

## Vancomycin Local application, role in Deep Sternal Wound Infection in our experience

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### ARTICLE INFO

Article type:  
Original article

Article history:  
Received: 26 August 2019  
Revised: 01 Dec 2019  
Accepted: 15 Feb 2020

Keywords:  
Coronary Artery Bypass  
Cardiopulmonary Bypass  
Deep Sternal Wound Infection  
Grafting  
Morbid Obesity

### ABSTRACT

**Introduction:** Deep sternal wound infection (DSWI) is one of the most complex and potentially devastating complications following median sternotomy in cardiac surgery. Despite many advances in prevention, it still remains significant and ranges between 0.5% and 6.8%. We aim to study the role of vancomycin paste applied locally over sternal edges in reducing DSWI.

**Materials and Methods:** We retrospectively collected data of patients who underwent open heart surgery from June 2017 to May 2019 in our institution. The rate of DSWI was compared in patients in whom vancomycin paste was applied and not applied. Vancomycin paste was prepared using 3 g of vancomycin with 4ml 0.9% normal saline and stirred until a 'paste' was formed. This vancomycin paste was applied just after sternotomy and at the time of sternal closure. The rate of DSWI was compared also compared in the following high risk sub groups: female patients, diabetes mellitus (DM), morbidly obese (Body Mass Index i.e. BMI>30) and chronic obstructive lung diseases (COPD).

**Results:** A total of 862 patients underwent open heart surgery during the specified period. Overall incidence of DSWI in our study was 3.48 %. DSWI was found to be significantly lower in vancomycin group (adjusted Odds ratio 2.116 and  $p < 0.0001$ ) than in the non vancomycin group, vancomycin independently lowered DSWI in all the groups on logistic regression analysis. Diabetes and obesity were statistically significant risk factors for DSWI. Gender, COPD and type of surgery did not affect the incidence of DSWI significantly. No death was recorded due to primary cause as DSWI in patients in our study.

**Conclusion:** Vancomycin paste application over sternal edges is an effective method to prevent DSWI. The use of local vancomycin paste application is recommended especially in patients with co morbidities like diabetes mellitus and morbidly obese (BMI>30) patients. These results need to be substantiated in randomized controlled trials and multiple centers.

► Please cite this paper as:

Jadhao M; Shah V; Raut C; Mishra P; Khandekar J, Surana K. Vancomycin Local application, role in Deep Sternal Wound Infection in our experience., *J Cardiothoracic Med.* 2020; 8(1):571-576

### Introduction:

According to Centers for Disease Control and Prevention (CDC) guidelines, the definition of a DSWI requires positive culture

results of surgical sites or drainage from the mediastinal area or evidence of infection during surgical re-exploration or fever, sternal instability, and positive blood culture

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results. Cardiac surgery procedures are considered to be clean procedures but still have the risk of infectious complications. The frequency of sternal wound infection (SWI) ranges from 0.5% to 8.0% and is linked with significant morbidity, mortality, and treatment cost. Surgical access site infection can never be fully prevented by perioperative antibiotic prophylaxis after cardiac surgery (1, 2). Deep sternal wound infection (DSWI) is one of the most complex and potentially devastating complications following median sternotomy in cardiac surgery. Despite many advances in prevention, DSWI still remains significant and ranges between 0.5% and 6.8% (3). A subject of growing interest has been the use of topical antibiotics over the sternal edges. We aim to study the role of vancomycin paste applied locally over sternal edges in reducing DSWI.

Patient and surgical factors contribute to the risk of DSWI after cardiothoracic surgery. Patient factors include Age, female sex, obesity, diabetes mellitus or hyperglycemia during the perioperative period (4). Use of vancomycin paste at sternal edges also avoids the use of bone wax, which is an independent risk factor for sternal dehiscence and wound infections (5).

