

Intradermal versus Staple Cutaneous Closure of Sternum after Coronary Artery Bypass Grafting: A Retrospective Comparison

*Emad M. Hijazi, Mohamed Bani Hani *¹*

Abstract

Background: Cardiac surgery infections are infrequent but cause important complications. Predicting their occurrence is essential for future prevention.

Objectives: This study aims at determining the difference in wound complication and infection rates between suture and staple cutaneous closure techniques applied to clean sternal incisions in coronary bypass patients at King Abdullah University Hospital, Jordan.

Methods and Results: In a retrospective study, 1,338 coronary artery bypass grafting cases have been analyzed from May 5, 2002, to December 31, 2007. A sternal wound was studied retrospectively. 572 patients had wound closed with intradermal (subcuticular) sutures, 766 patients had wound closed with staples. Wounds were categorized as complicated (greater than normal erythema). A complicated wound was identified as infected if the patient had purulent discharge, if antibiotics had been prescribed for cellulites, or drainage procedure had been performed. Wounds were examined at discharge, after discharge at one week in the clinic, and at 3 to 4 weeks after surgery.

Results: Significantly lower incidence of total wound complications with intradermal suture closure than with staple closure.

Conclusions: Subcuticular suture closure of sternal skin incision is more cosmetic and has a lower infection rate.

Keywords: Sternal Wound Infection, Mediastinitis, Sternal Wound Closure Technique.

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Introduction

Sternal wound complication is infrequent but important following Coronary Artery Bypass Grafting (CABG). This complication is associated with increased cost of care, prolonged hospitalization, and increased morbidity and

mortality.¹ Numerous host and technical factors are associated with the occurrence of wound complications. The reported incidence of sternal wound infection has ranged from 1.2% to 9%.²⁻⁴ Although prior studies have identified risk factors for postoperative mediastinitis,^{5- 10} no study to date has developed a simplified scoring system

1. Division of Cardiac Surgery, Department of General Surgery, Princess Muna AL-Hussein Cardiac Center, King Abdullah University Hospital and the Jordan University of Science and Technology, Irbid, Jordan.

* Correspondence should be addressed to:

Emad M. Hijazi

P. O. Box: 999, Irbid 22110, Jordan

E- mail: emad_hijazi@hotmail.com

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to estimate an individual patient's risk for major infection after coronary artery bypass grafting.¹¹ Severity can range from superficial wound infections, which do not reach the sternum, to fulminant mediastinitis that involves the sternum, heart, and major arteries.^{12, 13} While superficial infections are limited to the skin and subcutaneous tissues, deep infections involve sternal osteomyelitis, sternal dehiscence, and mediastinitis.^{14, 15} The rate of deep sternal infection after open-heart surgery is about 0.2% to 2.9%.^{12, 13, 16, 17} Staphylococci are the most important pathogens in sternal infections.^{12, 13, 17} The development of sternotomy complications is multifactorial, and many studies demonstrate the variables in patients and procedures.^{18- 22} In this study, we compared intracutaneous (subcuticular suture technique) and stapled closure techniques in open-heart surgery (CABG) with respect to superficial and deep sternal wound infection development, pathologic agents, therapy, cosmetic results, and possible risk factors.

Patients and Methods

1,338 consecutive patients who were undergoing Coronary Artery Bypass Grafting (CABG) from May 5, 2002, to December 31, 2007 were enrolled in this retrospective study. The study was a multisurgeon experience. Surgeon's preference of the method of skin closure was not taken into account. All patients had undergone CABG using a Left Internal Mammary Artery (LIMA) graft. Five hundred and seventy two patients (n=572) had wound closed with intradermal sutures (42.75 %), seven hundred and sixty six patients (n=766) had wound closed with staples (57.24 %). Eight hundred and twenty three men (61.50%) and 515 women (38.49%) (mean age, 59.5 years; range, 35-75 years) were enrolled. There were 325 men (56.81%) and 247 women (43.18%) in the subcuticular group (mean age 59.7 years; range, 35-67 years), and the stapled group had 498 men (65.01%) and 268 women (34.98%) (mean age 51. 2 years; range, 40-75) table (1). We excluded from our study the valves surgery, congenital open heart surgery and early postoperative deaths, not related to infection. Patients that we couldn't find proper follow up in their medical files were also

excluded from the study.

