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Comparison of Thoracotomy with Median Sternotomy Approach for Intra Cardiac Operations

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ABSTRACT
Minimally invasive approaches for cardiac surgery are gaining popularity, especially in patients who are young, have simple intra cardiac septal defects, mitral and tricuspid valve disease. The study was conducted to find the advantages and disadvantages of right anterior thoracotomy over median sternotomy with regard to length of incision, opening and closing time, types of material used, postoperative drainage, morbidity, mortality and postoperative hospital stay. The study included 100 patients, with 88 in 2nd through 4th decade of life. In 50% of the patients, the heart was approached by median sternotomy and in others by right anterior thoracotomy incision. The length of thoracic incision, chest opening / closing time, material used, postoperative drainage and hospital stay was significantly less in thoracotomy group. Repair of atrial septal defect was the common operation performed. In thoracotomy group aortic cannulation was difficult in few and fracture to costochondral junction was observed. None of the patients in thoracotomy group needed sternotomy, rib resection or peripheral cannulation. Cosmetic results were good in thoracotomy group. It is recommended that for operations in all patients with atrial septal defact, mitral and tricuspid valve diseases, the heart should be approached through right anterior thoracotomy.

Key words:- *Thoracotomy, Sternotomy,*

INTRODUCTION

Cardiac surgical procedures are among the most invasive and most expensive therapeutic procedures. Most invasive because the heart is approached after splitting the sternum, and intra cardiac operations are performed on arrested heart. Post operative complications of median sternotomy not only increase the morbidity, mortality and hospital stay, but can also leave an ugly scar. All the patients undergoing intra cardiac operations may not need these invasive approaches. The widespread introduction of laparoscopic techniques in various surgical disciplines has resulted in enhanced public awareness of, and desire for, "minimally invasive" surgical procedures even in cardiac surgery.

Cardiac surgery needs a wide approach, excellent access and cardiopulmonary bypass management, it is only after these issues are addressed in alternative approaches, an alternative to median sternotomy and concept of cosmesis may be sought. It has been stressed that the concept of cosmesis in cardiac surgery started only when safety of open heart surgery was beyond any doubt[1]. A vast array of cardiac surgical procedures that once required median sternotomy (which has been the gold standard for decades) can now be performed successfully and safely using endoscopic techniques and minimally invasive thoracotomy. These procedures are superior to standard sternotomy in that it reduces surgical trauma, decreases postoperative pain, narcotic use, and preserves pulmonary function. These attributes, in turn, result in a reduced incidence of perioperative complications, shorter hospital stay and a decreased need for intensive care services. Such procedures offer low cost, better cosmesis and increased patient satisfaction. Various alternative approaches for open heart surgery have been used, which include, upper or lower half sternotomy, ministernotomy, minithoracotomy, hemisternotomy, parasternal incisions, right anterior / anterolateral / and posterolateral thoracotomy. Any alternative to median sternotomy, should not hinder definitive surgical procedure, access to all chambers should be good, peripheral cannulation should not be needed and patient safety should be beyond any doubt. Right submammary anterior thoracotomy approach provides excellent access to both atria, mitral and tricuspid valve, makes entry to chest fast, bleeding is less, intra operative material needed is less, closure is quick, post operative period is relatively uneventful, hospital stay is less and cosmetic results are good. Right anterolateral thoracotomy has been used with acceptable results for patients undergoing intracardiac operations[2,3,4,5,6,7]. To improve the cosmetic results transverse sub mammary incision has been used in female patients undergoing open heart operations 8. To get the best post operative results, even horizontal sub mammary incision for median sternotomy has been recommended 9. Right thoracotomy through 4th intercostals space for open heart surgery is well known 10, and exposure of mitral valve by thoracotomy is excellent 11. The study was conducted to find an alternative to median sternotomy without compromising the field and patient safety, and also to present the benefits of thoracotomy if any over median sternotomy. Right anterior thoracotomy which provides excellent access to both atria should be used in patients undergoing surgery for atrial septal defects, mitral and tricuspid valve disease and atrial tumor excision.

