Chest & Heart Journal
Vol. 40, No. 2, July 2016

ORIGINAL ARTICLE

Comparison between the Effect of Vancomycin Paste and Traditional Bone Wax on Sternal Bleeding and Wound Healing after off Pump Coronary Artery Bypass Grafting Surgery

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Abstract

Background:

Bone wax is traditionally used to physically block blood from oozing out of the spongy bone of the cut sternal edges following median sternotomy to perform cardiac operations including CABG. Bone wax, it is still debated whether its use is beneficial or leads to various healing complications of the sternum like sternal wound infection, persistent post sternotomy pain and sternal instability. Use of vancomycinpaste not only will arrest bleeding but also contribute significantly in reducing sternal wound infection. Present study was designed to see the impact of vancomycin paste over bone wax on sternal healing following off pump Coronary Artery Bypass Grafting with median sternotomy both clinically and radiologically.

Methods: *This was an experimental non randomized control trial study. The total study population was 60. Patients were selected who fulfilled the selection criteria. Patients were divided into two groups bone wax group (group-A) and vancomycin paste group (group-B) based on application of bone wax or vancomycin paste after median sternotomy. Preoperative variables (Age, sex, BMI), peroperative variables (total operation time, number of grafts) and postoperative variables (duration of Intensive care unit stay, mechanical ventilation time, blood transfusion, postoperative hospital stay, postoperative drainage of blood, palpable midline gap over the sternal wound, post sternotomy pain, pulmonary complicationand gap between two sternal halves at CT scan of chest) were compared between the groups.Data was processed using software SPSS (Statistical Package for Social Sciences) version 16.0. The categorical data was presented as frequency with corresponding percentage and was compared between groups using Chi-square (c^2) test and Fishers' Exact Test, while the quantitative data was express as mean±SD (standard deviation) and was compared between groups*

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using unpaired Student's t-Test. For all analytical tests the level of significance was set at 0.05 and p < 0.05 was considered significant. CT scan of chest was evaluated by two radiologists who were blinded of exposure.

Results:*Preoperative characteristics (age, sex and BMI) were compared and no significant differences were found between the two groups. In all patients of both groups LIMA was used. Number of venous graftsand time required for completing the operation (mean ±SD) 324.00±10.61 min and 325.33±12.68 min,respectively p=0.66 did not differ significantly. Total ventilation time at ICU (mean±SD) were 850.67±21.64 min and 843.33±55.20 min (p=0.50),Blood and FFP transfusion were 93.3% and 80%, p=0.25 and 00% and 3.3%, p=1.00,Postoperative drainage of blood(mean±SD)395.5±55.32 and 392.5±81.85 ml, p=0.868 Duration of ICU stay (mean±SD) 34.03±3.45 hours and 34.13±4.7 hours (p=0.92), Post-operative hospitalization time (mean±SD) were 8.00±1.61 days and 7.83±1.20 days werenon-significant. In group-A16.7% of patient suffered from superficial sternal wound infection which was statistically non-significant (p=0.19). None of the patients of both groups were having any deep sternal wound infection at any time after operation.40% of patient in group-A and13.3% of group-B were complaining of post sternotomy pain at discharge from hospital (p=0.02). At 1st follow-up the PSP was not statistically significant (p=0.67). At 2nd follow-up persistence of post sternotomy pain26.7% in group-A and 3.3% in group-B,p=0.031 which wasstatistically significantly. Plain CT scan of the chest done 7±1 months after surgery at 2nd follow up showed bony gap between two sternal halves were(mean±SD) 4.53±0.77mmin group-A and (mean±SD) 1.78±0.17mm in group-B,(p<0.001) which was statistically significant.*

Conclusion: *There was no significant difference of mean postoperative drainage of blood between two groups. Post sternotomy pain and bony gap between two sternal halves were more in patients using bone wax groupand less in vancomycin paste group.Vancomycin paste is more effective in decreasing bony gap, early sternal wound healing and reduce poststernotomy pain.*

[Chest & Heart Journal 2016; 40(2) : 122-132]

Introduction:

Median sternotomy described by Milton in 1887 and was recommended in 1957 by Julian for a more complete exposure of the heart. Cardiac surgery is predominantly performed through a median sternotomy. Because of its quick and easy procedural benefit, minimal blood loss and very little functional impairment, median sternotomy still remains the most popular gold standard technique of cardiac exposure (Robicsek,et al., 2000).

