Experience of dual topical antibiotics for prevention of sternal wound infection in coronary artery bypass grafting surgery

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ABSTRACT

Objective: To determine the role of dual topical antibiotics for prevention of sternal wound infection in patients undergoing coronary artery bypass grafting surgery.
Study Design: Comparative cross-sectional study.
Place and Duration: Cardiac Surgical department Army Cardiac Centre Lahore from 1st Aug, 2017 to 31st July, 2018.
Methodology: Data was collected on 134 consecutive patients of coronary artery bypass grafting surgery (both Off-Pump & On-Pump) and were divided into two equal groups. Group A includes patients with use of dual topical antibiotics (Topical Cefoperazone-sulbactam and topical Vancomycin) and Group B without the use of topical antibiotic. The primary outcome measure was to assess sternal wound infection prior to discharge till 30th postoperative day.
Results: Sternal wound infection was found to be more common in Group B than Group A (17.91% vs 5.97%) and was statistically significant (*p* 0.005). Deep sternal wound infection(DSWI) did not develop in patients of Group A as compared to 4.47% of patients of Group B. Deep Sternal wound infection was more common in females than males (*p* 0.001). DSWI related mortality was none in Group A verses 1.49% in Group B (0.006).
Conclusion: Topical Cefoperazone-sulbactam plus Vancomycin plays important role in the prevention of sternal wound infection especially deep sternal wound infection after coronary artery bypass grafting surgery.
Keywords: Sternal wound infection, Coronary artery bypass grafting, Topical antibiotic, Sternal dehiscence.

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INTRODUCTION

Sternal wound infections (SWI) especially deep sternal wound infection (DSWI) is avoidable serious complication after open heart surgery. It is associated with significant increase in morbidity and mortality as well as cost of treatment. The incidence of superficial sternal wound infection (SSWI) as reported in the literature varies from 0.5% and 8%and that of deep sternal wound infection (DSWI) is between 0.5% to 6.8%[1].The reported in- hospital mortality is quoted between 7% and 47%[2-4].

Various risk factors are identified for causing sternal wound infection after coronary artery bypass grafting surgery. The pre-operative risk factors include female sex, diabetes mellitus, obesity, renal dysfunction and history of previous surgery. Operative risk factors known to cause SWI are use of bone wax, asymmetrical sternotomy, use of bilateral mammary arteries, coronary artery bypass grafting surgery and prolong operation time. The post-operative risk factors are prolonged ventilation, re-exploration for bleeding and longer hospital stay[1,5]. Different methods have been adopted as reported in various studies for decreasing the incidence of sternal wound infection like the use of perioperative antibiotics, tight glycemic control with continuous administration of insulin infusion in perioperative

period, meticulous surgical technique, use of skeletonised internal mammary artery, avoidance of bone wax and use of topical antibiotic with variable results[6].

The management of superficial sternal wound infection is comparatively easy and straight forward. On the other hand, treatment of DSWI poses major problems due to the fact that microorganisms colonize the damaged tissues and form polymicrobial communities (biofilms). The biofilms are resistance to antibiotic treatment[7]. Therefore management of DSWI with mere dressing and intravenous antibiotics has found to be insufficient and needs aggressive treatment in the form of surgical debridement followed by the placement of a wound vacuum–assisted closure (VAC) and is found to be effective in the treatment of DSWI[8]. Sternal dehiscence requires debridement followed by sternal rewiring.

In this study, it is hypothesized that use of dual topical antibiotics in the form of Cefoperazone-sulbactam with Vancomycin would be associated with decrease frequency of sternal wound infection. To cover most of the pathogens causing sternal wound infection, we used dual topical antibiotics. The objective of the study is to determine the role of dual topical antibiotics for prevention of sternal wound infection in patients undergoing coronary artery bypass grafting surgery.

