
4	46	F	Y	N	L SVG	Y (R leg)	N	N	Nonhealing wound L leg, R leg compartment syndrome, R leg ischemia	Debridement and closure L leg, removal of balloon pump and vein patch, three-compartment fasciotomy R leg, R AKA
5	70	M	N	N	LIMA, L SVG	Y (L leg)	N	N	Skin necrosis L leg, iliofemoral thrombosis L leg, L leg ischemia	Iliofemoral thrombectomy, L femoral/popliteal/tibial thrombectomy and L popliteal angioplasty, L BKA
6	62	F	Y	Y	R SVG	Y	R: 0.71, L: 0.57	R: NS, L: 0.62	Wound necrosis R leg, cellulitis	Iliac angioplasty R leg, R femoral-popliteal and femorofemoral bypass, thrombectomy and endarterectomy previous bypass, debridement, R AKA
7	80	M	Y	Y	R SVG	Y	R: 0.91, L: 1.10	R: 0.53, L: 1.42	Nonhealing wound/ulcer	Debridement, R BKA
8	61	M	N	Y	LIMA, RIMA, L SVG	Y (L leg)	N	R: 0.38, L: 0.33	L leg compartment syndrome, open fasciotomy wound, L leg ischemia	Femoral embolectomy and fasciotomy L leg, superficial femoral artery angioplasty L leg, debridement × 4, wound closure and STSG
9	77	F	Y	N	SVG	Y	N	N	Wound necrosis	Debridement × 2
10	75	M	Y	Y	LIMA, SVG	Y	N	N	Skin necrosis	Patient died
11	69	M	N	N	R SVG	N	N	N	Nonhealing wound	Arteriogram R leg, R femoral-popliteal bypass, debridement and STSG, R AKA
12	61	F	Y	Y	LIMA, L SVG	N	N	R: 0.94, L: N/A	Cellulitis, nonhealing wound/ulcer L leg	Debridement × 3, STSG
13	64	F	Y	Y	R SVG	N	R: 0.73, L: 0.37	R: 0.26, L: 0.32	Cellulitis, nonhealing wound R leg	R leg angioplasty, debridement
14	80	F	N	N	LIMA, SVG	N	N	N	Skin necrosis	Debridement
15	82	F	Y	Y	L SVG	N	N	N	Nonhealing ulcer L leg	Debridement
16	72	M	N	Y	LIMA, SVG	N	R: 0.64, L: 0.67	N	Nonhealing wound/ulcer	L femoral-popliteal bypass, debridement, local fasciocutaneous flap, STSG
17	57	M	Y	Y	LIMA, SVG	N	N	N	Skin necrosis, cellulitis	Debridement × 2, STSG
18	72	F	N	Y	SVG	N	N	N	Non-healing wound/ulcer	Debridement
19	77	F	Y	Y	LIMA, SVG	N	N	N	Nonhealing wound, cellulitis	Debridement × 3, rectus abdominis free flap, STSG
20	57	M	Y	Y	LIMA, SVG	N	N	N	Nonhealing wound/ulcer	Debridement
21	63	F	N	N	LIMA, SVG	N	N	N	Nonhealing wound, epidermolysis, cellulitis	Debridement × 2, wound closure
22	67	F	Y	Y	LIMA, SVG	N	N	N	Skin necrosis	Debridement, wound closure
23	79	F	Y	Y	SVG	N	N	N	Nonhealing wound	Debridement

ABI = ankle-brachial pressure index; AKA = above-knee amputation; BKA = below-knee amputation; CABG = coronary artery bypass graft; DM = diabetes mellitus; F = female; IABP = intraaortic balloon pump; IMA = internal mammary artery; L = left; LIMA = left internal mammary artery; M = male; N = no; N/A = none available; NS = no Doppler signal; PVD = peripheral vascular disease; R = right; RIMA = right internal mammary artery; STSG = split thickness skin graft; SVG = saphenous vein graft; Y = yes.

