



## COMPARISON OF INCIDENCE OF POSTOPERATIVE STERNOTOMY SURGICAL SITE INFECTIONS AND IMPACT OF SUTURE TYPE (ABSORBABLE OR NON-ABSORBABLE) ON ITS FREQUENCY

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### Abstract

**Introduction:** Surgical site infections (SSIs) are associated with adverse outcomes in cardiac surgery patients and sutures can get infected at the surgery table. Median sternotomy is a delicate procedure carrying high risk of SSIs. It is important to study SSIs associated with types of sutures used in sternotomy procedure.

**Methodology:** To compare the incidence of SSIs associated with type of suture, Prolene was used in one and 4-0 Vicryl in the second group (each n=33) and data was analyzed prospectively over a six-month period. Only elective procedures were included, and the data was analyzed on SPSS version 25.0.

**Results:** Females comprised 36.4% of study population of mean age of 51.18 years. A total of 11 cases of infection were reported out of which 7 cases belonged to Prolene group.

**Conclusion:** The number of infections in 4-0 Vicryl group was lesser than the Prolene group indicating the safety of the Vicryl material.

**Keywords:** surgical site infections, 4-0 Vicryl, Prolene, elective cardiac surgeries, sternotomy

### Introduction

Sternotomy refers to the surgical procedure of vertically splitting the sternum along the midline in the thoracic cavity, typically performed before thoracic surgeries such as coronary artery bypass grafting (CABG) or heart valve replacement (1). The history of surgery, including wound closure, is closely intertwined with the progress of human society. The oldest surgical needles, reaching back to at least 20,000 BC, were crafted from bone, while primitive sutures were fashioned from plant material and linen. Ancient Egyptians employed linen strips treated with a mixture of honey and flour as an early form of adhesive substance for closing wounds. South American communities utilized the pincers of beheaded ants as a method for closing wounds. The utilization of gut as a suture material was initially documented in ancient Greece during the era of Galen, and it continues to be employed

in contemporary times (2). Steel wires were frequently employed for the purpose of suturing median sternotomy incisions in adult heart surgery (3). Surgical sutures are employed to hold tissues together, aiding in the closure of wounds and facilitating healing following surgery or trauma. There are several types of medical surgical suture materials, with the two most prevalent being absorbable and non-absorbable. Historically, absorbable sutures were solely used for the purpose of bringing together interior tissues. Nevertheless, the utilization of absorbable sutures in percutaneous wound closure has recently become increasingly common (4).

Surgical site infections (SSIs) are the most important nosocomial infections and are a reason for poor or delayed healing in surgery patients (5). These infections manifest within a 30-day period following surgery or within a 1-year period in patients with implants located in or around the surgical site (6). It is crucial to determine the global prevalence of general surgical site infections (SSI) in order to accurately assess the scope of the problem and aid policymakers in enhancing the organization and provision of surgical treatment (7). The worldwide combined occurrence of surgical site infections (SSI) was determined to be 2.5% and the subgroup analysis conducted by world health organization (WHO) area and survey period revealed different incidence of SSI. The African Region had the highest reported incidence rate at 7.2%, whereas studies done between 1996 and 2001 had an incidence rate of 2.9% (5). Other studies reported incidence of sternal wound infection (SWI) ranging from 0.5% to 10%, and it is associated with a 1-year mortality rate of 0.5% to 9% in one cohort (8) and 1-3% in another cohort (9). The incidence of SSI is influenced by the definition of mediastinitis, risk factors for SSI, implementation of preventive measures, and level of surveillance. One of the manifestations of SSI is SWI. SWIs can be classified into various categories, ranging from minor and superficial to severe and deep sternal wound infections (DSWI). In some cases, infections that initially affect the surface might progress to the mediastinum, sternum, major blood arteries, and even the heart. Although Staphylococcus species are responsible for most sternal wound infections, there have been documented cases of infections caused by other microbes (9). Suture-associated surgical site infection (SSI) can occur when bacterial infections colonize the surface of the suture and form biofilms that are extremely resistant to antibiotic therapy. Antimicrobial sutures, which are coated with antiseptics like triclosan and chlorhexidine, have been employed to reduce the incidence of surgical site infections (SSI). Nevertheless, the effectiveness of antiseptic-based sutures might be compromised by the rise of resistant bacteria (10). Median sternotomy is associated with a high risk of morbidity and mortality (11). Despite the extensive knowledge of the pathophysiology of SWI and the development of successful surgical and non-surgical treatments, SWI still results in financial instability, physical limitations, and psychological problems (9). Keeping in view the high risk associated with sternotomy and the role of suture materials in wound healing after surgery; it is important to study SSIs associated with different types of sutures.