To prevent bleeding from the cut sternal edges bone wax is traditionally used to physically block blood from oozing out of the spongy bone. Bone wax consists of sterilized, white bleached honeybees wax (ceraalba) blended with a softening agent such as paraffin. The product is very effective for diminishing the amount of intra-operative bleeding. Bone wax acts as a physical barrier which inhibits osteoblasts from reaching the bone defect and thus impair bone healing (Vestergaard, et al., 2010).Since bone wax is not absorbed by the body, it hinders osteogenesis and therefore impairs bone healing (Achneck, et al., 2010). Bone wax is known to increase infection rates, interfere with bone healing and elicit chronic inflammatory reactions (Schonauer, et al., 2004).

Sternal instability is a major risk factor in the development of sternal wound infections. Bleeding from sternal wound after median sternotomy is a dominant major contributing factors for sternal and mediastinal infection leading to mortality and morbidity (Fynn-Thompson, F. and Salm, T.J.V., 2004).

Mediastinitis is one of the most feared surgical complications faced by cardiac surgeons. It is a contributing factor in morbidities and mortalities after OPCAB surgery. It affects 0.5% to 5.0% of the patients who underwent cardiac surgery. It may increases in severity up to 8% of the patients who underwent coronary revascularization using both internal mammary arteries as grafts. The risks of mediastinitis depends on several factors such as diabetes, obesity, bilateral internal mammary artery graft, cigarette-smoking, pneumonia, surgical re-exploration, post-operative bleeding, emergency surgery and sustained mechanical ventilation .The greatest incidence of complication begins from 10 to 20 day postoperatively. Complications affect mainly the patients who underwent coronary artery bypass grafting (50%), valve replacement (20%), aortic diseases (20%) and rest in other cardiac surgeries (Arruda, et al., 2008).

Deep sternal wound infection (DSWI) is rare but serious complication of cardiac procedures that require sternotomy with incidences ranging from 0.15% to 8%. Despite medical and surgical therapeutic interventions, DSWI can recur and lead to sepsis increasing the cost and the length of stay in the hospital. Moreover, the presence of DSWI is also associated with increased mortality with incidence rate from 0.5% up to47 % (Ozcan, et al., 2006).

Vancomycin is a bactericidal glycopeptides antibiotic (Desmond, et al., 2003).Vancomycin is primarily used to treat serious infections caused by gram-positive bacteria which are known to be resistant to other antibiotics .Topical plus systemic vancomycin treatment might be more effective in patients with deep sternal wound infections caused by methicillin-resistant S. aureus(Ozcan, et al., 2006).

Intraoperative administration of vancomycin has been shown to be effective in reducing sternal SSI (Surgical site infection). In a prospective randomized study of 416 patients, the use of topical vancomycin applied to the cut sternotomy edges reduced SSI rates from 3.6% to 0.45% ,p=02 (McHugh, et al., 2011).

A haemostatic paste composition comprising powdered vancomycin mixed with biocompatible carrier. The haemostatic paste composition is easily handled, adhere to cut bone surface or an exposed bone surface has no systemic or local adverse effect and provides bacteriostatic and bacteriocidal protection and also provides effective homeostasis to prevent blood loss during surgery. The ratio of the powdered vancomycin to the biocompatible carrier is preferably 1:1(gram weight: cubic centimeter volume).The composition is stirred until the powdered vancomycin is homogenized with the biocompatible carrier (Dharan, et al., 2005).This Vancomycin paste is generally prepared at the moment of sternotomy and its application should immediate (Arruda,et al., 2008).The vancomycin paste successfully occludes bleeding from cut sternum during the surgical procedure.

