OUTCOMES AND SAFETY OF STERNAL CLOSURE USING NON-ABSORBABLE POLYESTER BRAIDED SUTURE: SINGLE TERTIARY CARE CENTER EXPERIENCE OF 5 YEARS.

Surgery

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ABSTRACT

Introduction: Median sternotomy is done as regular practice in cardiac surgery, which can lead to morbidity and mortality after sternal closure. Inappropriate sternal closure can lead to sternal dehiscence, sternal wound infection and mediastinitis.

Aim: Efficacy and outcomes of sternal closure in adults weighing 2.5 kgs to 50 kgs using non-absorbable polyester braided suture.

Methods: Total of 1091 patients underwent standard median sternotomy, weighing between 2.5 kgs to 50 kgs had sternal closure using non absorbable, braided, sterile, surgical suture composed of Poly ethylene terephthalate [polyester]. A retrospective analysis was done to review outcomes and complications related to this sternal closure technique.

Results: Nineteen patients developed superficial surgical site infection and sternal sinus were seen in eight patients, whereas one patient had sternal dehiscence during immediate post-operative period. No sternal sutures were broken during the sternal closure and no case of mediastinitis was seen. Follow-up analyses of patients were done for 6 months after open heart surgery.

Conclusion: Sternal closure using non-absorbable polyester braided suture is a safe and effective method with very less chances of post sternal wound complications in patients weighing between 2.5 kgs to 50 kgs.

KEYWORDS

polyester, sternal closure, non-absorbable suture

INTRODUCTION:

Median sternotomy has been the ubiquitous approach in patients undergoing cardiac surgery. Sternal reapproximation using stainless steel wires in a figure-of-8 or simple interrupted fashion has been the most accepted method worldwide [1-2].

Over the time, techniques have been modified for effective sternal closure in selected patients such as trans-sternal/parasternal wiring, bilateral and longitudinal parasternal running wires (Robicsek, Daugherty, and Cook pattern), double wires, steel band, techniques like H-shaped titanium plates, reinforced sternal closure system, thermo-reactive clips, and rigid plate fixation [3]. Various complications that have been encountered in postoperative duration with aforementioned techniques include chronic pain, wound dehiscence, infection, and mediastinitis [4]. Several factors such as, diabetes, hypertension, renal failure, chronic pulmonary disease, obesity, osteoporosis, advanced age, and poor nutritional status predisposes to sternal wound complications.

Conventional sternal closure using transverse non absorbable polyester braided suture in patients weighing up to 50 kilograms in selected group of patients has been a standard practice at our institution over the past many years.

This retrospective study aims to evaluate the efficacy of sternal closure using non absorbable polyester braided suture weighing up to 50 Kgs on sternal stability, post-operative surgical site infections, sinus formation, sternal dehiscence, mediastinitis and post sternotomy pain.

MATERIAL AND METHODS:

A retrospective analysis was performed of patients undergoing sternal reapproximation using non absorbable polyester braided suture following cardiac surgery at ABVIMS & Dr. RML Hospital for the period from January, 2015 to December, 2019. A total of 1091 patients were included in study.

Patients included those undergoing first or repeat sternotomy for congenital heart disease, valvular heart disease and, coronary artery diseases were included. Primary end-points analysed were incidence of sternal dehiscence, and superficial or deep sternal wound infection including mediastinitis. Secondary end-points were chest pain, hospital-stay, and mortality.

As a matter of institutional policy non absorbable polyester braided suture was not used for sternal closure in patients weighing more than 50 Kilograms. Patients were further subdivided into three weight categories based on tensile strength of braided polyester suture used for sternal closure:

Section A: weighing between 2.5 kgs to 5 kgs

Section B: weighing between 6 kgs to 15 kgs

Section C: weighing between 16 kgs to 50 kgs

Surgical technique:

All patients underwent median sternotomy. Post procedure conventional sternal closure using transverse non absorbable polyester braided suture in simple or figure of eight fashion was done. Sutures were passed through the bone in manubrium and parasternally below by encircling the sternal body. The subcutaneous layer was approximated with 2-0 vicryl double layer and the skin was closed with either 3-0 monocryl intracutaneous continuous sutures or 3-0 ethilon percutaneous interrupted sutures in a single layer. On an average 6 sutures were being applied in paediatric patients for sternal closure and 7-8 sutures for adult patients depending on length of sternum. Special care was taken during knot application, so that initial two knots were seated in a single throw with maximum tightening to hold sternum in proper approximation without gap or instability. Subsequently minimum of 6 knots were applied to each suture and cutting the knot edges 5mm above last applied knot, along with burial of knotted suture under fatty sub-cuticle layer. A gap of approximately 2cm was maintained between two sutures for even distribution. Variable non

absorbable polyester braided sutures (Ethibond) No.2.0 up to 5 kg of weight, No.2 for 6 kg to 15 kg weight and No.5 for 16 kg to 50 kg weight were used in order to provide tensile strength with increasing weight.