METHODOLOGY

This comparative cross-sectional study was conducted in Cardiac Surgical Department of Army Cardiac Centre Lahore. Data was collected from hospital database on a total of 134 patients of Coronary artery bypass grafting surgery (both On-pump & Off-pump) between 1st Aug, 2017 and 31st July, 2018. These patients were recruited in the study through non random consecutive sampling as per comparable demographic characteristics and were divided in two groups. Group A (n=67) includes patients with use of dual topical antibiotics in the form of Cefoperazone-sulbactam with Vancomycin while Group B (n=67) consisted of patients without the use of topical antibiotic. All patients of both sexes over the age of 35 years underwent coronary artery bypass grafting whether by Off-Pump or On-pump techniques were included in the study. Patients of redo operations, valvular heart disease, infective endocarditis and adult congenital heart diseases were excluded from study.

Data on patient's demography was recorded. Intraoperative variables like use of bone wax, internal mammary artery harvesting, clamp time, Cardiopulmonary bypass (CPB) time and total operation time along with the number of grafts were also recorded. Postoperative data include ventilation time, need for mediastinal re-exploration, type of sternal wound infection, intensive care unit (ICU) and hospital stay. The in-hospital mortality was also noted. The bacteriology and treatment of the sternal wound infection was also noted.

All patients of each group received intravenous Cefazolin 2gms and Amikacin 500mg on induction of anaesthesia and continued for 48 hours in the postoperative period. Surgical technique was identical in both groups. In Group A, One gram of Cefoperazone-sulbactam is poured into the mediastinum before sternal closure. The sternum was routinely closed with steel wires by simple trans-sternal closure technique and topical Vancomycin powder 1 gram was sprinkled over the closed sternum. In Patients of Group B, No topical antibiotic was used during sternal closure. Subcutaneous tissue and skin layer were closed using running monofilament absorbable sutures in each group. The primary outcome measure for our study was sternal wound infection prior to discharge till 30thpost operative day.

Operational Definitions: Superficial sternal wound infection (SSWI) was defined as infection involving the skin, subcutaneous tissue, and pectoralis fascia. Deep sternal wound infection (DSWI) was defined as the infection involving sternal bone, sternal wires or collections beneath the sternum. A wound was considered infected if there was purulent discharge or evidence of positive culture for an organism[9]. Mortality was defined as death caused by sternal wound infection before discharge or within 30 days of surgery.

Data Analysis: Data was entered in Statistical package for Social sciences (SPSS version 23) for analysis. Data had been described through descriptive statistics. Quantitative variables of each group were analyzed using Independent sample t-test, while Qualitative variables of both the groups were analyzed by Chi-square test. Differences were considered statistically significant at $p< 0.05$.

RESULTS

Patient demographic and perioperative clinical characteristics are shown in Table-I. There was no statistically significant difference in age, gender, hypertensive status, smoking, angina class and creatinine clearance levels. Diabetic patients were more in group B as compared to Group A (p=0.05). Four patients (5.97%) in group A developed superficial sternal wound infection (SSWI) while 12 (17.91%) patients of Group B had sternal wound infections with 9(75%) patients had SSWI and 3(25%) developed DSWI. DSWI was found only in patients of Group B with 1(1.49%) male and 2(2.98%) female patients and none in Group A (p=.005). All patients with deep sternal wound infection were obese with BMI above 30kg/m^2. Only 01(3.33%) Diabetic patient of Group A had sternal wound infection. On the other hand, 7(17.07%) diabetic patients of Group B developed sternal wound infection. Out of these patients of Group B, 5(71.4%) developed SSWI and 2(28.5%) patients had DSWI. Sternal wound infection (SWI) was found predominantly in male patients of each group with 3(5.17%) in Group A and 7(12.28%) patients in group B; however DSWI was found mainly in female patients with 2(20%) female patients and 1(1.75%) male patient of Group B (p=0.001). SWI was noted in patients of both groups having renal dysfunction (creatinine clearance less than 83 ml/min) with 3(4.47%) patients in Group A and 11(16.41%) patients in Group B but was not statistically significant (p=0.9). Out of 12(17.9%) patients of Group B who underwent Off pump coronary artery bypass grafting surgery (OPCAB), 1(8.3%) patient had sternal wound infection, while none of the patients of Group A 18(26.9%) having OPCAB surgery developed SWI. Mean operation time was less in Group B than Group A and was statistically significant (p=0.00).