The vancomycin paste is not removed from the cut bone surface or exposed bone prior to closing the surgical site. The paste forms a caramelized-like coating after prolonged contact with the cut bone or exposed bone surface. This caramelized – like coating results from the interaction between the vancomycin paste with blood and other body fluids.Prophylactic topical vancomycin has been proven to prevent sternal wound infections in individuals undergoing median sternotomy for cardiac surgery. Topical antibiotics have been demonstrated to achieve higher local wound concentration that systemic and topical vancomycin applied to the cut edges of sternum during cardiac surgery to decreased sternal wound infection (Dharan, et al., 2005).

Use of vancomycin paste after median sternotomy successfully occluding bleeding from cut sternal edge and decreased sternal wound infection thereby improve sternal wound healing. Bone wax is known to increase infection rates, interfere with bone healing and elicit chronic inflammatory reactions. Bony movement and separation of as little as 2 mm can result in a critical sized gap and nonunion. Greater chest pain in patients with sternal nonunion compared to patients with sternal healing (Stacy, et al., 2014).

To evaluate sternal wound healing it needs clinical examination of sternal wound infection (superficial and deep), palpable midline gap over sternal wound and follow up radiology by CT scan of chest.

Fig.-1: *Preparation of vancomycin paste*

Composition of vancomycin paste:

Powdered vancomycin is mixed with a volume of biocompatible carrier to form a paste 1 gram of powdered vancomycin is transferred to a sterile vessel such as a disposable medicine cup, medicine glass or small kidney basin. A volume of biocompatible carrier being selected from the group consisting of sterile water, aqueous saline solution and Lactated Ringers is then added to the sterile mixing vessel and the composition stirred with a sterile mixing instrument. Sterile water or saline solution (0.9% saline concentration) is the preferred biocompatible carrier. The ratio of the powdered vancomycin to biocompatible carrier is preferably 1:1(gram weight: cubic centimeter volume. The volume of biocompatible carrier may vary up to 20% depending on the accuracy of the instrument used to measure the volume of the biocompatible carrier to compensate for atmospheric humidity and to adjust for the thickness of the paste. The composition is stried until the powdered vancomycin is homogenized with the biocompatible carrier. In prototype development the length of time to homogenize the composition will be one to two minutes. The amount of powdered vancomycin used in preparing the hemostatic paste composition varied from 1 gram to 3 grams. (Dharan, et al., 2005)

Mechanism of action:

Vancomycin acts by inhibiting proper cell wall synthesis in gram –positive bacteria. Due to the different mechanism by which gram-negative bacteria product their cell walls and the various factors related to entering the outer membrane of negative organism vancomycin is not active against gram –negative bacteria (except some nongonococcalspecies of Neisseria).Depending on the accuracy of the instruments used to measure the volume of the biocompatible carrier to compensate for the atmospheric humidity and to adjust for the thickness of the paste. The composition is stirred until the powdered vancomycin is homogenized with the bio compatible carrier. In prototype development, the length of the time to homogenize the composition was one to two minutes. (Dharan, et al., 2005)

Composition of Bone wax

Bone wax consists of sterilized white-bleached honeybees wax (ceraalba) blended with a softening agent such as paraffin (Vestergaard, et al., 2010).Bone wax is manufactured from sterilized white bleached honey bees' wax (ceraalba). 1 g bone wax is composed of 750 mgceraalba, 150 mg paraffin sol. and 100 mg isopropylispalmitate. Under the microscope body parts of bees such as mandibles, wings and legs can be found in commercially availablebone wax. The main components of beeswax are palmitate, palmitoleate, hydroxyl palmitate and oleate esters of long-chain (30 to 32 carbons) aliphatic alcohols with a 6:1 ratio of the two principal components triacontanylpalmitate $CH_3(CH_2)_{29}O\text{-}CO\text{-}(CH_2)_{14}CH_3$and cerotic acid $CH_3(CH_2)_{24}COOH$. Beeswax has a melting point range of 62°C to 64°C (144°F to 147°F). If beeswax is heated above 85°C (185°F) discoloration occurs. Density at 15°C ranges from 0.958 to 0.970 g/cm^3 (Prziborowski, et al., 2008).

Adverse Effects of Bone Wax

Bone wax has been known to encourage the growth of Staphylococcal bacteria. The presence of this inert material may prevent bone in-growth from the healthy vascular contra lateral hemi sternum especially during the early postoperative period (3 weeks). (Francel, T.J and Kouchoukos, N.T., 2001).