Figure 1: Sternal reapproximation using non absorbable polyester braided suture.

STATISTICAL ANALYSIS:

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Software. The values were represented in Number (%) and Mean $\pm$ SD.

RESULTS:

This observational study included 1091 patients of which, 565 [51.7%] were males and 526 [48.21%] were females. Mean ages as per weight categories A: B: C were 2.4 $\pm$ 0.8: 8.7 $\pm$ 2.1: 33.2 $\pm$ 3.8 respectively. Mean weight of these groups A: B: C were found to be 3.2 $\pm$ 0.7: 9.5 $\pm$ 2.2:

31.6 $\pm$ 4.8 were respectively. Among total of 1091 patients, nineteen patients developed superficial surgical site infection and sternal sinus were seen in eight patients, whereas one patient had sternal dehiscence during immediate post-operative period, which was found to be due to unravelling of knot without breakage of any suture near xiphisternum during CPR in ICU and this was being managed with resuturing sternum after stabilization of patient immediately. Among eight patients with sternal sinuses, five were observed to be diabetic and remaining three patients had cachexia/malnutrition. These patients were managed with antibiotic course initially and among these 6 patients required non absorbable polyester braided suture removal, which was performed on outpatient basis under local anaesthesia. None of the patient had complication related to any suture breakage. None of the patient developed complications of mediastinitis during immediate postoperative period. None of the patient had any influence of post-operative hospital stay or mortality.

Follow up

Postoperatively, non-absorbable polyester braided suture composed of Poly-ethylene terephthalate was observed for inflammatory reaction, sternal dehiscence, mediastinitis and deep sternal wound infection. Three patients developed superficial surgical site infections which were managed by local debridement and antibiotics course. None of the patients developed sternal complications like mediastinitis and deep sternal wound infection with non-absorbable polyester braided suture. None of the patients during 6 months follow-up period had any suture tear or any breakage or sternal instability.

[TABLE 1: sections with various sternal complications]

Section	No. of patients	Male	Female	Mean $\pm$ SD weight [in kg]	Mean $\pm$ SD age [in years]	Superficial surgical infections	Dehiscence	Mediastinitis	Sinus formation	Requiring Re-intervention
A [Upto 5 kgs]	355	185	170	3.2 $\pm$ 0.7	2.4 $\pm$ 0.8	8	1	Nil	2	1
B [6 kgs to 15 kgs]	379	198	181	9.5 $\pm$ 2.2	8.7 $\pm$ 2.1	6	Nil	Nil	1	Nil
C [16kgs to 50 kgs]	357	182	175	31.6 $\pm$ 4.8	33.2 $\pm$ 3.8	5	Nil	Nil	5	Nil
Total [2.5 kgs to 50 kgs]	1091	565	526	-	-	19	1	Nil	8	1

DISCUSSION:

Initial description of median sternotomy was given in 1887 by Milton and has since been the choice of approach to gain access to mediastinal structures and for cardiac exposure. Ideal method for sternal reapproximation should provide a precise sternal alignment and stable closure. Strict adherence to perioperative aseptic techniques impacts the surgical outcome significantly [4-6].

Sternum reapproximation with non-absorbable sutures such as steel wires used either as single wire-cerclage or figure-of-8 is most widely accepted method and easily reproducible [6-9]. However, the advantages of stainless steel wires are that it provides good strength and stability, at the cost of several risks of post-operative sternal complications [4-5]. Disadvantages of stainless steel wires for sternal closure has shown evidences in past such as, rupture/fracture of suture wire, dehiscence of the sternum, malpositioning of the wire ligature, cutting-through of the bone by creating fracture, pseudoarthrosis and inflammation [5]. Several peri-operative risk factors including advanced age and comorbidities such as obesity, COPD, diabetes mellitus, poor nutritional status, prolonged duration of operation, massive blood transfusion, prolonged mechanical ventilation, renal insufficiency, sepsis, and hospital induced infection predisposes patients to sternal complications in post-operative duration. Postoperative sternal wound complications [PSWC] are rare, accounting its incidence rates varying from 0.5% to 5% and mortality rates ranging between 14% and 47% [10-12]. Noyez et al. [13] described risk of PSWC varying with age wherein patients below the age of 50 years had risk of 0.9%, which risk increases to 2.7% between 50 and 70 years, and 3.1 % above 70 years of age. Losanoff et al. [14] depicted the incidence of mediastinitis decreases with improved sternal closure with surgeon's technique performance.