MATERIAL AND METHODS

The prospective study included 100 patients, 50% of whom are operated by sternotomy and rest by thoracotomy. Since the study was the first of its kind at the centre, the patients were randomly allocated in to two groups. The group are matched with respect to age, sex, pathology, functional class and operative procedure planned. The exclusion criteria for thoracotomy is age less than 4 years, previous right thoracotomy, active and chronic chest disease, hypertensive cardiovascular and peripheral vascular disease and patients with abnormal aortic valve. Patients in New York Heart Association functional (NYHA) class IV, severely depressed left ventricular (LV) function , and patients for double / triple valve replacement or repair, coronary artery bypass grafting, ventricular tumors excision, and complex congenital heart defects surgery by median sternotomy are not included in the study. Sternotomy is median and is performed by using electric saw. Thoracotomy is right sided, minimally invasive, anterior or anterolateral. The incision is given over 5th intercostals space and pleural cavity entered through 4th intercostals space. Chest cavity is inspected for any concomitant pathology, bleeding from chest wall and hemothorax. Thymus is separated, pericardium is opened 3 cm anterior to phrenic nerve, and the pericardiotomy extended up to left

innominate vein superiorly and diaphragm inferiorly. Pericardial stay sutures are given, these stay sutures at upper end are very helpful in getting aorta more anteriorly, facilitating dissection between aorta and pulmonary vein, and also make aortic cannulation easy. Purse string sutures, aortic and caval cannulation, putting patient on bypass and cardioplegia are given as in standard median sternotomy. LV venting is done directly or through mitral valve from left atrium to LV or through right superior pulmonary vein. The intra cardiac operative procedure are performed as per the indication in both thoracotomy and sternotomy group. In patients with atrial septal defect (ASD) after oblique right atriotomy direct repair in two layers or patch repair (using PTFE patch) is done, mitral valve repair/replacement (MVR) is done after performing left atriotomy and atrial myxoma is approached through right atriotomy.

Both the approaches sternotomy and thoracotomy are compared with regard to length of incision, opening and closing time, intraoperative material used, postoperative blood loss, and post operative hospital stay. The incision length is measured from the start to the end of the sternotomy and thoracotomy incision. The opening time is taken from start of skin incision to completion of pericardiotomy. Closure time is recorded from closure of pericardiotomy to closure of skin. Chest tube drainage is recorded in underwater seal chest bags in the first 24 hours after surgery. Material and equipment as needed is noted in operation theatre. Post operative stay in the ward is recorded. Results of the two groups are also observed for operative, extracorporeal and cross clamp time, but not analysed statistically. Morbidity and mortality is recorded and the patients are followed in outpatient department regularly.

Photograph showing submammary scar

RESULTS

A total of 100 patients were operated, with almost similar sex, age, diagnosis and operative procedure. 60% were female patients, 88% in 2nd to 4th decade of life and the eldest was 67 years old male. ASD was the common indication for open heart surgery in 64% of the patients. Heart was approached by median sternotomy in 50% and right thoracotomy in 50% of patients. Surgical procedures performed were direct closure of ASD in 58%, mitral valve replacement in 33%, patch repair of ASD in 6%, and more than one procedure were performed in 3% of patients. In thoracotomy group 28% of the patients had fracture of costochondral junction, and 8% had difficult aortic cannulation. The length of incision in thoracotomy was less then sternotomy (table 1),with a mean of 10.58 cm in thoracotomy and a mean of 18.80 cm in sternotomy group, the difference was statistically significant, ($p< 0.005$). Heart was approached faster in thoracotomy with a mean of 15.4 minutes compared to sternotomy with a mean of 24.6 minutes (table 2), the difference being statistically significant, ($p< 0.005$). In the two groups there was no difference in aortic and vena caval cannulation. Though not studied statistically, yet the intra cardiac procedure, extracorporeal circulation and cross clamp time was more in thoracotomy group. Sternotomy closing time was more with a mean of 25.4 minutes compared to a mean of 20.12 minutes in thoracotomy (table 3) which was again

significant statistically, ($p < 0.005$). More material was needed in patients undergoing sternotomy (table 4). Postoperative drainage was more in sternotomy group with a mean of 435 ml compared to a mean of 150 ml in patients with thoracotomy (table 5), which is statistically significant, ($p < 0.005$). Postoperative hospital stay was more in patients operated by sternotomy with a mean of 13.2 days compared to a mean of 10.6 days in thoracotomy group (table 6), statistically significant, ($p < 0.025$). Post operative wound infection, consolidation, wound dehiscence and re exploration for continuous bleeding (6%) was more in sternotomy group, and 4% of the patients died of mediastinitis. In thoracotomy group 14.58 % had wound infection which subsided with simple dressings, 8.33% had consolidation, 4.16% had wound dehiscence and 2.08% had pyothorax. One patient needed re suturing and one had prolonged chest tube drainage. There were 7 deaths, 2 in thoracotomy and 5 in sternotomy approach.