Since bone wax is not absorbed by the body it hinders osteogenesis and therefore impairs bone healing. Bone granuloma formation secondary to a foreign body reaction has been extensively described in the literature as a complication of using bone wax in orthopedic surgery, neurosurgery, dental surgery and in sternotomies, among many other procedures. It may even embolize to distant sites including the pulmonary circulation (Achneck,et al., 2010).

Experimental studies have shown that when a bonedefect is treated with bone wax the number of bacteria needed to initiate an infection is reduced by a factor of 10,000.Bone wax acts as a physical barrier which inhibits osteoblasts from reaching the bone defect and thus impair bone healing (Vestergaard,et al., 2010). Bone wax is known to increase infection rates, interfere with bone healing and elicit chronic inflammatory reactions (Schonauer,et al., 2004)

Bony movement and separation of as little as 2 mm can result in a critical sized gap and nonunion. Greater chest pain in patients with sternal nonunion compared to patients with sternal healing (Stacy, et al., 2014).

Materials and methods.

This Experimental non randomized control trial study was carried out in the Department of cardiac surgery at National Heart FoundationHospital and Research Institute (NHFH & RI), Dhaka from July, 2014to June, 2016. Samples were collected frompatients undergoing elective off pump coronary artery bypass graftingsurgery. Prior to the commencement of the study, the research protocol was approved by the ethical committee of National Heart Foundation Hospital & Research Institute. A total number of 60 samples were enrolled in the study by purposive and convenient sampling technique following the inclusion and exclusion criteria. Informed written

consent was obtained from each and every patient after elaborative explanation regarding the

undergoing study. Initial evaluation of the patient by history and clinical examination was performed and recorded in the preformed data sheet.Patients were divided into two groups bone wax group (group-A) and vancomycin paste group (group -B) based on application of bone wax or vancomycin paste after median sternotomy. Preoperative variables (Age, sex, BMI), peroperative variables (total operation time, number of grafts) and postoperative variables (duration of Intensive care unit stay, mechanical ventilation time, blood transfusion, postoperative hospital stay, postoperative drainage of blood, palpable midline gap over the sternal wound, post sternotomy pain, pulmonary complication and gap between two sternal halves at CT scan of chest) were compared between the groups. Data was processed using software SPSS (Statistical Package for Social Sciences) version 16.0. The categorical data was presented as frequency with corresponding percentage and was compared between groups using Chi-square (c^2) test and Fishers' Exact Test, while the quantitative data was express as mean±SD (standard deviation) and was compared between groups using unpaired Student's t-Test. For all analytical tests the level of significance was set at 0.05 and $p < 0.05$ was considered significant. CT scan of chest was evaluated by two radiologists who were blinded of exposure.

Results:

This was an experimental non randomized control trial study with a total study population of 60. Patients were undergoing isolated and elective off-pump coronary artery bypass grafting surgery in our Institution and fulfilled the study selection criteria constituted the study cohortfrom July 2014 to June 2016. Patient were divided into two groups according to use of bone wax and vancomycin paste at the cut sternal edges after median sternotomy. Those patients in whom bone wax was used were designated as group A and those patients in whom vancomycin paste was used were designated as group B.

Table-I shows age distribution and BMI of group-A and group-B both the groups are age and BMI matched. Age and BMI range were (30-70) years and (18-29.5) kg/m^2 respectively.

Table-I

Age distribution and BMI in study subjects.

	Group		
Demographic variable	Group- A(n = 30)	Group-B(n = 30)	*p*-value
Age (years)Mean ± SD	54.9±8.81	54.87±8.54	0.988^{NS}
Body mass index (kg/m^2) Mean ± SD	24.46±3.12	23.80±2.80	0.388^{NS}

Figure-II shows the sex distribution of the patients. Out of 60 patients, male was predominant in both groups (90% in group-Aand 86.7% group-B). The two groups sex difference was not statistically significant (p=1.00).