## Methodology

This study was done by observing a cohort of patients at our tertiary care hospital that underwent cardiac surgery from 1<sup>st</sup> April 2023 to 30<sup>th</sup> September 2023. The patients were followed up postoperatively for a period of 3 months and the data was collected and analyzed prospectively. Absorbable sutures are used at our hospital in surgical closure to close deep wounds and not soft tissue or skin except for cosmetic surgeries. Recently we have employed use of 4-0 Vicryl sutures for soft tissue in sternal closure. The aim of this analysis was to evaluate the difference in incidence of surgical site infection with use of Prolene (synthetic monofilament non absorbable polypropylene) sutures and 4-0 Vicryl (synthetic monofilament absorbable polyglactin) sutures. We prospectively inducted patients in our study in which absorbable suture was used through consecutive sampling, and there were 33 patients in which this suture was used during the study period. Same number (n = 33) of matching cases in which non absorbable suture was used were inducted. The participants were selected from the patients who underwent an elective CABG surgery or valve repair with CABG. Emergency cardiac surgery was an exclusion. Preoperative infection, bacteremia, septicemia, recent antibiotic history for bacterial infection, chronic conditions that already compromise the process of

wound healing by suppressing immune system like patients with end stage renal disease were also excluded. The primary outcome of sternotomy in CABG was not measured in this analysis but the secondary outcome; surgical site infections (SSIs) were measured. Superficial and deep sternal wound infection (SWIs) incidence was measured by documenting number of events of superficial infection, and infection with discharge that needed a culture report respectively. The pre surgical, perioperative and postsurgical data was all gathered manually. Pre-operative blood cultures were done to exclude cases of septicemia and blood stream infections.

The surgery was done according to standard protocols for CABG and the sternum was closed with SS wires. The soft tissue was closed with Vicryl in 33 cases and with Prolene in 33 matching cases (patients with similar clinical characteristics). The postoperative evaluation was done on day 3 and day 30 in postoperative follow-up. The superficial and deep wounds were categorized according to CDC definition (12). The need for antibiotics after surgery, antibiotics treated SSIs, and culture proven infections were noted and ASEPSIS score was calculated (13). The ASEPSIS score was divided into quartiles: 0–10 indicating no infection, 11–20 indicating disruption, 21–30 score showed minor infection, moderate infection indicated with 31–40 score and severe infection with score of more than 40.

### Results

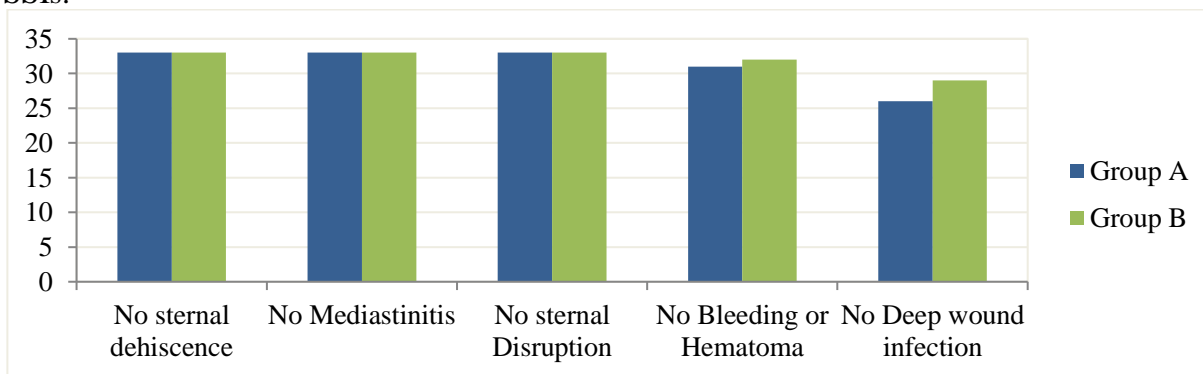
The study participant’s age ranged between 21 years to 72 years with mean age of 51.18 years in overall sample. The female participants were 36.4% among 66 study participants.

