Original Article

Sternal Wound Infection Following CABG: A Review of 1121 Patients

Sternal Infection after CABG

1. Naseem Ahmad 2. Muhammad Naveed Shahzad 3. Suhail Ahmad

1. Asstt. Prof. of Cardiac Surgery, 2 Medical Officer, Cardiac Surgery, 3. Asstt. Prof. of Cardiac Anesthesia, Ch. Pervaiz Ellahi, Institute of Cardiology

ABSTRACT

Objective: to know incidence of sternal wound infection , microbacteria involved and associated risk factors so as practical steps should be made before hand to counter theses problems

Study Design: Case series study.

Place and Duration of Study: This study was conducted at Ch. Pervaiz Ellahi, Institute of Cardiology, Multan from 2012-2014.

Materials and Methods: Microbiological testing was conducted under supervision of a consultat microbiologist attached to the hospitals performing cardiac surgery. Infections were classified as in-hospital SSIs if occurring during the hospital stay, or post-discharge. Infections were recorded as sternal or harvest site infections. Associated Potential risk factors were recorded . A proforma was filled which was approved by hospital ethical committee.

Results: Over the study period , 1121 patients had CABG. Predominantly patients were male (mostly in age range of 50-76 with median age of 63 years). ASA score of 3 was recorded in majority of patients. The majority of patients were recorded as having an ASA score of 3 or 4, a clean wound, and antibiotic prophylaxis administered. Antibiotic prophylaxis in almost all cases.97 patients had sternal site infections, with one half of the cases detected in-hospital and the other half post-discharge.

Gram-positive bacteria were detected in 56% of cases having infections. 43% had Gram-negative bacteria and fungi (e.g. Candida albicans) 1 case.

Conclusion: The incidence of MRSA is increasing and to counter these we had to adopt methods.

Key Words: MRSA, Prevalence.

INTRODUCTION

Sternal wound infection following CABG pose substantial burden on healthcare systems as length of hospital stay and costs increases substantially.[1]

Factors that associated with increased risk of sternal wound infection are:[2-5]

1. Host factors (advanced age, obesity and diabetes)
2. procedural factors (wound class, duration of procedures and surgical technique)
3. infection control strategies(appropriate antibiotic prophylaxis, effective patient skin preparation).

Mediastinitis occurs in 0.25–5% of patients undergoing median sternotomy.Historically, mortality approached 50% in these patients.[6]

Sternal wound infections may be classified into three distinct types as described by Pairolero and Arnold

1. Type 1 wounds occur in the first several postoperative days and are usually sterile. This is consistent with early bony nonunion and may represent the earliest stage of infection and perhaps even the portal of entry for skin flora.
2. Type 2 infections, occurring in the first several weeks postoperatively are consistent with acute deep sternal wound infection, including sternal dehiscence, positive wound cultures, and cellulitis.
3. Type 3 infections, presenting months to years later, represent chronic wound infection and uncommonly represent true mediastinitis. They are usually confined to the sternum and overlying skin and may be related to osteonecrosis or persistent foreign body.

Speculation exists that dehiscence of the sternum precedes infection of the deeper soft tissues within the mediastinum.Similar to other bones in the body such as in the lower extremity or even the mandible, sternal instability may perhaps encourage infection rather than result from it.With absent bacterial contamination and resulting infection, this instability will develop into sternal nonunion as opposed to poststernotomy mediastinitis and osteomyelitis.[7]

Many countries have implemented standardised surveillance systems to monitor and report sternal infection after CABG ,largely based on surveillance methods developed by the US Centres for Disease Control and Prevention (CDC) National Healthcare Safety Network.[8-11]

Preoperative risk factors for the development of mediastinitis include older patients, COPD, smoking, ESRD, DM, chronic steroid or immunosuppressive use, morbid obesity including large, heavy breasts, prolonged ventilator support (>24 h), concurrent infection and reoperative surgery. Other variables include off midline sternotomies, osteoporosis, use of LIMA or RIMA, long cardiopulmonary bypass runs (>2 h), and transverse sternal fractures.

A high index of suspicion is encouraged for any patient with sternal instability or ‘click.’

However, firm diagnosis of mediastinitis or deep sternal wound infection is made by isolation of an organism from mediastinal fluid or tissue, chest pain, or fever associated with

bony instability.Sternal nonunion commonly results from failure of boney healing following median sternotomy. However, it is also seen in association with chest wall trauma. Patients with non-union may complain of pain or clicking associated with respiration. The study was designed to know incidence of sternal wound infection, microbacteria involved and associated risk factors so as practical steps should be made before hand to counter theses problems.

