

Efficacy of Diluted Betadine vs. Antibiotic Installation Before Surgical Wound Closure in Prevention of Post-Cardiac Surgery Wound Infection

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Abstract:

Purpose: This study evaluated the efficacy of intraoperative, pre-closure diluted Betadine versus powdered vancomycin in preventing surgical site infections (SSIs) in post-cardiac surgery patients undergoing median sternotomy.

Methods: A retrospective study was conducted on 90 patients (12 months to 65 years) undergoing primary sternotomy. Patients were divided into three groups: Group A (3.5% diluted Betadine), Group B (powdered vancomycin), and Group C (placebo). Wound healing and infection outcomes were assessed over a two-month follow-up period.

Results: The Betadine group had the lowest SSI rate (6.7%), significantly lower than the vancomycin group (43.3%) and the control group (23.3%). SSIs were primarily superficial, except for two deep wound infections in the control group. The duration of the procedure and sternal healing did not differ significantly between the groups. However, in the Betadine group, higher patient weight was significantly correlated with an increased risk of infection. No such correlations were found in the vancomycin group. All the patients showed good healing signs in the Betadine and vancomycin group compared to the control group.

Conclusions: 3.5% diluted Betadine reduced superficial SSIs following median sternotomy more effectively than vancomycin and placebo. While no significant difference existed between the intervention group in the case of deep wound infection, both showed lower DSWI rates than the Placebo. Betadine demonstrated superior infection prevention, particularly regarding superficial infections.

Keywords: Superficial sternal wound infection (SSWI); Deep sternal wound infection (DSWI); Cardiac surgery; Median sternotomy; Diluted Betadine; Vancomycin; Wound closure.

Introduction:

The presence of reproducing microorganisms in a surgical wound is known as a surgical wound infection. The infection that affects the epidermis, subcutaneous tissues, and pectoralis fascia is known as superficial sternal wound infection

(SSWI). Infections that affect the muscle layer and the bony sternum are known as deep sternal wound infections (DSWIs). [1][2] They are among the most complicated and potentially fatal complications that can occur after a median sternotomy in cardiac surgery, and they have a major effect on hospital budgets and patient outcomes.

Despite numerous advancements in prevention, DSWIs are still a major problem, with rates ranging from 0.5% to 6.8% [2] and in-hospital mortality between 7% and 35%. Furthermore, patients who have had DSWI have a much worse mid- and long-term survival rate.[3] commonly associated with mediastinitis, sternal dehiscence, which means separation of the sternal bone, might occur. [4] Intraoperative irrigation is a crucial part of any regimen, even if infection prevention after arthroplasty necessitates a diverse strategy. A diluted povidone-iodine solution should be used before wound closure, according to recent clinical practice guidelines from the World Health Organization, the Centers for Disease Control, and the International Consensus Meeting on Musculoskeletal Infection. According to our experience, this procedure is simple, affordable, and safe to use. [5] The impact of intraoperative dilute povidone-iodine irrigation versus vancomycin irrigation in preventing postoperative infection following heart surgery will be covered in this study.

.Patients and Methods

This study is a retrospective, descriptive, case-control trial with a three-arm design from the 1st of January 2021, to the 1st of January 2022. The participants were divided into three groups based on the intervention used during the operation. Group A received 3.5% diluted betadine, administered by washing the wound pre-closure intraoperatively three times. Group B received powdered vancomycin installed pre-closure during surgery, while Group C served as the placebo control group. The study was approved by the local ethical committee of Assiut Faculty of Medicine, and all participants provided written informed consent before enrollment, ensuring compliance with ethical standards. (no:17101838)

A total of 90 patients who underwent median sternotomy at Assiut University

Hospitals were included in the study. The patients were stratified into three equal groups based on the intervention. Inclusion criteria included patients aged between 12 months and 65 years, who were undergoing primary median sternotomy procedures. Both male and female patients were included, provided they were willing and able to give written informed consent and adhere to the study requirements. Exclusion criteria included patients outside the age range, those undergoing minimal invasive procedures, mini sternotomy, or partial sternotomy, diabetic patients, active systemic infections at the time of surgery, and patients requiring re-exploration during the same hospital admission.

