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Surgical Site Infections Risk after Coronary Artery Bypass Surgery Using Endoscopic Saphenous Vein Harvesting: A Review Article

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Abstract

Background: Saphenous vein graft (SVG) is the most common conduit for coronary artery bypass graft (CABG) surgery. SVG harvesting has two techniques: open and endoscopic. At present, endoscopic vein harvesting (EVH) has become prevalent due to reduced complications and increased patient satisfaction.

Objective: To introduce and establish basic knowledge about the risk of surgical site infections after coronary artery bypass surgery through the use of endoscopic saphenous vein harvesting.

Conclusion: SSI following CABG continues to be a major cause of morbidity. This serious complication often occurs after discharge and is associated with open SVG harvesting, larger body mass, and blood transfusions. The endoscopic procedure seems to lessen wound-related complications, increase patient satisfaction, and decrease postoperative pain, length of hospital stay, and use of wound-management resources.

Keywords: saphenous vein; coronary artery bypass; surgical site infections

Introduction

Despite the improvements in medical care and the increased emphasis on quality improvement programs for reducing postoperative infections, about 5% of patients suffer from major infections after cardiac surgery. [(1)] In a recent prospective, multi-institutional cohort study of infections associated with cardiac surgery, findings revealed that substantial increases have been observed in morbidity, mortality, and costs associated with these events. [(2)]

1% to 4% of patients suffer from surgical site infections (SSIs) of the saphenous vein graft (SVG) harvest site following coronary artery bypass grafting (CABG), which are associated with substantial morbidity and cost. In rare cases, these infections can even result in the loss of a limb. [(3)]

Endoscopic saphenous vein harvesting was first introduced in the mid-1990s and is currently estimated to be the method of choice in more than 70% of CABG procedures in the United States. [(6-8)] Three-quarters of patients undergoing CABG in the present study had endoscopic vein

harvesting, of whom 2.4% developed a secondary SSI, which is less than one-half the proportion of the open vein harvest group (4.8%, P<.01). [(4)]

CABG operation can be performed with (on-pump CABG) or without (off-pump CABG) the aid of the cardiopulmonary bypass, which comprises connecting (or grafting) a healthy patient artery or vein to the narrowed coronary artery beyond the critical lesion, supplying the heart muscle with oxygen-rich blood. [(5)]

Among postoperative complications, mean 30-day mortality after CABG is 2.1%, while stroke, gastrointestinal bleeding, and renal failure requiring dialysis occur in less than 1.5% of patients who underwent the operation. [(6)] 5% to 21% of the subjects had infectious complications, which are associated with higher morbidity and mortality. [(7)] The incidence of sternal and leg wound infections following CABG reached 8.4% and 7.0%, respectively. [(8)] The rate of surgical site infections (SSIs) after cardiac surgery can be reduced through adopting prevention practices including modification of risk factors and surgical procedures techniques together with vigilance during the postoperative course. [(7)]

2% to 20% of coronary artery bypass grafting (CABG) procedures in the United States were estimated to have resulted in complications, namely, surgical site infections (SSIs) at the sternal or conduit harvest site incisions. [(9)] Considerable attention has been paid to deep chest infections and mediastinitis due to their potential for serious morbidity and mortality, although graft harvest site infections may be more common following CABG. Leg harvest site infections led to higher morbidity for patients and increased the length of hospital stay and hospital costs. Few published studies have included an analysis of risk factors, especially for harvest site infection in CABG patients. Most of the literature related to SSI in CABG patients has concentrated on sternal wound infections or has comprised an analysis of all wound infections occurring after surgery (combining chest and harvest sites). To recognize patients with an increased risk of harvest site infection and to develop strategies for reducing its risk, it is essential to identify specific risk factors for leg harvest site infections. [(10)]

The risk factors for leg harvest site infection illustrated in previous studies comprised obesity, female gender, diabetes, wound depth, continuous open incision method of harvesting the saphenous vein(s),

wound length, peripheral vascular disease, left ventricular end-diastolic pressure greater than 15 mmHg, longer cross-clamp time, placing an intra-aortic balloon pump postoperatively, postoperative treatment with nicardipine, lacking postoperative treatment with dobutamine or nitroglycerin, and leg incision open more than 150 min. [11]

Open SVG harvest [hazard ratio (HR): 2.12; 95% CI: 1.28–3.48] is associated with developing SSIs at multivariable analysis along with packed red blood cell transfusions (HR: 1.13; 95% CI: 1.05–1.22) and increased body mass index (HR: 1.08; 95% CI: 1.04–1.12). [12]

Endoscopic Saphenous Vein Harvest

Endoscopic vein harvesting (EVH) is a procedure performed for harvesting the greater saphenous vein (GSV), which is the most commonly utilized conduit in coronary artery bypass graft surgery. This procedure requires making small incisions as well as utilizing an endoscopic camera such as a blunt dissector to create a subcutaneous tissue tunnel under the skin. The activity presents the key steps of the procedure and illustrates the responsibilities of the healthcare team performing this procedure. During the past ten years, endoscopic vein harvesting (EVH) has been the main chosen method for harvesting the greater saphenous vein (GSV), which is the most commonly utilized conduit in coronary artery bypass graft (CABG) surgery. The saphenous veins are often utilized because of their ease of harvesting and length. There has been a greater demand for more and better conduits as a result of the global demand for CABG surgery, in addition to the increasing need of performing multiple coronary artery bypasses for patients in the same procedure. [13] In the past, the conventional open technique of GSV harvesting comprised a long skin incision, which often resulted in a higher incidence of wound complications and pain. This was often associated with increased length of hospital stay and reduced patient satisfaction. The endoscopic vein harvesting technique has evolved and developed for improving the previously mentioned drawbacks of the open procedure. [14]