A wide range of modifications for sternal reapproximation have been used in past by altering techniques for placement of steel wires to facilitate better outcomes. The anchoring-based Robicsek's technique and its derived modifications were usually applied to complicated

sternal closures [15]. Jolly et al. [16] described "the butterfly technique", which required twelve steel wires to perform sternal closure, which was based on twisting two conjoined wires on the same side, forming a cable, and then twisting these cables with the opposite ones to form a final cabled knot. Saxena et al. [17] proposed the use of double wires for sternal closure in obese patients, with a reduction in sternal dehiscence rate. Casha et al. [18] published an alternative method with interlocking multitwisted wires to enhance sternal stabilization and minimize bleeding from sternal fractures. Kamiya et al. [19] reported that the number of wires applied has a significant influence on preventing sternal complications and the use of less than eight wires was significantly associated with postoperative sternal complications in high risk patients. Casha et al. [20] in another study analysed the biomechanical effect of different techniques under physiologic limits, caused due to coughing and cyclic respiration begets to untwisting of steel wires.

Over the span of developing cardiac surgery, in view to decline the complications for sternal reapproximation various other sutures have been used by various surgeons. Hamid et al. [21] analysed sternal closure using absorbable suture such as polydioxanone suture in figure-of-eight technique has been found safe and suitable method in children with good clinical results. Sirivella et al [22] used non absorbable suture as mersilene tape for sternal closure with good outcomes. Malhotra et al. [23] reported in his analysis, that the use non absorbable suture such as polyester suture for sternal closure in adult patients resulted in increased wound infection, wound pain, and late wound complications, but lower mediastinal drain output. Causes associated for sternal reapproximation in previous studies with such absorbable / non-absorbable suture has been observed due to unravelling of knots, slippage of knots, sternal imbalance and infection related to braided suture.

In our study, we observed that while using non absorbable polyester braided suture, the chances of sternal dehiscence was 0.09 %, surgical site infection rate was 1.6 % and sinus formation rate was 0.07 %.

When compared with other surgical closure techniques, which has been reported PSWC with its incidence varying from 0.5% to 5%. In our series, we observed no cases of suture breakage/fracture leading to PSWC. We infer that, despite the higher tensile strength of steel wires in comparison to non-absorbable polyester braided suture, chances of PSWC such as fracture, sternal cut through and wire breakage may be more with stainless steel wires when higher tension is applied. Over tightening of steel wires under physiological loads such as coughing, cyclic respiration can lead to breakage of such steel suture, while non-absorbable polyester braided suture due to its inherent elasticity may avoid these issues while having adequate tensile strength to prevent sternal dehiscence.

In this study, we evaluated the effectiveness of non-absorbable polyester braided suture in sternal stability and postoperative outcomes in patients weighing between 2.5 kgs to 50 kgs. We found this sternal closure technique safe, easy and effective method for sternal closure retaining sternal stability with minimum post-operative complications in paediatric as well as adult population. We also observed its utility in osteoporotic sternum due to its elasticity and less chances of sternal cut-through.

Sternal closure with non-absorbable polyester braided suture is ubiquitous nowadays, with chances of less bleeding and fewer complications. In addition, this non absorbable polyester suture is an effective, safe, easy handling and reproducible method for sternal closure in paediatric as well as adult's age group of patients weighing up to 50 kgs along with osteoporotic sternum producing better clinical outcome.

Despite being abstruse to mollify individual surgeon's approach pertaining to his adaptive method of sternal closure, we hereby deduce this technique to be equally effective to others when applied with effective technique, without vying or impugning the usefulness of stainless steel.

CONCLUSION:

Sternal closure using non-absorbable polyester braided suture is a safe and effective method with very less chances of post sternal wound complications. However, when in comparison further evaluation of studies comparing steel wires or band or other sutures may be done in future.

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