Demographic data, including name, age, sex, and medical record number, were collected for all participants. Pre-intervention variables included the patient's age in years and weight in kilograms. The duration of the operation, defined as skin-to-skin time, was recorded as an intervention variable. Following the procedure, participants were followed up postoperatively during the first two months to monitor wound healing and infection. Clinical examination by an expert surgeon was performed to assess wound healing and infection, while radiological assessments, including chest X-rays in both posteroanterior and lateral views, were used to evaluate sternal stability and the presence of infection. Sternal dehiscence was assessed both clinically and radiologically.

The study's primary outcome was the presence of wound infection, which was classified into three categories: no, superficial, and deep. These were assessed within the first week and at the first month postoperatively. The secondary outcomes included the rate of wound infection at two months postoperatively, the presence of sinus formation, and the stability of the sternum, which were evaluated through both clinical examination and radiological imaging.

Results

Table (1): Distribution of the studied cases according to Sex and Age

		All Cases
		No. = 90
Sex	Female	38 (42.2%)
	Male	52 (57.8%)
Age	Median (IQR)	28 (4 – 53)
	Range	1–64

Table 1: The age ranged from 1 to 64 years (median 28 years), and there were 38 female cases and 52 cases were Male

Table 2: Comparison between studied groups regarding Sex and Age

		Diluted Betadine Group	Vancomycin Group	Control Group	Test value	P-value	Sig.
		No. = 30	No. = 30	No. = 30			
Sex	Female	17 (56.7%)	12 (40.0%)	9 (30.0%)	4.464*	0.107	NS
	Male	13 (43.3%)	18 (60.0%)	21 (70.0%)			
Age	Median (IQR)	5.00 (2.5 – 11)	45.00 (28 – 56)	32.00 (4 – 48)	9.992¥	0.000	HS
	Range	1 – 64	4 – 64	2 – 62			

P-value >0.05: Non-significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)

*:Chi-square test, •: One Way ANOVA Test, ¥: Krskal- Wallis test

Table 2: There were statistically significant differences between the Diluted betadine Group, Vancomycin Group, and Control Group Regarding Age, while there

were non-statistically significant differences between the Diluted betadine Group, Vancomycin Group, and Control Group Regarding Sex.

Table 3: Comparison between studied groups regarding Weight, Time of procedure, SSI, and Healing of sternum

		Diluted betadine Group	Vancomycin Group	Control Group	Test value	P-value
		No. = 30	No. = 30	No. = 30		
Weight	Median (IQR)	19 (14 – 45)	69 (60 – 82)	52.5 (15 – 70)	14.077¥	0.000
	Range	8 – 110	14 – 105	9 – 120		
Time of procedure	Mean ± SD	5.02 ± 0.77	5.03 ± 0.78	5.07 ± 1.05	0.033•	0.967
	Range	3.5 – 6	3 – 6	3 – 8		
SSI	No Wound Inf	28 (93.3%)	17 (56.7%)	21 (70.0%)	15.091*	0.005
	Superficial Wound Inf.	2 (6.7%)	13 (43.3%)	7 (23.3%)		
	Deep Wound Inf	0 (0.0%)	0 (0.0%)	2 (6.7%)		
Healing of sternum	No	0 (0.0%)	0 (0.0%)	2 (6.7%)	4.091*	0.129
	Yes	30 (100.0%)	30 (100.0%)	28 (93.3%)		

P-value >0.05: Non-significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)

*: Chi-square test, •: One Way ANOVA Test, ¥: Krskal- Wallis test

Table 3: There were highly statistically significant differences between the Diluted betadine Group, Vancomycin Group, and Control Group Regarding Weight and SSI, while there was a non-statistically significant

difference between the Diluted betadine Group, Vancomycin Group, and Control Group Regarding Time of procedure and Healing of sternum