Surgical Techniques

The skin was incised with a sterile lancet, midline sternotomy, and pericardial and presternal tissues were cut by electrocauterization. Bone wax was used. Cardiopulmonary bypass was instituted with a single right atrial two stage cannula and an ascending aorta perfusion cannula. Standard bypass management included membrane oxygenators, arterial line filters, systemic hypothermia down to 32°C, and non-pulsatile flow of 2.4 l/min/m², with a mean arterial pressure greater than 50 mm Hg. The myocardium was protected by using intermittent antegrade cold blood cardioplegia (4:1 blood to crystalloid ratio). Anticoagulation was achieved using 300 U/kg of heparin. If required, heparin was supplemented to maintain the activated clotting time above 480 seconds and was reversed by protamine at the end of the procedure. All patients underwent standard placement of mediastinal and left pleural chest drains. In both groups, steel wires were used for closing the sternum, and 2 layers of Vicryl 2.0 dyed suture were used to close subcutaneous tissues avoiding dead spaces between the subcutaneous tissues. Subcuticular closure was performed with (polyglactin 910) absorbable Vicryl undyed for intracutaneous closure group. Stainless staple clips were used to staple closure group. Wound was washed with povidone iodine and sealed with dressing for three days (usual protocol in the cardiac unit and ward). Antibiotic therapy was as follows: an initial 750mg dose of Intravenous (IV) zinaceff 30 minutes before the operation, followed by 750mg IV zinaceff every 8 hours. Patients who were allergic to penicillin received 1-g IV vancomycin every 12 hours, until their drains were removed.

Postoperatively, patients were observed in the cardiovascular intensive care unit until they were hemodynamically stable and extubated. The drains were retained until drainage was less than 100 cc in 12 hours. Postoperative wound inspection was done on the third day, unless oozing was present, then regularly during the first 5 days.

Wounds were examined at discharge (5-7 days post surgery if there is no surgical complications), after discharge at one week in the outclinic, and at 3 to 4 weeks after surgery. Wounds were categorized as complicated (greater than normal erythema) or uncomplicated. Wound smear and aspiration cultures were obtained from patients who developed infections. Antibiotic therapy was initiated in accordance with the results of an antibiogram. A complicated wound was identified as infected if the patient had purulent discharge, if antibiotics had been prescribed for cellulites, or if any debridement or drainage procedure had been performed. The cosmetic results were evaluated at the end of the 4th postoperative week. $P < 0.05$ was taken as statistically significant.

Results

Deep sternal wound infection was observed in 3 patients in subcuticular closure group (0.52%) with unstable sternum, and 5 patients in staple closure group (0.65%). Total deep wound infection = 0.59%. Two of the patients in subcuticular group with deep wound infection were female's insulin-dependent diabetic patients. One of them died before surgical intervention. In staple closure group, two patients were female insulin-dependent diabetic, one patient is female diabetic on oral hypoglycemic agents, the other two patients are not diabetic male patients, two of these patients died before surgical intervention (death related deep wound infection = 0.22%), and no other risk factors for infection are found in either group. Reoperation was needed for sternal wound stabilization in these patients except in one patient treated conservatively. These patients were excluded from the study. The total incidence of early superficial sternal wound infection for the 4-week follow-up period was 4.92% for the subcuticular group (patients $n=28$) and 8.93% for the staple group (patients $n=68$). No late wound infections were detected in either group medical files. Eighteen of the 28 subcuticular group patients who developed superficial wound infections were diabetic (64.28%). Eighteen (9.18%) of the 196 diabetic patients in the subcuticular group developed superficial wound infections. Forty (58.82%) of

the 68 staple group patients who developed superficial wound infections were diabetic. Forty (16.32%) of the 245 diabetic patients in the staple group developed superficial wound infections. Ten (4.08%) of the 28 patients in the subcuticular group who developed superficial wound infections were women and seven of them were diabetic (7.29%), but eighteen (5.55%) were men, eleven of them were diabetic (11%), and no other significant factor regarding superficial wound infections. Forty (15.09%) of the 68 patients in the staple group who developed superficial wound infections were women and twenty two of them were diabetic (20.18%). Twenty eight patients in the staple group who developed superficial wound infections (5.64%) were men; eighteen were diabetic (13.23%) table (2). Wound smear and aspiration cultures were obtained from patients who developed infections. *Staphylococcus aureus* was isolated in 9 patients of the subcuticular group, and in 14 patients of the staple group. *S. epidermidis* was isolated in 6 patients of the subcuticular group, and in 9 patients of the staple group. *Enterococcus faecalis* was isolated in 4 patients of the subcuticular group, and in 8 patients of the staple group. *Escherichia coli* were isolated in 3 patients of the subcuticular group, and in 4 patients of the staple group. The remaining patients did not have proliferation documented. Patients were placed on an antibiotic regimen depending on the proliferation of pathogenic microorganisms. It has been found that the incidence of wound infection was significantly higher in diabetic patients in the staple group than in the subcuticular group. Diabetes mellitus and female sex are associated with significant higher infection rates. In general, staple group closure was associated with higher infection rates in comparison with subcuticular group. The cosmetic results assessed by the patients and by the surgeons were significantly different between the two groups, in favor of the subcuticular closure. The duration of postoperative hospital stay of patients who developed infection was significantly higher. The patient with superficial infection in the subcuticular group was discharged on the 10th-12th postoperative day; a patient in the staple group was discharged on the 12-15 postoperative day.