**Table 1:** General and Clinical characteristics of the patients and its association with surgical site infection

Variables		Group 1	Group 2	p-value
Gender	Male	42 (63.6)	22 (66.67)	0.752
	Female	24 (36.4)	11 (33.33)	
Age	Years	51.18±6.4	52.92±7.06	0.003
Years lived with Disease	Years	6.7 (3.5– 10)	6.9 (3–11)	0.037
History of Smoking	No	35 (53)	18 (54.3)	0.081
	Yes	31 (47)	15 (45.7)	
Diabetes	No	39 (59.1)	20 (60.6)	0.049
	Yes	27 (40.9)	13 (39.4)	
Cerebrovascular Disease	No	62 (87.88)	30 (90.91)	0.206
	Yes	4 (12.12)	3 (9.09)	
COPD	No	64 (98.5)	66 (100)	1.000
	Yes	1 (1.5)	0	

COPD: chronic obstructive pulmonary disease, Group 1: Non-absorbable suture, Group 2: Absorbable suture

Among general and clinical characteristics, age and diabetes were risk factors for surgical site infections (SSIs). The presence of other comorbid conditions or the gender did not affect prevalence of SSIs.



**Figure 1:** Outcomes (absence of adverse reaction (n)).

Absence of an adverse outcome was considered as a favorable outcome and number of events was recorded.

**Table 2:** Adverse outcomes

Adverse Outcomes	Group 1	Group 2	p-value
Superficial wound Infections	12	9	0.231
Bleeding at suture site	2	1	0.583
Wound infections with discharge (culture positive) at follow-up	7	4	0.038
ASEPSIS score > 40	8	4	0.029

Group 1: Non-absorbable suture, Group 2: Absorbable suture

**Table 3:** The culture Report

Culture	Group 1	Group 2	Total	p-value
Positive Report	7 (21.2)	4 (12)	11 (16.7)	0.041
Negative Report	26 (78.8)	29 (88)	55 (83.3)	
Gram Positive	7/7 (100)	4/4 (100)	11/11 (100)	0.079
Gram Negative	5/7 (71.4)	3/4 (75)	8/11 (72.72)	
Organisms Identified				
	Staphylococcus aureus		9/11 (81)	
	MRSA		1/11 (9.0)	
	Escherichia Coli		5/11 (45.5)	
	Pseudomonas Aeruginosa		7/11 (63.6)	

MRSA: methicillin resistant staphylococcus aureus

The culture reports were taken for patients who were diagnosed with signs of infection, needed antibiotics and had discharge from wound.

## Discussion

Surgical site infections (SSIs) are significantly associated with various surgical procedures and result in prolonged hospitalization and the requirement for supplementary treatments and care. Deep sternal wound infections (DSWI) is associated with various risk factors, which can be categorized into four groups: demographic factors (such as sex and age), behavioral factors (such as smoking and obesity), baseline clinical conditions (such as diabetes, hypertension, and COPD), and surgical operative risk factors (such as duration of operation and emergency operation) (14) or they can be classified as either patient-related or procedure-related factors (9). Steel wires are frequently employed for the purpose of suturing median sternotomy in adult heart surgery (15). Sternal disruption or infection can occur in between 0.3 to 8% of patients (16). The combined 30-day cumulative occurrence rate (incidence 11%) of surgical site infections (SSI) differed depending on the specific anatomical location, surgical method, and importance of the surgery (i.e., whether it was elective or an emergency) (7). The incidence of surgical site infection particularly in patients who undergo sternotomy during the cardiac surgery is an important parameter to evaluate successful surgery. Our study focused the population from a tertiary hospital in Pakistan. The hospital receives patients from all over Pakistan so this study will hopefully give insights into SSIs related with sternotomy in our population.

CABG associated SSIs prevalence varies between 2% and 20% in various studies (17)(6). The pooled prevalence of SSIs in Ethiopia was 12.3% (18), 5.1% incidence was reported in Norway (19), 8.2% incidence in Sierra Leone (5.5 per 1,000 patient-days) (20), 11.5% in Freetown, Sierra Leone where the rate of SSIs was greater in contaminated (43.6%) compared to clean-contaminated wounds (30.8%) and clean wounds (25.6%) (21). The factors significantly associated with surgical wound infections were blood transfusion, hemoglobin level below 7 g/dl, shock (6), previous surgery and hospitalization for 7-14 days (6,16). Surgery duration exceeding 1 hour, diabetes mellitus, clean-contaminated wound (18), American Society of Anesthesiologists score higher than 1 (16,19), male gender, receiving general anesthesia, and having raised fasting glucose levels (21) are some of the risk factors (all with  $p < 0.05$ ). In our study, there were 11 culture positive cases of infection out of a total of 66 study participants and the risk factors were age and diabetes mellitus.