Discussion

Surgical site infections in the sternum after cardiac surgeries are common and cause significant morbidity and mortality. SSIs affect up to 10–20% of patients undergoing major surgery and contribute to the augmentation of the risk of a poorer prognosis.[1] One of the most complicated and sometimes fatal side effects of heart surgery after median sternotomy is deep sternal wound infection (DSWI). A recent population-based study revealed that individuals with deep sternal wound infections (DSWI) after heart surgery face a mortality rate that is four times higher within a year.[2] In addition to negatively impacting patient outcomes, complications from sternal wound infections place a considerable financial burden on healthcare resources.[3] Patients with DSWI have hospital stays that are over three times longer, and their treatment costs are nearly

2.5 times higher compared to those without major adverse events.[2] Even with numerous advancements in preventive measures, the incidence remains substantial, with a range between 0.5% and 6.8% [4], with a mortality rate of 7% to 35% within the hospital.[5] A 10-year follow-up study post-coronary artery bypass grafting revealed a survival rate of 39% for patients who experienced deep sternal wound infection (DSWI), in contrast to 70% for those who did not.[6]

Povidone-iodine is a widely used antimicrobial agent for skin disinfection, surgical procedures, and local infection control. Has a wide range of activity against various species, including Gram-positive and Gram-negative bacteria, viruses, mycobacteria, protozoa, and fungi. Because of its excellent tissue penetration, povidone-iodine is advised for deep wounds, lacerations, and bruises in addition to acute wounds.[7] More recent research has shown

that, with negligible risks, betadine irrigation of surgical wounds significantly reduced the incidence of postoperative infection in a range of surgical operations.[8]

According to that, prevention of SSI could be preventable but challenging. Our study aims to assess the effectiveness of irrigation by diluted betadine versus vancomycin before wound closure in preventing wound infection post-cardiac surgery operated through sternotomy.

Our results showed that the age ranged from 1 to 65 years (median 28 years), and there were 38 female cases and 52 cases were Male. To collect a variety of cases with minimal age and sex bias. Age was a strong predictor of SSI, as there was a high correlation between risk of SSI and aging, while there was a non-statistically significant difference between SSI and Sex. A few earlier studies found that the risk of SSI rose with age, despite variations in methodology and study designs.[9][10] This observation might be explained by an overall increase in immunological dysfunction and the accumulation of comorbid diseases with advanced age.[11]

Our results demonstrated a highly statistically significant difference between SSI and Weight; the greater the weight, the greater the incidence of SSIs. Some studies found a relationship between weight and SSI that agrees with our study, as **Cheadle (2006)** reported that Important patient-related factors for SSI include obesity [10]. **Noun and colleagues (2008)** show that the incidence of operative surgical infection was significantly increased in obese vs. non-obese patients [12]. Still, these variable findings may be related to comorbid conditions that manifest with weight, such as diabetes and smoking, as well as differences in surgical technique. On the other hand, some studies have failed to find a relationship between weight and SSI. **Wigfield and colleagues (2006)** were unable to confirm the finding that obese and extremely obese patients have a higher incidence of postoperative superficial or deep wound infections [13]. **Gaynes and**

colleagues reported a similar experience [14].

Our result showed that there was a highly statistically significant increase in Diluted betadine Group as compared to Vancomycin Group and Control Group Regarding absence of wound infection, Also there were significantly increased wound infection in Vancomycin Group as compared to Diluted betadine Group and Control Group Regarding Superficial wound infection, but there was no huge difference in presence of superficial SSIs between vancomycin and control groups. Our study showed the almost equal efficacy of both agents in preventing deep wound infection compared to the control group.