Table 2. Correlation of Risk Factors With Major Leg Wound Complications

Risk Factor	Major Leg Wound (n = 23)	No Leg Wound (n = 3,502)	*p*
Age (y)	67.8 ± 8.8	66.3 ± 9.9	NS
AXC time (min)	76.9 ± 33.8	78.5 ± 43.4	NS
BMI (kg/m^2)	29.1 ± 6.0	28.3 ± 4.8	NS
CPB time (min)	130.5 ± 61.5	133.3 ± 58.0	NS
Diabetes (%)	60.9	35.7	0.01
Female gender (%)	60.9	27.2	0.0007
GSV graft	1.8 ± 1.3	2.0 ± 1.1	NS
IABP (%)	43.5	11.3	< 0.0001
IMA (%)	56.5	53.5	NS
PVD (%)	69.6	11.2	< 0.0001

AXC = aortic cross clamp; BMI = body mass index; CPB = cardiopulmonary bypass; GSV = greater saphenous vein; IABP = intraaortic balloon pump; IMA = internal mammary artery; NS = not significant; PVD = peripheral vascular disease.

tors for development of major leg wound complications whereas diabetes dropped out of the analysis model (Table 3).

Comment

The reported leg wound complications after myocardial revascularization range from 1% to as high as 44%. In 1981, DeLaria and associates [3] noted a 1% incidence of leg wound complications in a retrospective review of 2,545 coronary revascularizations using GSV grafts. Approximately 0.5% were identified as major leg wounds requiring surgical debridements and closures. They concluded that leg wound complications were more likely to occur in obese women. In 1989, a prospective study by Utley and colleagues [4] found a 24.3% incidence of leg wound complications and further demonstrated significant correlation between impaired wound healing and female sex, diabetes mellitus, PVD, impaired left ventricular function, and preoperative hematocrit less than 35%. Our incidence of leg wound complications (4.1% overall, 0.65% major wounds) and the associated risk factors noted in this study are in agreement with others [2–5]. Although obesity had been previously shown to be a risk factor for development of leg wound complications, we did not find significant BMI differences between the patients with major leg wound complications (29.1 ± 6.0) and the rest of the cohorts (28.3 ± 4.8).

Table 3. Multivariate Analysis of Risk Factors

Risk Factor	Univariate *p*	Multivariate F	Multivariate *p*
Female gender	0.0007	28.59	< 0.0001
Diabetes	0.01	0.76	NS
PVD	< 0.0001	242.18	< 0.0001
IABP	< 0.0001	179.44	< 0.0001

IABP = intraaortic balloon pump; NS = not significant; PVD = peripheral vascular disease.

There is no clear explanation as to why leg wound complications are more prevalent among women. One hypothesis is that female patients tend to have smaller peripheral arteries than males and overall have a higher morbidity and mortality after myocardial revascularization. Second, since the majority of female patients undergoing CABG procedures were postmenopausal, it is possible that decreased estrogen level may also impair leg wound healing in addition to its deleterious effect on cardiovascular disease. Estrogen receptors have been identified in various cells of human skin [10], and administration of estrogen has been shown to increase the release of platelet-derived growth factor alpha and to stimulate fibroblastic and myofibroblastic wound contraction [11]. Recently, Calvin and coworkers [12] demonstrated a slower rate of wound contraction in oophorectomized rats and proposed hormone replacement therapy months before elective operations. However, information on the effect of hormone replacement on wound healing is still lacking.

Preexisting PVD is more common among patients undergoing CABG, and these patients tend to rely on collateral circulation to supply blood to their distal extremities. Kitamura and colleagues [13] reported a rare case of lower extremity ischemia after use of the left IMA for coronary revascularization. Their workup of the patient indicated that the left IMA was a major contributor to collateral blood flow to the left iliac artery. They recommended using only the GSV rather than the IMA in patients with "markedly enlarged" IMA and severe PVD to avoid limb ischemia. In our study, 1,872 patients had IMA grafts with their CABG procedures. Limb ischemia did not develop in any of these patients, and there was no significant correlation found between the use of IMA and major leg wound complications ($p = 0.741$).

However, a strong correlation was found between preexisting PVD and the development of major leg wound complication at the GSV harvest sites. Preexisting PVD was identified in 416 of 3,525 patients (11.8%). In contrast, 16 of the 23 patients (69.6%) with major leg wound complications had preexisting PVD ($p < 0.0001$). Among them, we were able to find only 4 patients with documented lower extremity vascular evaluations before their operations (ABI ranged from 0.67 to 0.91). Three of these 4 patients subsequently required postoperative revascularization procedures to achieve wound healing. Clearly, preoperative vascular evaluations are not indicated in all patients. However, if a patient demonstrates evidence of significant PVD on physical examination, a vascular workup of the lower extremity before harvesting GSV is advised. Scher and associates [14] recommended segmental Doppler pressure and pulse volume recordings for patients at risk for ischemic complications of distal leg incisions. GSV harvest should be avoided for Doppler ankle pressures less than 50 mm Hg. Furthermore, they recommended arteriography and vascular bypass for existing necrotic leg wounds with ankle pressure less than 50 mm Hg, as this may be incompatible with wound healing.