### Materials and methods:

We retrospectively collected data of patients who underwent open heart surgery from June 2017 to May 2019 in Lokmanya Tilak Municipal Medical College and General Hospital. Study design was retrospective observational study. The rate of DSWI was compared in patients in whom vancomycin paste was applied and not applied. All patients undergoing cardiac surgery were selected and the local application of vancomycin over sternal edges was according to surgeon discretion. Vancomycin paste was prepared using 3 g of vancomycin with 4ml 0.9% normal saline and stirred until a 'paste' was formed (6) (Figure 1). This vancomycin paste was applied just after sternotomy and at the time of sternal closure (Figure 2). All patients underwent the same type of sternal wire and subcutaneous closure. The rate of DSWI was compared also compared in the following high risk sub

groups: Female patients, diabetes, morbidly obese (BMI>30) and chronic obstructive lung diseases. Patients having only superficial surgical site infection (SSSI), those undergoing reoperation and emergency surgeries were excluded from study. Statistical analysis was done using Binary Logistic regression test, using SPSS version 23 software by IBM. The level of significance being 0.05 and confidence interval of 95%. The data was collected from the patient database and indoor patient register which is maintained at our department for all the patients undergoing cardiac surgery. Individual patient consent and ethics committee approval was waived off as this was a retrospective study.

We used IV antibiotics 3rd generation cephalosporin with aminoglycosides perioperatively one dose and further for 3 days intravenously and later on shifted to oral antibiotic for 7 days as our institutional antibiotic policy. All those patients with DSWI were either readmitted or intervened before discharge only depending on time of presentation. Hemogram and Wound culture were sent for antibiotic sensitivity and treated accordingly with IV antibiotics. Some patients required secondary suturing, some managed with vacuum assisted dressing or simple daily dressing.

### Results:

A total of 862 patients underwent open heart surgery during the specified period, out of which 500 (58%) were male and 362 (41.9%) were female. Out of these 588 (68.21%) underwent CABG and 274 (31.79%) other open heart surgeries.

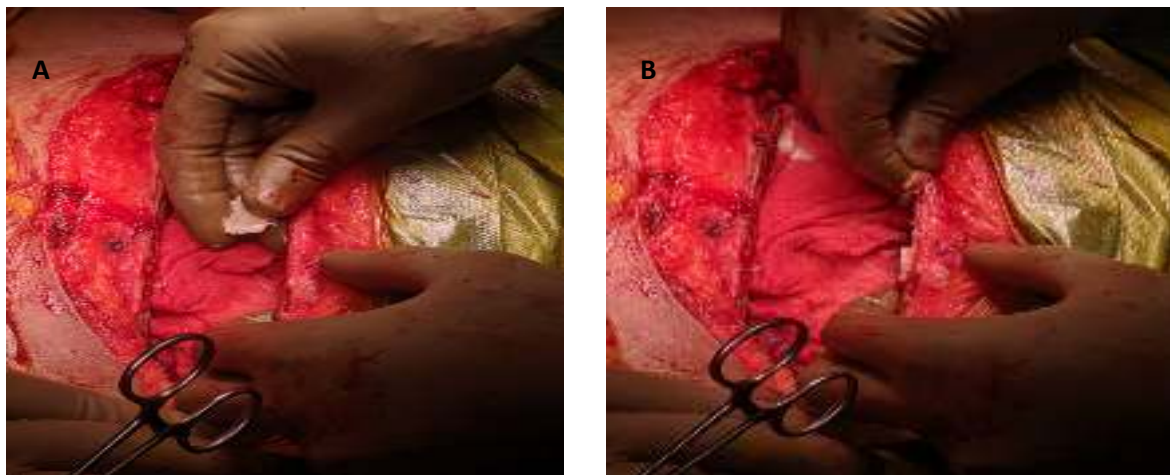
We found that among the total cases, in 430 cases vancomycin paste was used and in 432 cases vancomycin paste was not used. Accordingly they were divided into 'vancomycin group' and non vancomycin group'. There were total 246 patients with DM out of which 146 were in vancomycin group and 100 were in non vancomycin group. Patients with morbid obesity were 68 out of which 42 were in vancomycin group and 26 in non vancomycin group (Table 1 and chart 1). The occurrence of DSWI in various groups is as shown in Table 1.

