

How to Cite:

Taha, A. M., El-Haish, M. K., Mohammed, M. M., & Rushdi, M. H. (2022). Prospective cohort study in evaluation of risk factors for infection during and after coronary graft operations. *International Journal of Health Sciences*, 6(S4), 8140–8146.
<https://doi.org/10.53730/ijhs.v6nS4.11782>

Prospective cohort study in evaluation of risk factors for infection during and after coronary graft operations

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Abstract---Introduction: There is a strong suggestion that an impairment of vascular supply of the sternum may be one of the most important factors influencing the incidence of deep sternal wound infection (DSWI). Several studies have studied the risk factors for SSIs including DSWI in cardiac surgery. Methods: All patients who are presented to Assiut University Heart Hospital in need of Coronary artery Bypass Grafting from 1st of January, 2018 to 30th June, 2021 were included in the study prospectively. Exclusion criteria included patients who were diagnosed with infective endocarditis, have undergone open heart surgery before or had sternotomy been done for any other reason- redo surgery is excluded-, and where other surgical accesses were used other than sternotomy. Results: During the study duration, we included 99 patients. Our patients were followed for 1 week post-operative and then on day 30 post-operative. 81 patients showed perfect skin healing at 1 week post-operative follow-up with very nice and neat scar at 1 month follow-up. 5 patients showed wound breakdown with subcutaneous being exposed (Type I SWIs). 3 patients suffered type I SWI with exposed subcutaneous but with severe infection and loss of skin. . 2 patients suffered Type II SWI with sternum being exposed and with palpation there was sternal rocking. They were prepared for surgical intervention for debridement and sternal fixation. Conclusion: Surgical site infections (SSIs) are either superficial or deep and may involve the organs, or spaces accessed

during an operation. The reported incidence of SSIs in coronary artery bypass grafting (CABG) surgery ranges between 0.3% and 8%.

Keywords---sternal infection, surgical site infection, bypass surgery, CABG, ischemic heart disease.

Introduction

There is a strong suggestion that an impairment of vascular supply of the sternum may be one of the most important factors influencing the incidence of deep sternal wound infection (DSWI). Several studies have studied the risk factors for SSIs including DSWI in cardiac surgery⁽¹⁾. These risk factors included obesity, diabetes mellitus, chronic obstructive pulmonary disease (COPD), connective tissue disease, steroid use, smoking, peripheral vascular disease and renal insufficiency. In addition, intraoperative factors (e.g., use of bilateral internal mammary arteries [BIMA] grafting, prolonged cardiopulmonary bypass [CPB] duration) and postoperative variables (e.g., prolonged mechanical ventilation, reoperation for bleeding, postoperative transfusions and gastrointestinal, nephrological and respiratory complications) have been shown to be associated with DSWI.^[2,3,4]

The risk for sternal wound infection (SWI) is increased if cardiac surgery involves internal thoracic arteries grafting and a valve procedure, or use of a ventricular assist device.^[5,6] Leg wound infections at donor sites account for >70% of cases with severe infection following cardiac surgery.^[7] Bilateral skeletonized internal thoracic arteries grafting is catastrophic for the sternum. Old age, females post menopause and osteoporosis make the sternum very fragile with high probability of sternal fractures and SSI post-operatively.

Methods and Patients

All patients who are presented to Assiut University Heart Hospital in need of Coronary artery Bypass Grafting from 1st of January, 2018 to 30th June, 2021 were included in the study prospectively. Inclusion criteria included patients elder than 18 years old and sternotomy should be the chosen surgical access. Exclusion criteria included patients who were diagnosed with infective endocarditis, have undergone open heart surgery before or had sternotomy been done for any other reason- redo surgery is excluded-, and where other surgical accesses were used other than sternotomy.

Informed written consent was obtained from the patients explaining the purpose from the study and the probability of sternal wound infection post-operative, the modalities of management and the necessary precautions to avoid such complications. Withdrawal from the study is possible at any time without clearing their reasons is guaranteed and no personal data of the patients should be disclosed for any reason.

Results

During the study duration, we included 99 patients. Nine patients were excluded due to their inability to commit to follow-up time-table and we could not connect with them after discharge. 90 patients completed the study. Female patients represented 30.7% (n=18) while male patients represented 69.3% (n=72). Age of the patients ranged from 41 to 70 years old. Body mass index (BMI) of patients ranged from 24 to 30. Of the male patients 40 patients were known to be diabetics (66.6%). Of the female patients there were 10 who were known to be diabetics (42.8%). All patients who had high HbA1C (above 7 mg/dl) were excluded from the study for better control of their blood sugar level. 53 patients were known to be hypertensive (52.7%) including 18 female patients and 30 male patients.

	SSI (n= 12)	No-SSI (n= 78)	P value
Age (years)	57.17 ± 5.45	59.18 ± 12.34	0.14
Sex			< 0.001
Male	3 (25%)	69 (88.5%)	
Female	9 (75%)	9 (11.5%)	
Obese (BMI> 30 kg/m ²)	8 (66.7%)	10 (12.8%)	0.01
Smoking	1 (8.3%)	23 (29.5%)	0.11
Diabetes mellitus	12 (100%)	38 (48.4%)	0.01
Hypertension	5 (41.7%)	48 (61.5%)	0.16
Obstructive lung disease	4 (33.3%)	3 (3.8%)	0.02
Chronic kidney disease	1 (8.3%)	1 (1.3%)	0.25

All patients were accessed by standard median sternotomy and, hemostasis was done by diathermy at upper and lower edges of sternal plates and bone wax at inner side and at the end of the surgery another turn of hemostasis is done then all cases were closed by figure of eight technique using stainless steel wires of size 7. Muscle and subcutaneous layers were closed in two layers by vicryl 0 with round needle and skin was closed by vicryl 3/0. Dressing was started in all patients in the second day post-operative and then daily using betadine solution in a septic way using sterile surgical gloves and covered by self-adhesive sterile dressing.