The reported lower extremity complications after IABP insertion ranged from 20% to 30%, with limb ischemia being the most common problem [15]. In our study, postoperative IABP was required in 395 patients, 10 of whom experienced major leg wound complications. All these patients received 40 cc DataScope intraaortic balloons (Datascope Corp, Fairfield, NJ). Limb ischemia developed in 5 of these patients as a result of arterial thrombosis, and 2 patients consequently required limb amputations. As expected, the majority (3 of 5 patients) had preexisting PVD, but none had vascular evaluations before their operations. Other reported risk factors for developing limb ischemia from IABP include female sex, diabetes mellitus, and smoking [15, 16]. Previous research at our institution demonstrated that patient body surface area, method of balloon placement, age, preoperative hemodynamic status, and preoperative ventricular function were not independent predictors of vascular complications from IABP [16]. Although it is difficult to predict which patient will require IABP during the postoperative period, most potential leg wound complications can be avoided with careful vascular examination before balloon insertion and contralateral placement of the balloon pump in the leg where the vein grafts were not harvested. If limb ischemia does occur, removal of the IABP (as allowed by the patient's condition) and/or local thrombectomy may be sufficient. If continued IABP support is indicated, contralateral placement of IABP or a femorofemoral arterial bypass is recommended [17].

Predictably, significant correlation ($p = 0.01$) was found between diabetes mellitus and the development of major leg wound complications. Although multivariate analysis failed to identify diabetes mellitus as a significant independent risk factor in our study, alterations in wound healing in diabetic patients contributed greatly to the development of leg wound complications. In patients with hyperglycemia, a higher concentration of glycosylated hemoglobin has an increased affinity for oxygen, thus contributing to low oxygen delivery at the capillary level [18]. This predisposes patients with diabetes mellitus to wound healing impairment at the GSV harvest site. Other contributing factors include atherosclerotic disease targeted at the lower extremity, increased blood viscosity due to stiffened red blood cells, and impaired immune system. Diabetes-related wound complication can be minimized with vigilant control of blood glucose level both preoperatively and postoperatively.

Minimally invasive techniques for GSV harvest have been described in the literature in attempts to reduce the incidence of leg wound complications [19, 20]. Most recently, Allen and associates [19] demonstrated a significantly lower complication rate with endoscopic vein harvesting technique compared with the traditional method. However, procurement of the GSV is still being performed with the usual longitudinal incision. Adherence to basic surgical principles and proper vein harvest site selection still remain the essential factors in preventing leg wound complications, especially in patients with compromised lower extremity circulation. Minimal dissection, adequate hemostasis, careful approximation of subcutaneous tissue and skin, and prompt drainage of hematomas are key principles in reducing leg wound complications. Placing incisions anterior to the medial malleolus, as performed in the standard approach, carries the risk of wound breakdown due to the poor tissue quality in proximity to the ankle joint. The risk is further enhanced in the presence of diabetes mellitus and PVD. Chukwuemeka and John [20] described placing the leg incision 5 cm above the midpoint of the medial malleolus. This location can significantly reduce the incidence of leg wound complications and minimize the chance of tendon, joint, or bone exposure in the event of wound complication, thereby avoiding extensive reconstructive procedures for limb salvages and potential limb amputation.

In summary, the causes of major leg wound complications after GSV harvest for CABG procedures are multifactorial. Multivariate analysis suggests female gender, preexisting PVD, and postoperative IABP use as strong independent predictors of major leg wound complications. The complexity of management of these complications parallels their severity and ranges from simple debridement to free tissue transfer using microvascular techniques. Potential serious complications can be avoided by (1) identifying patients at risk, (2) obtaining preoperative vascular evaluations and appropriate interventions, (3) selecting proper vein harvest sites and applying meticulous surgical techniques, (4) promptly recognizing and treating early complications, and (5) administrating aggressive therapy for established complications.

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The Society of Thoracic Surgeons: Thirty-seventh Annual Meeting

Mark your calendars for the Thirty-seventh Annual Meeting of The Society of Thoracic Surgeons, which will be held in New Orleans, Louisiana, January 29–31, 2001. The Postgraduate Course will provide in-depth coverage of thoracic surgical topics selected to enhance and broaden the knowledge of practicing thoracic and cardiac surgeons.

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