Overall incidence of DSWI in our study was 3.48 % (30 out of 862). DSWI was found to be significantly lower in vancomycin group (adjusted Odds ratio 2.116 with  $p < 0.0001$ ) than in the non vancomycin group, i.e. vancomycin independently lowered DSWI in all the groups on logistic regression analysis (Table 2). Diabetes and obesity were statistically significant risk factors for DSWI

(adjusted Odds ratio 2.543 and 2.736 respectively with  $p < 0.0001$ ) in both the groups. Gender, COPD and type of surgery did not affect the incidence of DSWI significantly overall. No death was recorded due to primary cause as DSWI in patients in our study.



**Figure 1:** Vancomycin and its paste after mixing with saline.



**Figure 2:** Intra-operative photographs showing application of vancomycin 'paste'.

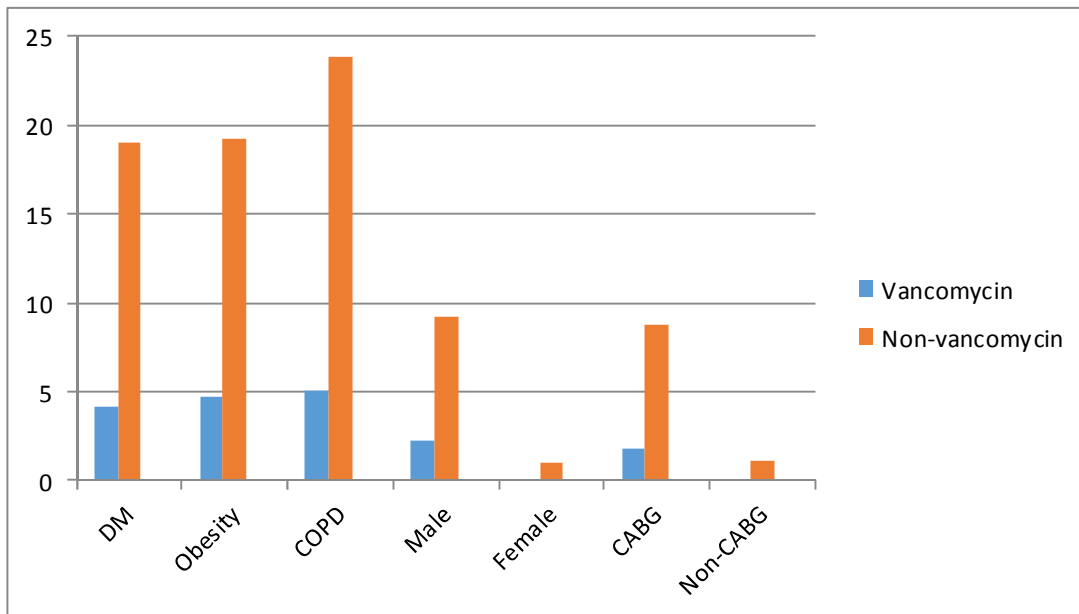
**Table 1:** Risk factors and frequency of DSWI associated with them

	Vancomycin	Non vancomycin
n	430	432
DSWI	8/430 (1.86%)	22/432 (5.09%)
<b>Risk factors</b>		
DM	6/146 (4.10%)	19/100 (19%)
obesity	2/42 (4.76%)	5/26 (19.23%)
COPD	2/40(5%)	10/42(23.80%)
Sex Male	6/262(2.29%)	22/238(9.24%)
Female	0/168(0%)	2/194 (1.03%)
CABG	6/338(1.77%)	22/250(8.80%)
Non CABG	0/92(0%)	2/182(1.09%)

CABG: Coronary artery bypass grafting

**Table 2:** Logistic Regression Analysis Result

	Adjusted ODDs Ratio	Sig. (p-Value)
Vanco	2.116	.000
Gender	16.432	.997
DM	2.543	.000
Obesity	2.736	.000
COPD	.847	.077
CABG/NON CABG	15.730	.997



**Chart 1:** Percentage wise distribution of DSWI in vancomycin and non vancomycin group in different risk factor category