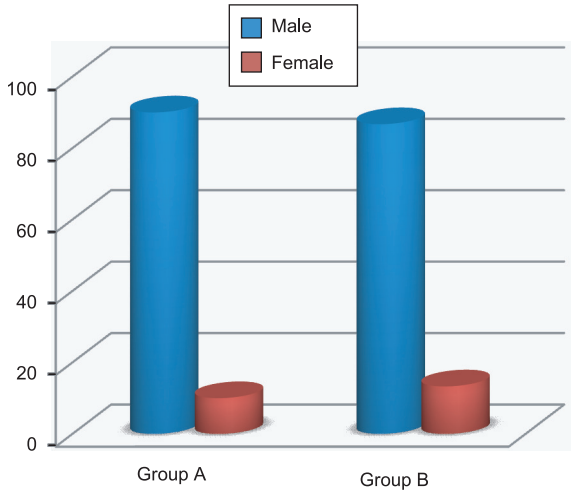

Fig.-2: *Sex distribution in the study subjects.*

Fisher's Exact Test was done to measure the level of significance.
Group- A Bone wax group
Group-B vancomycin paste group
(n= number of patients, NS= Not significant).
Not significant (P>0.05)

Table-II shows total operation time and number of venous grafts of group-A and group-B both the groups are total operation time and number of venous grafts matched. Total operation time and number of venous grafts range were (300-350) minutes and (2-4) respectively.

Table-III shows blood transfusion and fresh frozen plasma transfusion of group-A and group-B both the groups are matched.

Table-IV shows total operation time and number of venous grafts of group-A and Group-B both the groups are total operation time and number of venous grafts matched. Total operation time and number of venous grafts range were (300-350) minutes and (3-5) respectively.

Table-V shows post-operative superficial and deep sternal wound infection.Superficial infection of group-A and group-B are matched. None of groups were having any deep sterna wound infection.

Table-VI shows 40% of patient in group-A were complaining of post sternotomy pain (pain on posture change from lying to sitting or pain on walking, if any of the two is present and required analgesic) compared to 13.3% of group-B at the time of discharge from hospital with statistically significant. At 1st follow up the PSP reduced to 13.3% for group-A and 6.7% for group-B. At 2nd

Table-II

Per operative variables

Variable	Group		*p*-value
	Group- A (n = 30)	Group-B (n = 30)	
Total operation in minutes (Mean ± SD)	324.75±10.61	325.33±12.68	0.66^{NS}
Number of venous grafts (Mean ± SD)	3.57±0.56	3.5±0.731	0.69^{NS}

Unpaired Student's t-Test wasdone to measure the level of significance.
Group- A Bone wax group Group-B vancomycin paste group
(n= number of patients, NS= Not significant).
Significant (P<0.05)

Table-III

Blood transfusion during per and post-operative in study subjects.

Requirement of transfusion	Group		*p*-value
	Group-A (n = 30)	Group-B (n = 30)	
Blood transfused requiredYes	28(93.3%)	24(80%)	0.25^{NS}
No	2(6.7%)	6(20%)	
FFP transfusion required			
Yes	0(00.00%)	1(3.3%)	1.00^{NS}
No	30(100%)	29(96.7%)	
Fisher's Exact Test was done to measure the level of significance.			

Group- A Bone wax group Group-B vancomycin paste group
(n= number of patients, NS= Not significant).
Not significant (P>0.05)

follow up26.7% patients of group-A and 3.3% patients of group-B were complaining persistent post sternotomy pain which was statistically significant.

Table-VII shows that no patient in both groups had palpable midline gap over the sternal wound at any time after operation.

Table-VIII shows that plain CT scan of the chest done 7±1 months after surgery at 2nd follow up

Demonstrate that 4.53±0.77 mm of patients in group-A and 1.78±0.17mm of patients in Group-

B have bony gap between two sternal halves which was statistically significant.

Figure- III: Plain CT scan of Chest. Group-A (Bone wax)

Figure-IV: Plain CT scan of Chest. Group-B (Vancomycin paste)

Table-IV

Post-operative variables.