Table-I: Comparison of Perioperative variables between groups (N=134)

Perioperative Variable		Group A (n=67)	Group B (n=67)	Test applied	*p* Value
Age (Yrs)		58.09±8.13	58.69±6.71	Independent sample t-test	0.64
BMI(Kg/m^2)		25.53±3.09	26.97±6.03		0.08
Operation time (mins)		210.28±42.7	182.99±42.9		0.00
Ventilation time (hrs)		4.06±1.9	4.09±3.2		0.95
ICU stay (hrs)		40.33±34.2	47.21±49.04		0.34
Hospital stay (days)		5.25±1.4	7.09±7.5		**0.05**
Gender	Male	86.56% (58)	85.07% (57)	Chi-square test	0.81
	Female	13.43% (9)	14.92% (10)		
Diabetic		30(44.7%)	41(61.2%)		0.05
Smoker		19(28.3%)	25(37.3%)		0.08
Previous MI		28(41.8%)	34(50.7%)		0.80
Operation	CABG	49(73.1%)	55(82.1%)		0.07
	OPCAB	18(26.9%)	12(17.9%)		

The total number of cases was 134 with 67 patients each in Group A and Group B.

In group A, out of 4(5.97%) patients of sternal wound infection, wound swab for culture was positive in 2(50%) patients with Staphylococcus aureus detected. In Group B, out of 12(17.91%) cases of sternal wound infection, culture was positive in 7(58.3%) patients with Staphylococcus aureus detected in 6(50%) cases and Klebsiellapneumoniae in 1(8.3%) case. 5(41.6%) cases of SWI in this group had negative report of culture. On the whole, Staphylococcus aureus was found to be the most common organism involved. In Group A, all 4(100%) patients with SSWI was managed with daily antiseptic dressing, while in Group B, 07(58.33%) of SSWI was treated with daily dressing, 02(16.6%) patients of SSWI and 1 patient (8.3%) of DSWI with Negative-pressure wound therapy and 02(16.6%) patients of DSWI with sternal dehiscence was managed with Debridement and sternal rewiring. Surgical site infection in Group A is less as compared to Group B and is statistically significant (*p* 0.004). 1(8.3%) patient in Group B expired due to sternal wound infection with sternal dehiscence and none in Group A (*p* 0.006).

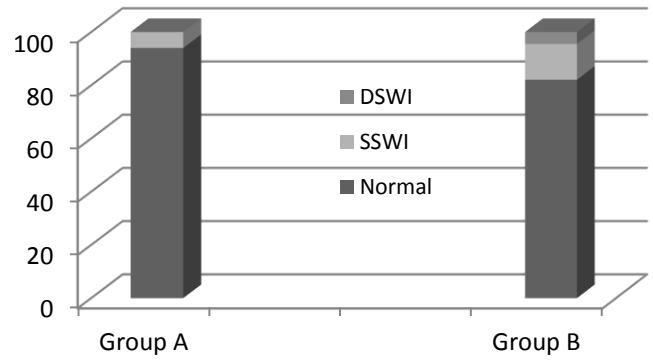

Figure-I: Sternal Wound Infection in Group A & B (%)

*SSWI: Superficial sternal wound infection; DSWI: Deep sternal wound infection

DISCUSSION

Sternal wound infection, though rare, can be a dreadful complication after open heart surgery. Different preoperative risk factors like female sex, diabetes mellitus increased body mass index and deranged renal function have been reported in various studies for causing sternal wound infection[9,10]. Lee and colleagues have identified that diabetic patients, having perioperative uncontrolled blood glucose levels, are at increased risk for superficial and deep sternal wound infection[11]. We, however, did not find diabetes as a significant risk factor for causing sternal wound infections. This finding might be on account of keeping tight glycemic control in the perioperative period. Thelwall[12] has shown that the risk of sternal wound infection were significantly increased in the obese patients. Moulton have also found strong link between obesity and superficial sternal wound infection[13]. Our findings are in contrast to that reported earlier as majority of patients who developed SSWI were not obese. However DSWI were noted only in obese patients with BMI above 30 kg/m^2. Similarly we did not identify significant association between renal dysfunction having low Creatinine clearance and sternal wound infection (p=0.9). Optimization of pulmonary function with cessation of smoking and aggressive pulmonary toilet has been recommended in the literature for prevention of sternal wound infection[14]. We had subjected all the cases of each group, including smokers, to aggressive preoperative chest physiotherapy for optimization of lung function. Sternal wound infection is found in insignificant number of smokers in current study (1 case in GP A& 2 cases in GP B).