Sutures are employed to expedite the process of wound healing and have a crucial function in guaranteeing the efficacy of surgical procedures in healthcare establishments (10). To prevent most cases of surgical site infections (SSIs) and hypertrophic scars (HSs), it is recommended to modify the suture method to avoid excessive stretching tension and ischemia, and to provide appropriate wound care following surgery (11). Empirical investigations have demonstrated the advantageous effects of

triclosan-coated sutures (TCS) in the prevention of surgical site infections (SSI) and wounds were classified as clean, clean-contaminated, and contaminated (22–24). The rate of sternal wound infection in Vienna was 3.0% in the group that received conventional closure (n = 198), 2.3% in the group that had only the sternal fascia closed with triclosan sutures, and 3.2% in the group that had total closure with triclosan sutures (n= 765) showing no advantage of TCS (25). In our hospital, absorbable sutures are not generally used for soft tissue closure after sternotomy. For this comparison to be conducted, the absorbable sutures were used after thorough consideration of patient characteristics.

Historically, the focus of most studies has been on suturing techniques rather than the specific materials used for sutures. Age more than 45 years, rather than the use of closure devices such as sternum plates or wires, was identified as a risk factor for sternal non-healing in low-risk individuals. The utilization of additional wires had a beneficial effect on the process of sternal healing (3). Our study also identified age as a risk factor. The lower region of the sternum poses greater risk of inflammatory scar (26). Compared to the sternal closing approach, the use of a single wire suture results in less pain on the 14th and 30th day after surgery (27). Complications associated with steel sutures include the degradation of the suture material, erosion of the sternum's outer layer, particularly in patients with osteoporosis, erosion of the skin's inner layer, particularly in patients with a thin sub dermal layer, and the potential for infection. Another drawback of using steel suture material is the potential for cosmetic issues or discomfort. Recently, silk, polyfilament polyester, monofilament material, and polypropylene have been utilized as suture materials due to their advantageous properties. Silk and polyester carry a high risk of infection, while polypropylene can lead to the formation of granulation tissue based on the number of knots. These factors promoted the utilization of a suture material that can be absorbed by the body. A few years ago, the polyfilament absorbable sutures that were available in the market had a brief absorption period, which led to sternal infection and dehiscence. Polydioxanone, a recently released monofilament suture material, has a significantly extended absorption period (28). We used Prolene (synthetic monofilament non absorbable polypropylene) sutures and 4-0 Vicryl (synthetic monofilament absorbable polyglactin) sutures in 33 patients each. The efficacy of each suture is established, and these sutures are easily available and commonly used at our hospital for different surgical procedures.

When a blend of absorbable sutures and pins as a substitute for full median sternotomy in a cohort of 24 adult patients undergoing routine thoracic surgery was used; computed tomography revealed three instances of sternal dehiscence, all of which did not necessitate further surgical intervention. Diabetes mellitus and previous use of steroids was risk factor (29). At two and six weeks post-surgery, results indicate that utilizing running subcuticular Vicryl rapide suture is a favorable substitute for interrupted nylon sutures in surgical closure, without any notable disadvantages (30). When Vicryl Plus and Monocryl Plus triclosan-coated sutures (n = 179) or sutures without triclosan (n = 178) were used; 12.8% triclosan-coated sutures, while 11.2% sutures without triclosan caught SSIs. Superficial sternal infections were 10.1%, whereas 2.0% were categorized as deep sternal wound infections. The predominant pathogens found were *Staphylococcus aureus* (45.4%) and coagulase-negative staphylococci (36.4%) (31). There were no instances of sternum re-exploration for bleeding and tamponade, wound infections, or mediastinitis observed in any of the patients in either group when braided #2 polyglactin sutures and double-looped monofilament polyglyconate sutures were used. Among the patients treated with polyglactin, five individuals had the development of seroma and/or instability of the sternum after a period of more than two weeks following the surgery. However, none of these patients needed to undergo surgical re-fixation of the sternum. No complications related to the sternum were observed in any of the participants in the polyglyconate group. Based on these findings, polyglyconate sutures show promising suitability for sternum closure (16). In our study, no sternal dehiscence, disruption was reported but we examined cases of superficial and deep SSIs.