	Group		
	Group-A (n = 30)	Group-B (n = 30)	*p*-value
ICU stay (in Hours) Mean ± SD	34.03±3.45	34.13±4.7	0.92^{NS}
Total ventilation time at ICU(in minutes) Mean ± SD	850.67±21.64	843.33±55.20	0.50^{NS}
Postoperative drainage of blood (in ml) Mean ± SD	395.5±55.32	392.5±81.85	0.868^{NS}
Post-op hospital stay(indays) Mean ± SD	8.00±1.61	7.83±1.20	0.65^{NS}

Unpaired Student's t-Test was done to measure the level of significance.
Group- A Bone wax group Group-B vancomycin paste group
(n= number of patients, NS= Not significant). Significant (P<0.05)
Table-IV shows total operation time and number of venous grafts of group-A and Group-B both the groups are total operation time and number of venous grafts matched. Total operation time and number of venous grafts range were (300-350) minutes and (3-5) respectively.

Table-V

Post-operative sternal wound infection in study subjects.

Post-operative sternal wound infection	Group		*p*-value
	Group-A (n = 30)	Group-B (n = 30)	
Superficial			
Yes	5(16.7%)	1(3.3%)	0.19^{NS}
No	25(83.3%)	29(96.7%)	
Deep			
Yes	0(0)	0(0)	—
No	30(100)	30(100)	

Fisher's Exact Test was done to measure the level of significance.
Group- A Bone wax group Group-B vancomycin paste group
(n= number of patients, NS= Not significant).
Not significant (P>0.05)

Table-VI

Post Sternotomy pain in the study subjects.

Post Sternotomy pain	Group		*p*-value
	Group-A (n = 30)	Group-B (n = 30)	
At Discharge(Analgesic required)			
Yes	12(40%)	4(13.3%)	0.02^{S}
No	18(60%)	26(86.7%)	
1st follow up			
Yes			
No	4(13.3%)	2(6.7%)	0.67^{NS}
2nd follow up	26(86.7%)	28(93.3%)	
Yes	8(26.7%)	1(3.3%)	
No	22(73.3%)	29(96.7%)	0.026^{S}

Fisher's Exact Test was done to measure the level of significance.
Group- A Bone wax group Group-B vancomycin paste group
(n= number of patients, S= Significant, NS= Not significant). Significant (P<0.05)

Table- VII

Palpable midline gap over the sternal wound in the study subjects.

Palpable midline gap over the sternal wound	Group		*p*-value
	Group-A(n = 30)	Group-B(n = 30)	
1st follow up			
Yes	0(0)	0(0)	—
No	30(100)	30(100)	
2nd follow up			
Yes	0(0)	0(0)	—
No	30(100)	30(100)	

Figures in the parentheses denote corresponding percentage.
Group-A Bone wax group Group-B vancomycin paste group
(n= number of patients).

Table-VIII

Gap between two sternal halves seen at plain CT scan of the chest in the study.

Gap between two sternal halves seen at plain CT scan of the chest (mm)	Group		*p*-value
	Group-A(n = 30)	Group -B(n = 30)	
2nd follow up Mean ± SD	1 4.53±0.77	1.78±0.17	$<0.001^{S}$

Chi-Square (c^2) Test was done to measure the level of significance.
Group- A Bone wax group Group-B vancomycin paste group
(n= number of patients, S = Significant).
Significant (P<0.05)

Discussion:

In this study age of the patients in years were(mean±SD) 54.9±8.81and(mean±SD) 54.87±8.54in group A and group B respectively and there was no significant (p=0.988) difference between the groups. Similar insignificant difference of age between groups was also seen in a previous study by Prziborowski and colleagues

(2008). Although a male preponderance was observed in both groups.

The patients with known risk factors for sternal healing problems like diabetes mellitus, bilateral use of internal mammary artery, chronic obstructive lung disease, urgency and obesity as mentioned by Prziborowski and colleagues (2008) were carefully excluded from the study. All the patients of group-Aand group-B showed mean BMI (mean±SD) were 24.40±2.44 kg/m^2 and 24.15±2.51 kg/m^2 respectively and there was no significant difference (p=0.749) and which correlates well with the insignificant difference of BMI between groups in the German study (Prziborowski, et al., 2008).

Time required for completing the operation were (mean±SD)324.00±10.61min and (mean±SD) 325.33±12.68min respectively in group A and group B respectively and there was no significant difference (p=0.66) Similar non-significant result was given by (Prziborowski, et al., 2008).