All patients operated by thoracotomy approach, were satisfied with early ambulation, less pain, early discharge and excellent cosmetic results figure 1.

COMMENTS

A thoracotomy was used in late 1940s, 1950s, and 1960s for both closed and open mitral valve operations [12,13]. Median sternotomy became the incision of choice in the late 1960s because it was recognized that intra cardiac air was more completely removed. Though median sternotomy is still the gold standard, the fact is this approach at times increases morbidity and mortality, and cosmetically the scar may not be acceptable. Patients being in 2nd to 4th decade of life is well known[4,7,8]. ASD and mitral valve disease being more in females is in accordance to the observations by other authors [4,7,10]. The results of functional class are at variance to the studies where patients were in functional class I [6,] and are also in contrast to the observations where all the patients were in functional class IV[11]. The difference could not be taken as significant in view of the fact that functional class IV patients were deliberately excluded from the present study, also the higher number of patients in functional class III in present study could be because of relative ignorance of the disease, lack of specialized health care facilities in remote areas. Right thoracotomy being an acceptable alternative to median sternotomy is in accordance to the findings that anterolateral thoracotomy has acceptable results for patients undergoing intra cardiac operations[2,3,4,5,6]. That the incision should be given lower down on 5th intercostals space and chest entered through 4th space is in accordance to the recommendations of other authors [4,6,7,10], but differs from authors who used 4th space for incision and chest entry[11]. Some used incision below 5th intercostals space and entered chest through 4th space[14]. Anterolateral thoracotomy with entry through 3rd intercostals space has also been reported 15. Majority of the patients having minimally invasive anterior thoracotomy is in accordance to results from other institutions[6,7]. To improve the cosmetic results even transverse submammary skin incision followed by median sternotomy for open heart surgery is well established[8,9,16]. Our observation are not in accordance to studies ,where right thoracotomy, femoro femoral bypass and deep hypothermia has been used for the re-replacement of mitral valve[10]. Right anterolateral thoracotomy without aortic or right atrial cannulation has been used for re-operations on mitral valve[11]. The observation of the present study are in accordance to reports from other centres in so far as right submammarian thoracotomy is concerned, but differs in that all their patients with atrial septal defect were female [4.] The thoracotomy approach, aortic and bicaval cannulation has been used by others also with acceptable results [4,6,14], but some had only patients with atrial septal defect in their study [17].

Length of incision in sternotomy being more, a mean of 18.8 cm was significant statistically ($p < 0.005$) when compared to thoracotomy with a mean of 10.58 cm, but is in contrast to

thoracotomy incision length of 6-7 cm only used by others for approaching heart, but all these authors had used peripheral cannulation to maintain extracorporeal circulatio[7,11,12]. Heart is approached faster in thoracotomy with a mean of 15.4 minutes ($p < 0.005$), which is in contrast to the observation, that minimally invasive approaches were more time consuming than the sternotomy ($p < 0.01$), the difference could be in the present study the significance was recorded for opening and closing time only and not for the intra cardiac procedure. Pericardiotomy should be 3 cm above phrenic nerve is as per the established recommendations[4,7,10], but differs from studies, who incised pericardium[2], 2, and 1 cm anterior to phrenic nerve respectively[6,15,18].

The pericardiotomy should not be a problem as long as phrenic nerve is safe and we have not reported any patient with phrenic nerve palsy. Fracture ribs is common during thoracotomy[4], but fracture to costochondral junction in 28% is in contrast to deliberate subluxation of chondrosternal junction to get adequate exposure[4, 6],with the difference that they later sutured the subluxated area with sternum.