**Discussion:**

Although cardiac surgery is considered as clean surgery but it remains loaded with the risk of infectious complications. Most cardiac

surgery procedures are conducted via median sternotomy. According to Centers for Disease Control and Prevention (CDC) guidelines, the definition of a DSWI requires



positive culture results of surgical sites or drainage from the mediastinal area or evidence of infection during surgical re-exploration or fever, sternal instability, and positive blood culture results. The frequency of sternal wound infection (DSWI) ranges from 0.5% to 8.0% and is linked with significant morbidity, mortality (1, 2) and treatment cost. Numerous predictive factors for surgical site infections in cardiac surgery have been recognized, which can be divided into patient factors and surgical factors. Patient factors include older age, female sex, insulin dependent diabetes mellitus, morbid obesity and chronic obstructive pulmonary diseases. Surgical factors include emergency surgery, re operations, use of bone wax and CABG with bilateral internal thoracic artery use. With an overall rise in prevalence of the co morbidities, it is anticipated that the number of patients at high risk for the development of DSWI will increase.

Vancomycin is a branched tricyclic glycosylated peptide with bactericidal activity against most organisms and bacteriostatic effect on enterococci. At a site different from that of penicillin and cephalosporin, vancomycin binds tightly to the D-alanyl-D-alanine portion of cell wall precursors, thereby interfering with bacterial cell wall synthesis. This leads to activation of bacterial autolysins that destroy the cell wall by lysis. Vancomycin may also alter the permeability of bacterial cytoplasmic membranes and may selectively inhibit RNA synthesis. For local application, Vancomycin paste was prepared using 3 g of vancomycin with 4ml 0.9% normal saline and stirred until a 'paste' was formed and it was used just after sternotomy as well as before sternal wire closure. It was applied uniformly over sternal edges and bone marrow.

Lazar and colleagues (6) in a retrospective, nonrandomized, single-center study involving over 3,000 patients undergoing cardiac surgical procedures, found that vancomycin paste, in conjunction with peri-operative antibiotic agents and tight glycemic control, totally eliminated all superficial (0% v/s 1.6%), deep (0% v/s 0.7%), or any type of sternal wound infection in both non-diabetic (0% vs 2.1%) and diabetic patients (0% vs. 3.3%). Similar to

what we observed in our study that DSWI was reduced due to use of local application of vancomycin in diabetic patients.

The use of vancomycin was first advocated by Vogt P. and colleagues for the reduction of sternal wound infections (7). Filsoufi et al (3) reported that obesity was associated with a more than 2-fold increased risk of DSWI. This was also found in our study as vancomycin reduced the incidence of DSWI in all the groups on logistic regression analysis. Dodds Ashley ES et al (4) reported increased incidence of DSWI in female patients similar to our study. Similarly Gummert et al (8) found a 1.5-times increased adjusted risk of DSWI after cardiac surgery in patients with body mass index > 30 kg/m<sup>2</sup>. This is also similar to our study.

In a prospective, randomized trial involving 416 patients undergoing median sternotomy, Vander Salm and colleagues [9] found that vancomycin paste reduced the incidence of sternal wound infections from 3.6% to 0.5%, similar to this study (8/430, 1.86% vs. 22/432, 5.09%).

In another retrospective study involving over 1,000 patients, Arruda and colleagues (10) reported reduced incidence of sternal wound infections to 0.5% by using vancomycin paste, similar to this study.

In an expert consensus American Association for Thoracic Surgery review, topical antibiotics use over the sternum upon opening and before closing in all cardiac surgical procedures involving a sternotomy was a class I recommendation (11).

#### **Limitations:**

Besides being a retrospective observational single center study, the other study limitations were that we did not take into consideration about the HbA1c levels and did not divide the patients on the basis of controlled or uncontrolled diabetes mellitus. We also did not take into consideration the effect of single or both internal mammary arteries harvesting on DSWI. Lastly we also did not consider the difference in DSWI on the basis of on pump or off pump cases.

#### **Conclusion:**

Vancomycin paste application over sternal edges is an effective method to prevent DSWI. The use of local vancomycin paste application is recommended especially in

patients with co morbidities like diabetes mellitus and morbidly obese (BMI>30) patients. These results need to be substantiated in randomized controlled trials and multiple centers.

**Conflict of Interest:** None

**Funding resources:** None

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