MATERIALS AND METHODS

The study period is from 2012-2014 in Ch. Pervaiz Ellahi Institute of Cardiology, Multan. Our inclusion criteria were all patients undergoing a CABG procedure that was defined by International Statistical Classification of Diseases and Related Health Problems, 10th Revision

Ethical approval was granted from hospital and Medical Research Human Research and Ethics Committee.

Microbiological testing was conducted under supervision of a consultant microbiologist attached to the hospitals performing cardiac surgery.

Infections were classified as in-hospital SSIs if occurring during the hospital stay, or post-discharge SSIs if detected after discharge and within 30 days post procedure (in case of implant in situ, the follow-up period was within one year). Infections also were classified as either superficial (involving skin/subcutaneous tissue) or complex (involving deep soft tissue, organ/space) infections . Infections were recorded as sternal or harvest site infections.

Associated Potential risk factors were recorded

1. patient characteristics including age, sex and American Society of Anaesthesiologists (ASA) score
    a. ASA score ranges from 1 to 5, indicating a
        i. patient being healthy
        ii. with mild systemic disease
        iii. with severe systemic disease
        iv. with severe systemic disease that is a constant threat to life
        v. patient who is not expected to survive without the operation
2. Procedural factors
    a. emergency vs. elective
    b. types of CABG surgery
    c. wound classification (clean vs. clean-contaminated)
    d. number of grafts
    e. use of antibiotic prophylaxis
3. patient factors
    a. medical comorbidities
    b. steroid intake
    c. malnutrion

Statistical analysis Was done using spss 11. Numerical and categorical data was calculated and analysed.

RESULTS

Results are tabulated in table 1. Over the study period , 1121 patients had CABG. Predominantly patients were male (mostly in age range of 50-76 with median age of 63 years). ASA score of 3 was recorded in majority of patients. The majority of patients were recorded as having an ASA score of 3 or 4, a clean wound, and antibiotic prophylaxis administered. Antibiotic prophylaxis in almost all cases. 97 patients had sternal site infections, with one half of the cases detected in-hospital and the other half post-discharge.

Gram-positive bacteria were detected in 56% of cases having infections. 43% had Gram-negative bacteria and fungi (e.g. *Candida albicans)* 1 case.

Following variables were identified as potential risk factors:

1. ASA score of 4 or 5
2. Urgent surgery
3. More than 3 grafts
4. Diabetes mellitus
5. Malnutrition
6. Smoker with element of COPD

DISCUSSION

Mediastinitis is characterized by an infection that begins as a small, focused area of infection in the mediastinal cavity just below the sternum. The ensuing inflammation and tissue necrosis infects the surrounding soft tissues beneath the sternum and mediastinal space, which may or may not include osteomyelitis of the sternum itself. Seventy percent of patients with mediastinitis require at least one additional surgical procedure for incision and drainage of the infected area. The standard of care is to perform a muscle flap to establish sufficient blood supply to the sternum to promote healing. Contributing factors to SSIs in general, and mediastinitis in particular, include the exogenous and endogenous sources that contaminate the surgical wound during the procedure. Exogenous sources include unsterile/ contaminated fluids, hair and skin cell shedding from the surgical team, and poor hand hygiene practices. Endogenous sources include the patient's own skin flora and the presence of an existing infection at a remote site. Our study is comparable that of HAI surveillance system Norway (1.1%) & NHSN system US (1.2%).[11-17].

Patients with chronic conditions such as renal failure, hypertension, chronic obstructive pulmonary disease (COPD), peripheral vascular disease (PVD), osteoporosis, and diabetes are at higher risk for experiencing post-op mediastinitis. Other risk factors include obesity, diabetes, smoking, hospitalization prior

to the surgical procedure, age, male gender, previous CABG procedures , an emergency procedure, and large