In all patients of both group-A and group-B LIMA was used and mean number of venous grafts did not differ significantly in group-A and group-B of patients were (mean±SD)3.57±.56 and(mean±SD) 3.5±0.731 respectively (p=1.000) which was similar to the study conducted by Prziborowski and colleagues (2008).

Duration of ICU stay in group-A and group-B was (mean±SD)34.03±3.45 hours and (mean±SD)34.13±4.7 hours and the difference between two groups was non-significant (p=0.92). In a previous study by Papadopoulos and colleagues (2013) similar result was shown.

Total ventilation time at ICU not significantly differed between group-A and group-B of patients (mean±SD) were 850.67±21.64 min and (mean±SD) 843.33±55.20 min respectively (p=0.50) and this comparison was done as prolonged ventilation dependency was shown to be a risk factor of sternal healing by Francel and colleagues (2001).

The difference of percentage of patients requiring blood transfusion and FFP transfusion were non-significant between the group-A and group-B 93.3% and 80%, p=0.25 and 00% and 3.3%, p=1.000 respectively which was also found non-significant between groups in a previous study (Prziborowski et al., 2008).

In this study the difference of mean postoperative drainage of blood between group-A and group-B of patients was non-significant (mean±SD) were 395.5±55.32 and (mean±SD) 392.5±81.85 ml, p=0.868.

The present study showed that the mean post-operativehospitalization time in group-A (mean±SD) were 8.00±1.61 days and in group-B were (mean±SD) 7.83±1.20 days and the difference between two groups was non-significant. Similar result showed in previous study done by Prziborowski and colleagues (2008).

Present study showed that 16.7% of patient in group-A suffered from superficial sternal wound infection after surgery which was statistically non-significant (p=1.00). None of the patients of both groups were having any deep sternal wound infection at any time after operation.

This study showed that no patient in both group-A and group-B had palpable midline gap over the sternal wound at any time after operation. Similar insignificant differences were also seen in a previous study byFrancel and colleagues (2001).

Post sternotomy pain was evaluated whether patients complained pain on posture change from lying to sitting or on walking if any of the two was present we considered that post sternotomy pain was present. In group-A 40% and group- B 13.3% of patients (p=0.02) were complaining of post sternotomy pain (PSP) atdischarge from hospital. At 1st follow-up the PSP reduced to 13.3%for group-A and 6.7% for group-B which was statistically non-significant (p=0.67).At 2nd follow up after 7±1 month persistence of PSP in group-A 26.7% andin group-B 3.3% whichwas statistically significantly (p=0.02). In a previous study by Papadopoulos and colleagues (2013) significant increase of post sternotomy pain was found with failed sternal reunion and imperfect ossification. During 2ndfollow up plain CT scan of the chest was done to see the bony gap and wound healing. Study showed that bony gap in group-A(mean±SD) 4.53±0.77mm and(mean±SD) 1.78±0.17mm in group-B (p<0.001). The presence of gap was significantly lower in group-Bthan group-A which was observed in a previous study done by Vestergaard and colleagues (2010).

In a study done by Stacy and colleagues(2014) showed that bony movement and separation of as

little as 2 mm can result in a critical sized gap and nonunion that causes greater chest pain with sternal nonunion compared to patients with sternal healing.

In this study group-B patients showed less bony gap between two sternal halves, early sternal healing and less post sternotomy pain.

Conclusion:

Thisstudy showed that there was no significant difference of blood loss which was measured by post-operativedrainage of blood and blood transfusion were almost identical between two groups. There were no significant differences regarding superficial or deep sternal wound infection, palpable midline gap. Persistent post sternotomy pain (PSP) was found significantly higher in bone wax group than in vancomycin paste group. Plain CT scan of the chest revealed that presence of gap between two sternal halves was significantly lower in vancomycin paste group and showed early sternal wound healing. Comparing the effect of bone wax and vancomycin paste there was no difference in hemostasis but vancomycin paste is more effective in decreasing bony gap between two sternal halves after median sternotomy. Vancomycin paste also improveearly sternal wound healing and reduce post sternotomy pain.

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