Table (1): Demographic characteristics and risk factors of (CABG) patients.

	Intracutaneous	Subcuticular	Staple Closure
	(n=572)		(n=766)
Age	59, 7		51, 2
Female	247		268
Male	325		498
Angina pectoris	336		542
Left main coronary lesion	257		336
History of cardiac surgery	-		-
History of MI	258		397
Diabetes mellitus	198		248
Male	102		139
Female	96		109
Chronic renal failure	7		4
Peripheral vascular disease	16		12
COPD	59		38
Smoking	279		302
Steroid use	3		6
Reopening for bleeding	11		19
LVEF	0,54		0,45
Emergency surgery	6		3
Dyspnea	246		464
Hypertension	267		359
Body mass index	<30 kg/m ²		<30 kg/m ²

COPD: Chronic Obstructive Pulmonary Disease; LVEF: Left Ventricular Ejection Fraction; MI: Myocardial Infarction.

Table (2): Incidence of infection in both groups (Males and Females).

	Subcuticular Group Closure		Staple Group Closure		P Value
	Number	Infection %	Number	Infection %	
Total N=	569	4.92	761	8.93	0.005
Male	324	5.55	496	5.64	0.956
Female	245	4.08	265	15.09	0.000
Diabetic	196	9.18	245	16.32	0.027
Male Diabetic	100	11	136	13.23	0.605
Female Diabetic	96	7.29	109	20.18	0.008

- Total number of patients in both groups after exclusion of deep sternal wound cases= 1330, Total diabetic= 196 in subcuticular group, and 245 in stable closure group.
- The overall rate of superficial sternal wound infection in both groups of patients in this retrospective study was 7.21%.

Discussion

Sternal wound complication is infrequent but important following Coronary Artery Bypass Grafting (CABG). It increases the length of hospital stay by 57% and cost of treatment by 42%.²³ Limited information exists in the literature regarding superficial infections in open-heart surgery. The reported incidence of sternal wound infection has ranged from 1.2% to 9%.²⁻⁴

The overall rate of superficial sternal wound infection in both groups of patients in this retrospective study was 7.21%. The acceptable range being 11%-15%.²⁴ Sternal site infection accounted for nearly 75% of the cases of surgical site infection.²⁵ The development of sternotomy complications is multifactorial. Bone wax is frequently used as a haemostatic agent to prevent bleeding from cancellous bone. Bone wax was used in all our patients. All our patients had received blood transfusion.

As we know in cardiac surgery, a certain amount of blood cannot be returned through the pump suction, and going out through the whole suction, additional to that blood loss, will be after the pump is off and protamine is already given. Robicsek et al.²⁶ have commented on the infection promoting role of bone wax. Another study²⁷ has suggested that bone wax augments infection. Blood transfusion is associated with impaired immunocompetence.²⁸ The rate of reopening for bleeding in the present study was 2.24% but no patient of them developed sternal wound infection. Reexploration for bleeding has been reported as an important risk factor.²⁹ In this retrospective present study, single pedicle Internal Mammary Artery (IMA) was used in all our patients. No bilateral IMAs were documented in these patients. We are avoiding the harvest of bilateral IMA in our practice here. Cautery is routinely used in our practice to separate the pedicle from the chest wall together with the vein, muscle, fat and accompanying endothoracic fascia. Cauterization damages to the blood supply to the sternum, impedes sternal wound healing and exposes the sternum to the risks of early dehiscence and infection, especially, if both IMAs are harvested.²⁵ There is frequently a substantial degree of ischaemic necrosis of the bone on the side of the IMA graft. Diabetic patents are immunosuppressant, with generalized microvascular disease, because of that they are more liable to infection in general and to surgical ischemia with poor healing wounds. The risk is particularly great in the elderly and the diabetic patients.³⁰ The major detected pathogens in this study were *Staphylococcus aureus*. Gram-positive bacteria are the most common organisms isolated from postoperative sternal infections. *Staphylococcus aureus* or *S. epidermidis* is identified in 70% to 80% of the cases.^{31, 32} The most common 10 pathogens as reported by Jonkers et al. (2003)³³ were *S. aureus* (26%), *P. aeruginosa* (10%), *Enterococcus faecalis* (9.5%), *S. epidermidis* (8%), *Escherichia coli* (7.7%), *Proteus mirabilis* (6.9%), *Enterobacter cloacae* (5.4%), *Bacteroides fragilis* (2.3%), other coagulase-negative staphylococci (2.3%), and *Morganella morganii* (1.7%). Of the five prospective randomized controlled trials^{34- 38} in cardiovascular surgery that compared staples