Table 1: Operative data of studied patients based on development of SSI

	SSI (n= 12)	No-SSI (n= 78)	P value
Operative time (minute)	375.61 ± 33.42	382.42 ± 38.45	0.50
By-pass time (minute)	45.58 ± 4.05	46.41 ± 4.67	0.56
Blood loss (ml)	445.83 ± 111.71	450 ± 214.56	0.94
Transfusion amount (ml)	625 ± 433.01	583.45 ± 3045.45	0.78
Use of internal thoracic artery	8 (66.7%)	63 (80.8%)	0.24

Data expressed as frequency (percentage), mean (SD). P value was significant if < 0.05. SSI: surgical site infection



Fig. 1: Sternal wound infection (SWI) with exposure of sternum needed debridement and tight closure with reinforced mattress sutures

We adopted the classification by J. Anger et.al. published at Brazilian Journal of cardiovascular surgery (2015) which classifies sternal wound infection into Type I: Skin and subcutaneous, Type II: Exposure of sternum and ribs, Type III: Bone loss of sternum or ribs, Type IV: Exposed mediastinum. Our patients were followed for 1 week post-operative and then on day 30 post-operative. 78 patients showed perfect skin healing at 1 week post-operative follow-up with very nice and neat scar at 1 month follow-up. 5 patients showed wound breakdown with subcutaneous being exposed (Type I SWIs). Those needed careful wound care with topical antibiotics and twice dressing per day. At 1 month follow-up those patients showed good response with improved healing with tight control of blood glucose. 3 patients suffered type I SWI with exposed subcutaneous but with severe infection and loss of skin. Those needed debridement of the wound with good local antibiotics and delayed primary closure of the wound. At 1 month follow-up, they showed good wound healing and perfect closure. 4 patients suffered Type II SWI with sternum being exposed and with palpation there was sternal rocking. They were prepared for surgical intervention for debridement and sternal fixation. There was severe mediastinitis. They improved with parenteral antibiotic combination according to culture and sensitivity and good nutrition care. It was found that out of those with SSI; 8 (66.7%) patients had superficial SSI and 4 (33.3%) patients had deep SSI.

Table 2: Hospital stay among studied patients based on development of SSI

	SSI (n= 12)	No-SSI (n= 78)	P value
ICU stay (day)	7.33 ± 1.98	5.41 ± 1.81	< 0.001
Hospital stay (day)	13.78 ± 1.85	10.17 ± 1.52	< 0.001

Table 3: Type of surgical site infection among studied patients

Type of SSI	N= 12
Superficial SSI	8 (66.7%)
Deep SSI	4 (33.3%)



Fig.2: Type I sternal wound infection exposing subcutaneous tissue

All those patients needed tight control of blood glucose which improved their response to supportive drugs. Together with good nutrition care and suitable antibiotic therapy helped to enhance immunity with good monitoring of lab investigations. Eventually, this leads to improving cardiac function and rapid recovery. This will hasten wound healing giving the patients a better quality of life.

Discussion

Wound healing is a complex process that necessitate a well-functioning immunity system.⁽⁷⁾ Sternal wound infection (SWI) is one of the morbidity and mortality causes in open heart surgery.^(6,10) Many classifications are described for better description and interpretation in relation to anatomical and surgical aspects.^(11,12) Timing of intervention and management protocol can save the patient a lot. Prevention of sternal wound infection should be the main target of care.⁽¹⁰⁾ This can be achieved by strict sterile conditions during dressing, suitable antibiotics choice,⁽⁹⁾ improving the nutrition habits of the patients and early addressing of any emerging problems.⁽¹²⁾

Superficial wound infection carries a better prognosis that deep sternal wound infection (DSWI).⁽¹²⁾ Avoiding mediastinitis is the principle concern in case of sternal wound infection.⁽¹³⁾ This can be achieved by good debridement of the wound, more frequent dressings per day, keeping strict sterile conditions, using appropriate antibiotics according to culture and sensitivity, correction of the general condition with good nutritional care.^(13,14)

Mediastinitis is a serious complication which threatens life.⁽¹⁵⁾ More rapid and cautious interventions should be taken as early as possible to avoid septicaemia⁽¹⁹⁾. Septic shock worsen the case very much and carries a very poor prognosis.⁽¹⁵⁾ Obesity and uncontrolled diabetes mellitus, uncontrolled hypertension,⁽¹⁶⁾ poor nutrition and negligence^(17,18) are very serious factors that should be addressed with the patient for better understanding and cooperation.

Conclusion

Surgical site infections (SSIs) are either superficial or deep and may involve the organs, or spaces accessed during an operation. The reported incidence of SSIs in coronary artery bypass grafting (CABG) surgery ranges between 0.3% and 8%. The risk for sternal wound infection (SWI) is increased if cardiac surgery involves internal thoracic arteries grafting and a valve procedure, or use of a ventricular assist device. Cardiac SSIs increase the length of hospital stay (LOS) and increase treatment costs in proportion to the severity of the infection. These costs increase by 3.8%, 14.7% and 29.4% in mild, moderate and severe infections respectively

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