Investigators have also found a relationship between the use of bone wax for securing haemostasis from sternal cut edges, asymmetrical sternotomy and harvesting of bilateral internal mammary artery with sternal wound infections[14,15]. On the contrary, we used bone wax in all patients of both groups and did not found its use as a convincing risk factor for causing sternal wound infection especially DSWI as seen in patients of Group A. We, however performed symmetrical median sternotomy and harvested single pedicled left internal mammary artery in patients of each group.

Post-operative factors like prolonged ventilation time, re-exploration for mediastinal bleeding and increase hospital stay has been reported in the literature for augmenting the risk of sternal wound infection[16], but we did not find significant difference in ventilation time in both the groups for causing sternal wound infection. Furthermore, re-exploration for mediastinal bleeding was not done in our patients. Hospital stay was comparatively more in patients of Group B but was not statistically significant.

The most common pathogen reported in causation of surgical site infection is Staphylococcus aureus[17,18]. Other organisms include Streptococci, gram negative bacteria and Candida albicans. Staphylococcus aureus is mainly found in the anterior nares of human beings with nearly 20% are persistent carriers. A higher rate has been identified in diabetic patients. Some studies have claimed that preoperative nasal screening for staphylococcus aureus and decolonization can reduce sternal

wound infection caused by these organisms[19]. Recent study conducted by Gaska and colleagues found that Staphylococcus epidermidis was mainly involved in causation of sternal wound infection[20]. In our study, Staphylococcus aureus was found to be the most common organism involved in sternal wound infection. However, we did not carry out preoperative nasal screening for the organism which is limitation of our study.

Different studies in the past have used various topical antibiotics for control of sternal wound infection with variable results[9,21]. Some studies have shown that use of Vancomycin paste applied to sternal cut edges instead of bone wax significantly reduce the incidence of surgical site infection especially deep sternal wound infection but recent study conducted by Lander HL et al found that use of Vancomycin paste did not help in prevention of sternal wound infection[21]. We did not use Vancomycin as a paste; instead our study have shown that Cefoperazone-sulbactam poured in the mediastinum along with Vancomycin powder sprinkled over the closed sternum after wiring significantly decrease the occurrence of sternal wound infection. Most importantly, there is marked reduction of DSWI as seen in our study (p=0.000).

Different techniques have been described in the literature for management of sternal wound infections ranging from dressing or negative pressure wound therapy (NPWT) to debridement and sternal rewiring[14]. For extensive DSWI, sternectomy, debridement followed by use of different myocutanous flaps for closure of sternal defect have been mentioned in various studies[22]. In current study, majority of SSWI were treated with dressing, while DSWI underwent either debridement and NPWT or sternal rewiring. None of the patients in the study was management by use of myocutanous flap.

Hiroshi Kubota et al[23] have found that thirty-day operative mortality in patients with DSWI with re-exploration for bleeding was significantly higher than DSWI without re-exploration. In our study, none of the patient had re-exploration for bleeding; however, mortality associated with DSWI was statistically significant in Group B.

Our study has some limitations that may importantly affect its findings. It is from single low volume centre and lack of preoperative nasal screening for staphylococcus aureus and decolonization. However, it was conducted in the same time period and there were no changes in perioperative protocols involving antibiotics, surgical techniques, or postoperative care during the study period.

CONCLUSION

In conclusion, Topical Cefoperazone-sulbactam plus Vancomycin play important role in the prevention of sternal wound infection especially deep sternal wound infection after coronary artery bypass grafting surgery.

Recommendation: In the light of current study results, it is recommended to use topical antibiotic (Topical Cefoperazone-sulbactam plus Vancomycin) during coronary artery bypass grafting surgery for prevention of sternal wound infection.

AUTHOR'S CONTRIBUTION

Paracha VI: Data analysis Data interpretation, Manuscript writing
Ahmed T: Final critical review of manuscript
Ahmad K: Conceived idea, Designed study
Ahmad A: Data collection and compilation
Sultan M: Literature review

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