In contrast to our study, **Maemoto and colleagues (2023)** investigated the evaluation of the dominance of wound irrigation (IOWI) with aqueous povidone-iodine (PVP-I) over that with saline intraoperatively to reduce the incidence of surgical site infection (SSI). They found that the incidence of incisional SSI in the aqueous povidone-iodine group was more than that in the saline control group.[15] According to a meta-analysis on vancomycin, local application of vancomycin powder seems to be linked to a markedly decreased incidence of Staphylococcus aureus SSIs, deep incisional SSIs, and other SSIs. However, estimates from research that reported deep incisional SSIs or all investigations varied.[16]

Our collected data showed non-statistically significant differences between the three groups regarding the procedure time. However, a study found a significant relationship between extended operation time and SSI, with a greater probability of SSI seen at various time levels. The likelihood increased with time increments, with patients with SSIs experiencing an average operative time of approximately 30 minutes longer compared to those without.[17]

Although in this study there were no major differences between the three groups regarding healing of the sternum, only two cases showed delayed sternal healing in the

control group. This agrees with the studies that emphasize the efficacy of local Antibiotics in preventing DSWI and thus decrease the incidence of delayed sternal healing. As Mariusz Kowalewski stated, Vancomycin and gentamicin are effective topical antibiotics in avoiding sternal wound infection after cardiac surgery without hindering safety or causing systemic toxicity or the emergence of resistant bacteria.[18]

Finally, the overall results indicated that the use of Betadine is better for avoiding superficial wound infection, because Povidone-iodine is good for tissue penetration, while powdered vancomycin usually shows unequal distribution within the wound, so it is less effective in preventing superficial SSI but still effective in preventing deep ones. This also appears in the presence of a rocking sternum in some cases, in the control group, only due to the delay of sternal healing.

Differences in effectiveness may be partly explained by the inherent inequalities in antibacterial qualities between povidone-iodine-type antiseptics and conventional antibiotics. Betadine has a wide range of microbicidal activity against protozoa, viruses, and fungi. Furthermore, resistance doesn't grow. This study's limited spectrum of antibiotics, such as vancomycin, can lead to resistance issues.

The comparison between vancomycin and diluted betadine, regarding their intraoperative use to prevent post-sternotomy SSI, in a single study did not occur commonly, but it is worth mentioning that a retrospective study in the neurosurgical field stated the presence of 33% lower rate of infection within 90 days after surgery when betadine was compared to a regular antibiotic.[19]

Conclusions

In this retrospective analysis, we show that adding betadine to the standard antibiotic vancomycin after heart surgery reduces the incidence of wound infections. Further complicating the results could be the heterogeneity of the groupings. A bigger

multicenter trial may be warranted due to the potential for betadine, a low-cost, low-toxicity antibiotic, to reduce infection rates and reoperation for infection. More research may be necessary to determine whether betadine irrigation may replace antibiotic irrigation, which would be less expensive.

Limitations

Limitations to this study: first, the study was evaluated in only one center (Assiut University Cardiothoracic Department), which may limit its generalizability to other populations. Second, the small sample size of patients in the study didn't give enough support to draw solid conclusions about the use of diluted betadine versus vancomycin.

Third, the comparison between the studied groups regarding Sex and Age showed that there was a higher range of age in the Vancomycin Group compared to the Diluted betadine Group and Control Group. Hence, the study shows that vancomycin has been used more in older ages than diluted betadine, regardless of gender. This is due to a common belief within the current surgical community that the use of vancomycin is better than diluted betadine in old age because betadine may delay wound healing. While young ages usually show better healing power, pediatric cardiac surgery consultants were more accepting of using betadine than adult cardiac surgery consultants.

Recommendations

Experimental studies that gather confounding factors, correct for them in the analyses, include a non-equivalent comparison group, and employ proper time-series analysis methods would also be acceptable. Furthermore, studies examining the pharmacokinetics of local application of diluted betadine and vancomycin, the acquisition of antimicrobial-resistant organisms, and complications associated with vancomycin (e.g., nephrotoxicity, ototoxicity, or pseudarthrosis following spinal operations) would be beneficial.

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