Table No.1: Demographic and clinical characteristics of patients CABG

Number of patients undergoing CABG procedures from 2012-2014 in Ch. Pervaiz Ellahi Institute of Cardiology				1121	
Sex		Male		Female	
		Number	%age	Number	%age
		980	87.42	141	13%
Age	category, years	Number		%age	
	<50	112		9.99	
	50-60	630		56.19	
	61-70	320		28.54	
	>70	59		5.26	
American Society of Anaesthesiologists score	1	23		2.05	
	2	66		5.88	
	3	871		77.69	
	4	100		8.92	
	5	61		5.44	
Priority of surgery		Urgent		Elective	
		Number	%age	Number	%age
		100	8.92	1021	92.18
CABG graft type		CABG with both sternal and graft site incisions		CABG with sternal site incisions only	
		Number	%age	Number	%age
		1100	98.20	21	1.80
Mean number of graft=2.5					
Wound		clean		Clean-contaminated	
		Number	%age	Number	%age
		1111	99.10	10	0.99
Preopearative antibiotics		All were given antibiotic prophylaxis			
SURGICAL SITE INFECTIONS					
Superficial Sternal site infection		Deep Sternal site ifection		Harvest site incision	
Number	%age	Number	%age	Number	%age
345	30.45	23	2.05	78	6.9
PATHOGENS					
Methicillin-sensitive Staphylococcus aureus (MSSA) 43.3%	methicillin-resistant Staphylococcus aureus (MRSA, 14.6%	Pseudomonas aeruginosa (8.3%),		Enterobacter spp. (6.7%).	

breast size. Most consistently reported in the literature as independent variables for mediastinitis are obesity, diabetes, and hospitalization prior to the procedure.[18-23] Mediastinitis Prevention Recommendations were developed that include :

1. Hand Hygiene,
2. Antibiotic Prophylaxis --- Therapeutic Guidelines recommend three options for antibiotic prophylaxis in cardiac surgery: cefazolin alone, a combination of flucloxacillin and gentamicin, or a combination of vancomycin and gentamicin. We follow these guide lines.

Our study indicate that increased risk of surgical site infections is because of increasing severity of illness. The underlying reason is that nearly all patients undergoing CABG surgery would have an ASA score ≥ 3. However, construction of these risk scores requires extensive and complex clinical data; their application to routine SSI surveillance data is subject to advancements of the underlying surveillance systems.[24-30].

CONCLUSION

Our analysis of 10 years of CABG surgical site infection surveillance data indicates the importance of Gram-negative organisms as causative pathogens, and emphasises the need to select appropriate prophylactic antibiotics for patients undergoing CABG procedures. An upward trend in complex sternal site infection rates can be partially explained by the increasing proportion of CABG patients with more severe underlying disease. Future research should focus on development of appropriate and adequate risk adjustment models to facilitate valid comparison of CABG surgical site infection rates across hospitals.