In the PREVENT IV trial performed on 3,000 patients who underwent CABG and were subjected to vein harvesting by EVH versus open technique, secondary analysis revealed a significant rate of vein-graft failure (38% open versus 46.7% EVH; OR: 1.45; 95% CI: 1.20–1.76) and

occlusion (33.8% open versus 42.6% EVH; OR: 1.47; 95% CI: 1.20–1.79). In addition, EVH had a higher rate of death and myocardial infarction or required further revascularization (20.2% versus 17.4%; adjusted hazard ratio: 1.22; 95% CI: 1.01–1.47) up to 3 years. [15]

Similarly, a sub-analysis of 1,471 patients, who underwent CABG using SVG, in comparison with EVH and open techniques from the ROOBY trial, revealed no significant differences between groups as regards death or major perioperative complications, such as reoperation, new mechanical support, cardiac arrest, coma, stroke, or renal failure requiring dialysis. However, in a subgroup of 894 patients with 1-year angiographic follow-up, SVG patency was 74.5% for EVH and 85.2% for open technique ($P<0.0001$). [16]

Contrary to the two previously mentioned trials that were not designed for evaluating EVH, a subsequent observational study was conducted by Williams et al. on 235,394 Medicare patients undergoing isolated CABG between 2003 and 2008 at 934 surgical US centers. It demonstrated no differences between EVH and open technique in terms of survival and the composite of death, myocardial infarction, or revascularization for 3 years, despite registering a reduced rate of wound infections (adjusted HR: 0.83; 95% CI: 0.77–0.89). Therefore, the vein graft damage hypothesis suspected for reduced patency or patient survival was not supported. [17] Regarding this issue, one might assume that inhomogeneous results associated with vein graft damage and patency outcome could be affected by the operators (EVH is generally carried out by physician assistants in the USA while young residents perform the procedure across Europe), various techniques, or device technology advances. [18]

Surgical Site Infections after CABG

Infectious complications represent a serious problem following cardiac surgery and are associated with reduced survival, prolonged length of hospital stay, and costs. [19]

Wound infectious complications have preoperative risk factors including female gender, DM, obesity, hypoalbuminemia, anemia, and steroid use. Furthermore, tissue trauma and wound closure methods may

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play a role. EVH lessened the impact of diabetes and obesity on the incidence of wound complications. EVH from the thigh may lessen the wound complications of diabetes because vasculopathy, which is a small vessel disease, affects wound healing more below the knees. [20]

BMI and the need for transfusion of more units of PRBCs were strongly associated with the risk of developing a secondary SSI on multivariable modeling with those who have higher BMI being more likely to develop a secondary SSI. This is hardly surprising provided that patients with higher BMI are commonly believed to be at greater risk of postoperative infection and poor wound healing. [22] Numerous theories investigate why this relationship occurs, including reduced wound circulation and oxygenation, in addition to increased wound tension. The need for transfusion of PRBCs was also associated with the risk of developing a secondary SSI (HR: 1.13 per unit; $p<0.01$) and is consistent with other studies, including the study performed by Horvath et al., who demonstrated an incremental crude risk for major infection of 29% for each unit of pack red blood cells transfused in cardiac surgery. [21]

Gulack et al. [22] demonstrated that other reported risk factors, including female gender, peripheral vascular disease, tobacco use, diabetes mellitus, renal failure, type of surgery and urgency, preoperative ejection fraction, need for an intra-aortic balloon pump, and postoperative hyperglycemia, were not related to a statistically significant increased risk of infection. They concluded that there is no way to clear infections, even if the whole process of care would be implemented and strictly applied.

Nonetheless, efforts in prevention are of paramount importance, aiming to reduce the infection rate in the next coming years. [19]

Screening glycemia in all patients and glycemic control to maintain perioperative blood glucose levels <200 mg/dL, smoking cessation, correction of hypoalbuminemia prior to surgery, decolonization of nasal *Staphylococcus aureus* carriage and intranasal mupirocin administration, adequate preoperative antibiotic prophylaxis with antimicrobial peak tissue levels at the time of skin incision, early weaning from ventilation, and removing indwelling vascular and urinary catheters have been proved to significantly lessen SSIs following cardiac surgery. [23]

To prevent sternal infections, it is essential to adopt proper techniques of wound closure. Peri-sternal crisscross double-wire techniques, also known as figure-of-eight closure, appear to be better than the standard interrupted steel wire closure, significantly reducing deep sternal wound infections. [(19)] Besides, the application of gentamicin-collagen sponges placed between the sternal edges prior to the end of the operation as well as effective surgical hemostasis for preventing re-sternotomy for bleeding significantly reduced deep sternal wound infections. [(24)]

Bilateral internal thoracic artery (BIMA) is the best choice for young patients and/or in the absence of BMI >30 or diabetic patients with HbA1c greater than 7%. [(25)] Skeletonized internal thoracic artery dissection instead of pedicled graft should be recommended for preventing mediastinitis in diabetic patients or when harvesting BIMA. [(26)] In those circumstances where BIMA is not recommended, radial artery and saphenous vein may still represent valuable options. EVH in comparison with open technique is associated with two- to threefold improvements in terms of the rate of wound-related complications and infections. [(18)]

Conclusion

SSI following CABG is still a major cause of morbidity. This serious complication often occurs after discharge and is associated with open SVG harvesting, larger body mass, and blood transfusions. The endoscopic procedure seems to lessen wound-related complications, increase patient satisfaction, and reduce postoperative pain, length of hospital stay, and use of wound-management resources.

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