Only one patient experienced sternal dehiscence, with no instances of wound complications or suture material incompatibility when the closure of the median sternotomy was performed with absorbable sutures (PDS-Ethicon). The use of "double" PDS sutures allows for quick and reliable closure of the

sternum, especially in cases when the sternum is fragile, without the need to cut through the sternal bone (32). The early postoperative period had an overall hospital mortality rate of 1.1% (3 out of 264) in relation to mediastinitis with 1.5% prevalence of sternal wound infection, sternal dehiscence, and mediastinitis. Absorbable suture poly-p-dioxanone (PDS), along with unique approach, provides a secure and reliable option for closing the sternotomy incision following open heart surgery in children (33). The use of polydioxanone absorbable suture in combination with the figure-of-eight technique for sternal closure is a secure and appropriate approach in children, yielding favorable clinical outcomes (1 – 132 months follow-up) (34). There were just two out of 153 patients who experienced sternal dehiscence when monofilament absorbable suture was used indicating that it was a secure substitute for various types of steel suture material in the closure of sternotomy (28). The culture of 11 (16.7%) discharge samples were positive out of which 7 were from group 1 and 4 cases belonged group 2 in our sample population indicating that deep sternal wound infection was reported more in patients in which Prolene was used as a suture.

Eight instances underwent a second sternotomy when polyglyconate monofilament (Maxon) suture was used for sternal closure (n = 216). There were no instances of sternal dehiscence, sternal infection, or empyema detected during a median follow-up period of 27 months. The overall perioperative mortality rate was 0.9%, with 2 out of 216 patients experiencing death during the surgical period (35). The use of 4-0 Vicryl for subcuticular skin closure is linked to comparable infection and other wound problems to 4-0 Monocryl (36). Monocryl (used in 28/81 cases) suture resulted in significantly smaller and less reactive scars compared to Vicryl-rapide (used in 53/81 cases) (37). Few patients exhibited sternal sinus, while one patient suffered sternal dehiscence immediately after the surgery when non-absorbable polyester braided sutures were used (n = 1091). During six months of follow-up, no fractures or mediastinitis was observed making it an efficient technique with minimal risk of post-sternal wound problems in patients weighing between 2.5 kilograms and 50 kilograms (38). When three types of absorbable suture systems, namely P (3HB-co-4HB), Maxon®, and Monomax®, were examined; the histology report after 7 weeks showed that the accumulation of inflammatory cells around the P (3HB-co-4HB) suture was less noticeable compared to the Maxon® and Monomax® sutures. Physical properties of the P (3HB-co-4HB) suture allow it to accommodate temporary tissue swelling and deformation caused by body movement hence preventing tightening (39). In our study 4-0 Vicryl interacted less incidents of deep infection.

In the positive cultures obtained in both groups (Prolene and 4-0 Vicryl), gram positive organisms were found in all (100%) cultures. Gram negative organisms were identified in 8/11 (72.72%) cases. The prevalence of organism most found in wound site cultures was as follows: Staphylococcus aureus in 81% cultures, MRSA in 1 out of 11 (9.0%), Pseudomonas Aeruginosa in 7/11 (63.6%) and Escherichia Coli in 5 out of 11 (45.5%) cultures. We identified superficial infections by clinical observation and most of the symptoms of superficial infection were resolved by the day of discharge. Absorbable sutures offer several benefits, such as obviating the necessity for an additional clinic appointment to extract the sutures, as well as a low likelihood of infections and minimal scarring. Barb sutures, a recent innovation in absorbable sutures, have revolutionized the medical field by eliminating the need for knots, distributing stress over the wound, and improving the efficiency of closures (4). In our participants, the absorbable sutures did not pose adverse effects and the healing was not disrupted to point where we need to open a wound for debridement. No sternal dehiscence or disruption was reported and very few cultures positive cases of infection were reported within 30 days of surgery.

**Conclusion:** The number of infections was fewer in group 2 indicating that use of absorbable sutures may reduce the chances of surgical site infections. The results employ that, absorbable Vicryl sutures can be used in wound closure in sternotomy procedures with safety.

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