Aortic and venacaval cannulation is done comfortably, upper end pericardial stay sutures help in getting aorta more anterior, make aortic cannulation easy and straight forward is in accordance to the observations made in other studies [4,6,14,17,18] , but in spite of all the efforts, aortic cannulation was taxing in 8% of our patients, fortunately there was no aortic dissection and none of the patient needed peripheral cannulation, which is in contrast to the studies where femoral cannulation was needed in 8.4% of patients who were otherwise planned for aortic cannulation at thoracotomy[15]. ASD repair, mitral and tricuspid valve operations, are comfortably done by anterior thoracotomy approach and in mild to moderate hypothermia is well established[7,10,11,15,17,18,19.] Sternum takes more time in closure ($p <0.005$) is well documented. More material is needed in patients with sternotomy, these findings are similar to the observations that sternotomy is significantly more costly ($p < 0.01$)[15]. Postoperative drainage being more in sternotomy group, mean 435.93 ml ($p < 0.005$), and re- explorations are needed more in sternotomy approach is similar to reports from other centres[5,10,14.] Hospital stay being less in thoracotomy patients, a mean of 10.6 days ($p < 0.025$) is well known, and a mean hospital stay of 10.6 and 9.17 days is according to results from other centres [6,14,] but this mean stay is in contrast to observation where post operative hospital stay has been very less with a mean of 6 and 2.8 days ($p < 0.001$)[15,17,] the reason could not be explained, may be the policy at our centre was to discharge patients after suture removal, or the patients like to go home after being fully fit.

The postoperative period being uneventfull in majority and mortality is less with thoracotomy approach is well documented [5,14], mortality can be more in sternotomy approach is reported [19], it is a fact that smaller incisions cause less trauma, less pain and decreased blood loss 20. Primary sternal closure carries a mortality of 8.7%, superficial sternal infection in 13.3%, mediastinitis 1.2% and sternal dehiscence in 3.7%[21]. Deep sternal wound infection increases morbidity and mortality [22], in cardiac surgery choosing a proper approach for a given procedure is a must, because even with minimally invasive cardiac procedures serious wound infections can occur [23].

In conclusion, in comparison to median sternotomy, right anterior thoracotomy is easy to perform, entry to pericardium and closure of wound is easy and quick, at times fracture to costochondral junction is inevitable, rarely the aortic cannulation may be inconvenient, access to both atria, mitral and tricuspid valve is excellent, intra and post operative blood loss is less, cost and hospital stay is less. It is therefore recommended that all patients with ASD, mitral and tricuspid valve disease should be operated by right anterior thoracotomy approach.

Table 1 Length of incision in thoracotomy and sternotomy (50 patients each)

Incision length in Centimeters	Thoracotomy No. of patients	Sternotomy No. of patients
07-10	29	nil
10-15	17	04
15-20	04	12
20 and more	nil	34

$X^2 df_3 = 75.04$; $p < 0.005$

The incision length in sternotomy group was more and is statistically significant.

Table 2 Thoracotomy and sternotomy opening time (50 patients each group)

Chest opening time (time in minutes)	Thoracotomy group Number of patients	Sternotomy group Number of patients
15	42	nil
15-20	08	16
20-30	nil	24
30-40	nil	10

X^2 $df_3 = 142.3$; $p < 0.005$

More time is needed for performing sternotomy which is statistically significant

Table 3 Thoracotomy and sternotomy closing time (50 patients each group)

Chest closing time (time in minutes)	Thoracotomy No. of patients	Sternotomy No. of patients
10-20	26	nil
20-30	17	18
30-40	07	27
40-50	nil	05

X^2 $df_3 = 68.82$; $p < 0.005$

Sternotomy takes more time for closure which is statistically significant

Table 4 Types of material used (50 patients in each group)

Types of material used	Thoracotomy	Sternotomy
Bone wax	00	126 pieces
Steel wire	00	88 pieces
Prolene	56 pieces	64 pieces
Drainage sets	95 (sets)	110 (sets)

More material was used in patients undergoing sternotomy.

Table 5 Postoperative drainage (50 patients each group)

Post operative Drainage (in ml)	Thoracotomy No. of patients (n=49)	Sternotomy No. of patients (n=48)
50-100	27	00
100-150	10	00
150-200	0 5	05
200-300	03	12
300-400	01	14
400-500	02	11
500-1900	01	06

$X^2 df_6 = 63.47$; $p < 0.005$

On day of surgery 3 patients died 2 in sternotomy and 1 in thoracotomy group, patients with sternotomy have more bleeding.

Table 6 Postoperative hospital stay in sternotomy and thoracotomy group

Hospital stay (in days)	Thoracotomy No. of patients (n=48)	Sternotomy No. of patients (n=45)
5-10	27	10
10-15	14	22
15-20	05	09
20-25	02	04

X^2 $df_3 = 10.88$; $p < 0.025$

7 patients had died till discharge 5 in sternotomy and 2 in thoracotomy group.

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