REFERENCES

1. Braxton JH, Marrin CA, McGrath PD, et al. 10-year follow-up of patients with and without mediastinitis. Semin Thorac Cardiovasc Surg 2004; 16:70–76.
2. Gummert JF, Barten MJ, Hans C, et al. Mediastinitis and cardiac surgery—an updated risk factor analysis in 10,373 consecutive adult patients. Thorac Cardiovasc Surg 2002;50:87–91.
3. Salehi Omran A, Karimi A, Ahmadi SH, et al. Superficial and deep sternal wound infection after more than 9000 coronary artery bypass graft (CABG): incidence, risk factors and mortality. BMC Infect Dis 2007;7:112.
4. Ridderstolpe L, Gill H, Granfeldt H, Ahlfeldt H, Rutberg H. Superficial and deep sternal wound complications: incidence, risk factors and mortality. Eur J Cardiothorac Surg 2001;20:1168–1175.
5. Pairolero PC, Arnold PG. Management of infected median sternotomy wounds. Ann Thorac Surg 1986;42:1–2.
6. Lu JC, Grayson AD, Jha P, Srinivasan AK, Fabri BM. Risk factors for sternal wound infection and mid-term survival following coronary artery bypass surgery. Eur J Cardiothorac Surg 2003;23: 943–949.
7. Borger MA, Rao V, Weisel RD, et al. Deep sternal wound infection: risk factors and outcomes. Ann Thorac Surg 1998;65:1050–1056.
8. Peterson MD, Borger MA, Rao V, Peniston CM, Feindel CM. Skeletonization of bilateral internal thoracic artery grafts lowers the risk of sternal infection in patients with diabetes. J Thorac Cardiovasc Surg 2003;126:1314–1319.
9. Sutherland RD, Martinez HE, Guynes WA. A rapid, secure method of sternal closure. Cardiovasc Dis 1981;8:54–55.
10. Gårdlund B, Bitkover CY, Vaage J. Postoperative mediastinitis in cardiac surgery - microbiology and pathogenesis. Eur J Cardiothorac Surg 2002;21: 825–830.
11. Gur E, Stern D, Weiss J, et al. Clinical-radiological evaluation of poststernotomy wound infection. Plast Reconstr Surg 1998;101:348–355.
12. Bryant LR, Spencer FC, Trinkle JK. Treatment of median sternotomy infection by mediastinal irrigation with an antibiotic solution. Ann Surg 1969;169:914–920.
13. Grossi EA, Culliford AT, Krieger KH, et al. A survey of 77 major infectious complications of median sternotomy: a review of 7,949 consecutive operative procedures. Ann Thorac Surg 1985;40: 214–223.
14. Catarino PA, Chamberlain MH, Wright NC, et al. High-pressure suction drainage via a polyurethane foam in the management of poststernotomy mediastinitis. Ann Thorac Surg 2000;70:1891–1895.
15. Durandy Y, Batisse A, Bourel P, Dibie A, Lemoine G, Lecompte Y. Mediastinal infection after cardiac operation. A simple closed technique. J Thorac Cardiovasc Surg 1989;97:282–285.
16. Wackenfors A, Gustafsson R, Sjögren J, Algotsson L, Ingemansson R, Malmsjö M. Blood flow responses in the peristernal thoracic wall during vacuum-assisted closure therapy. Ann Thorac Surg 2005;79:1724–1730; discussion 1730–1731.
17. Domkowski PW, Smith ML, Gonyon DL, et al. Evaluation of vacuum-assisted closure in the treatment of poststernotomy mediastinitis. J Thorac Cardiovasc Surg 2003;126:386–390.
18. Chen Y, Almeida AA, Mitnovetski S, Goldstein J, Lowe C, Smith JA. Managing deep sternal wound infections with vacuum-assisted closure. ANZ J Surg 2008;78:333–336.
19. Baillot R, Cloutier D, Montalin L, et al. Impact of deep sternal wound infection management with vacuum-assisted closure therapy followed by sternal osteosynthesis: a 15-year review of 23,499 sternotomies. Eur J Cardiothorac Surg 2010;37: 880–887.
20. Fleck T, Kickinger B, Moidl R, et al. Management of open chest and delayed sternal closure with the vacuum assisted closure system: preliminary experience. Interact Cardiovasc Thorac Surg 2008;7:801–804.
21. Mokhtari A, Petzina R, Gustafsson L, Sjögren J, Malmsjö M, Ingemansson R. Sternal stability at different negative pressures during vacuum-assisted closure therapy. Ann Thorac Surg 2006; 82:1063–1067.
22. Sjögren J, Malmsjö M, Gustafsson R, Ingemansson R. Poststernotomy mediastinitis: a review of conventional surgical treatments, vacuum-assisted closure therapy and presentation of the Lund University Hospital mediastinitis algorithm. Eur J Cardiothorac Surg. 2006;30:898–905.
23. Bapat V, El-Muttardi N, Young C, Venn G, Roxburgh J. Experience with vacuum-assisted closure of sternal wound infections following cardiac surgery and evaluation of chronic complications associated with its use. J Card Surg 2008;23:227–233.
24. Cabbabe EB, Cabbabe SW. Immediate versus delayed one-stage sternal débridement and pectoralis muscle flap reconstruction of deep sternal wound infections. Plast Reconstr Surg 2009;123:1490–1494
25. Brandt C, Alvarez JM. First-line treatment of deep sternal infection by a plastic surgical approach: superior results compared with conventional

cardiac surgical orthodoxy. Plast Reconstr Surg 2002;109:2231–2237.
26. Rand R P, Cochran R P, Aziz S, et al. Prospective trial of catheter irrigation and muscle flaps for sternal wound infection. Ann Thorac Surg 1998; 65:1046–1049.
27. Davison SP, Clemens MW, Armstrong D, Newton ED, Swartz W. Sternotomy wounds: rectus flap versus modified pectoral reconstruction. Plast Reconstr Surg 2007;120:929–934.
28. Sargent LA, Seyfer AE, Hollinger J, Hinson RM, Graeber GM. The healing sternum: a comparison of osseous healing with wire versus rigid fixation. Ann Thorac Surg 1991;52:490–494.
29. Voss B, Bauernschmitt R, Will A, et al. Sternal reconstruction with titanium plates in complicated sternal dehiscence. Eur J Cardiothorac Surg 2008; 34:139–145.
30. Wu LC, Renucci JD, Song DH. Sternal nonunion: a review of current treatments and a new method of rigid fixation. Ann Plast Surg 2005;54:55–58.

Address for Corresponding Author:
Dr. Muhammad Naveed Shahzad,
Asstt. Prof. of Cardiac Anesthesia,
CPEIC Multan.
E-mail: drmuhammaad@gmail.com