with suture closure, three^{34- 36} of the five studies found that the complication rate was lower with sutures and the other two found no difference. With regard to cosmesis, two^{34, 35} of the five studies found sutures to be superior and the remaining papers found no difference. In our series, none of the preoperative, perioperative, and postoperative factors presented in table (1) - other than diabetes mellitus-affected superficial sternal infection in either group. Obesity has been reported as a weak association with surgical site infection and that too only in relation to sternotomy.³⁹ The possible reasons for obesity being a risk factor include ineffective dose of prophylactic antibiotic, difficulty of proper skin preparation, adipose tissue providing a good substrate for infection and difficulties in vascular graft harvesting.²⁵ We could not compare obese patients with nonobese patients as a risk factor for infection in this retrospective study, as our patients were with Body Mass Index (BMI) <30 kg/m². Documented duration of surgery in this study was 4-5 hours. Operations lasting for more than 2 hours are associated with increased infection rates.⁴⁰ There is an interesting finding in this study which states that female patients developed more significant sternal wound infection and significantly in staple group but not as a female risk factor, the rate of diabetes is more in this group. We are inclined to believe that the acceptable range of superficial infection in our center is due to operative, and postoperative care of patients, as well as we are in the starting period in cardiac surgery in the north of Jordan, our cases are more selective. In spite of the fact that the quality of patients in the recent years and the improvement of invasive cardiology techniques and the experience of cardiologists, leaving us without a wide range of selections. During the period study (2002-2007), we witnessed significant fluctuations in the annual rate of superficial infection.

Limitations of the Study

This is a retrospective nonrandomized study in a new cardiac surgery center, as well as we have been in the starting period in cardiac surgery for 6 years in the north of Jordan, our cases are more selective.

Data available about only clinical diabetes were looked at and there was no subgroup analysis of patients who were insulin dependent or those who had subclinical diabetes (elevated HbA1C). Obesity as a risk factor for wound complications in general could not assist, as our patients are with BMI <30kg/m². The study was a multisurgeon experience. Surgeon's preference of the method of skin closure was not taken into account. A prospective randomized study with a large number of patients from one surgeon will give us a proper comparison between two techniques, as well as it will shed light on these negative points.

Conclusion

It has been concluded that sutured skin closure for chest wound is superior to stapled closure in diabetic patients. With regard to cosmesis, it has been found that sutures are superior to stapled closure. Re-opening of the sternal closure in an emergency situation is much quicker if subcuticular sutures are used instead of staples.

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رأب الجرح باستخدام الخيوط الجراحية مقارنةً بالتدبيس في جراحة القلب

عماد حجازي ، محمد بني هاني

مركز الأميرة منى الحسين لأمراض وجراحة القلب، مستشفى الملك المؤسس عبد الله الجامعي، جامعة العلوم والتكنولوجيا الأردنية،
اربد، الأردن

الملخص

مقدمة: التهابات الخمجية للجروح في عمليات جراحة القلب غير شائعة ولكنها تعد من المضاعفات الخطرة، وعليه فإن التنبؤ بحدوثها وتشخيصها مبكراً يعد ضرورة للتقليل منها ومحاولة تجنبها.

الهدف: تحديد نسبة التهاب الجروح بعد عمليات جراحة القلب باستخدام الخيوط الجراحية مقارنةً بالتدبيس.

الطريقة: أجريت هذه الدراسة في مستشفى الملك المؤسس عبد الله الجامعي وشملت دراسة (1338) مريضاً أجريت لهم عملية تطعيم الشرايين التاجية خلال الفترة من (أيار 2005 إلى كانون الأول 2007م). وقد وجد بعد مراجعة الملفات أن هناك (572) حالة قد تم رأب الجرح الصدري باستخدام الخيط الجراحي (Subcuticular) و (766) مريضاً تم رأب الجرح باستخدام التدبيس. وقد تم تعريف الالتهاب الخمجي بوجود صديد في الجرح.

النتائج: وجد أن نسبة الجروح المتهبة بعد استخدام الخيوط الجراحية بأنها أقل من استخدام التدبيس.

الخلاصة: رأب الجرح الجراحي باستخدام الخيوط الجراحية (Subcuticular) هو أفضل من ناحية تجميلية وأقل نسبة التهاب.

الكلمات الدالة: التهاب الجرح القصي، التهاب المنطقة لصدريّة، تقنية إغلاق الجرح القصي.