Comparison of post-operative and pulmonary morbidity due to subxiphoid and midaxillary chest drainage tubes after coronary artery bypass grafting

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AIM: *pain and pulmonary morbidity in patients who underwent coronary artery bypass grafting (CABG) using left internal thoracic artery (LITA) grafting.*
MATERIAL AND METHOD: *The study was prospective and included 40 patients who underwent elective isolated CABG with pedicled LITA grafts. Patients were divided into two groups according to the method used to place chest drainage tubes. Group 1 (n=20) had the left chest drain tube inserted through the sixth intercostal space along the anterior axillary line (mid-axillary approach), and Group 2 (n=20) had the left chest drain tube inserted through the midline inferior to the xiphoid process (subxiphoid approach). We evaluated the groups in terms of postoperative pain, pulmonary morbidity, amount of chest tube drainage, need for analgesic agents, and length of hospital stay.*
RESULTS: *In group 1, the pain was significantly higher during mobilization and drain removal ($p<0.05$) but was similar at rest. In Group 1 and Group 2, pulmonary morbidity rates were statistically similar for pleural effusion (2 vs. 5; $p=0.40$), atelectasis (2 vs. 5; $p=0.40$), and pneumothorax after drain removal (1 vs. 0; $p=1.00$). Two of the patients with pleural effusion in Group 2 underwent thoracentesis. There was no difference between the two groups regarding the amount of chest tube drainage, cumulative doses of an analgesic agent, and length of hospital stay ($p>0.05$).*
CONCLUSION: *According to these results, both procedures can be used safely for chest drainage tube placement after CABG.*

KEY WORDS: Chest Pain, Chest Tubes, Coronary Artery Bypass, Complications, Drainage, Postoperative

Introduction

In patients undergoing coronary artery bypass grafting (CABG) with a pedicled left internal thoracic artery (LITA), a chest and mediastinal chest drain tube is placed to prevent cardiac tamponade and pleural fusion. Mid-axillary approach is often preferred for chest drain tube placement and a straight chest tube is used. However, recently, the subxiphoid approach is also preffered for tube drainage into the thorax [1]. In the subxiphoid approach, an L chest drain is used and the drain extended towards the diaphragm to provide more effective drainage .

Affecting the pleura and intercostal nerves due to mechanical trauma during the placement of chest drain tubes may cause pain and related pulmonary morbidities in the postoperative period [2,5].

Pain after CABG may also develop as a result of musculoskeletal injury due to cauterization, sternal or rib retraction, and sternal wire use [2].

Pain due to chest drain tubes in CABG has been reported

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as an important problem in the early postoperative period quality of life.
Chest drain tube pain may increase pulmonary morbidity due to hypoventilation and atelectasis, especially in CABG patients with lung disease [4,6].
There are different opinions in the literature about the effect of chest drain tube placement on postoperative pain and pulmonary morbidities. In this study, we aimed to investigate the effect of chest drain tube application with subxiphoid and mid-axillary approach on postoperative pain and pulmonary morbidity.

Methods

Between January 2021 and January 2022, a total of 73 patients underwent CABG surgery in our hospital. Patients were included in the study protochol sequentially. Then they were enrolled into study groups and randomized with closed enveloped. All patients who were operated during the study period were assessed for the eligibility for the study protochol. Those who were selected for the study were randomized into study groups with closed envelopes. Single center prospective study includes 40 patients.
Patients who underwent elective, on-pump, isolated CABG surgery with pedicled LITA grafts by opening the pleura were included in the study.
The patients were divided into two groups according to the chest drain tube application method. Group 1, standard midaxillary straight drain, n=20; Group 2, L drain with subsphoid approach, n=20.
In both groups, the method of applying a chest drain tube was made according to the surgeon's preference, and no patient-related selection criteria were used. The study was performed in accordance with the Declaration of Helsinki, after institutional ethics committee approval (protocol number HNEAH-KAEK 2021/298-3393).
Patients who had emergency CABG, off-pump CABG, redo cardiac surgery, cardiac procedures accompanying CABG, CABG without LITA, and previously used chronic nonsteroidal anti-inflammatory drugs (NSAIDs) were excluded from the study.
We explained the surgical procedure, postoperative care plans, and Numeric Rating Scale (NRS) for pain to patients during the preoperative evaluation. This scale is widely used in pain related studies with good reliability and validity. The scale uses numbers instead of text to indicate the degree of pain, segmented in a straight line and the degree of pain expressed by 11 numbers from 0 to 10. In our study; 0 means no pain, 1-3 points for mild pain, 4-6 points for moderate, 7-10 points for severe pain. According to the NRS scale, the severity of pain at the drain site after extubation was at rest at the 6th, 12th,18th and 24th hours; 1, 2, 3, 4. Mobilizations; during chest tube removal and at the 1st hour after removal was evaluated. We differentiated postoperative pain due to chest drains and pain due to sternotomy based on pain scoring (NRS scale) and postoperative analgesic need.

Anesthesia Technique

All patients were premedicated with 0.03mg/kg midazolam 20 minutes before the operation. General anesthesia induction was achived using midazolam (0,1 mg/kg), fentanyl(2μ/kg), vecuronium (0,1 mg/kg), and propofol (1 mg/kg). Anesthesia was maintained with fentanyl (2-3 μ/kg/hour), midazolam (0,04 mg/kg/hour), vecuronium (0.1 mg/kg/hour), sevoflurane and %50 air-oxygen mixture.

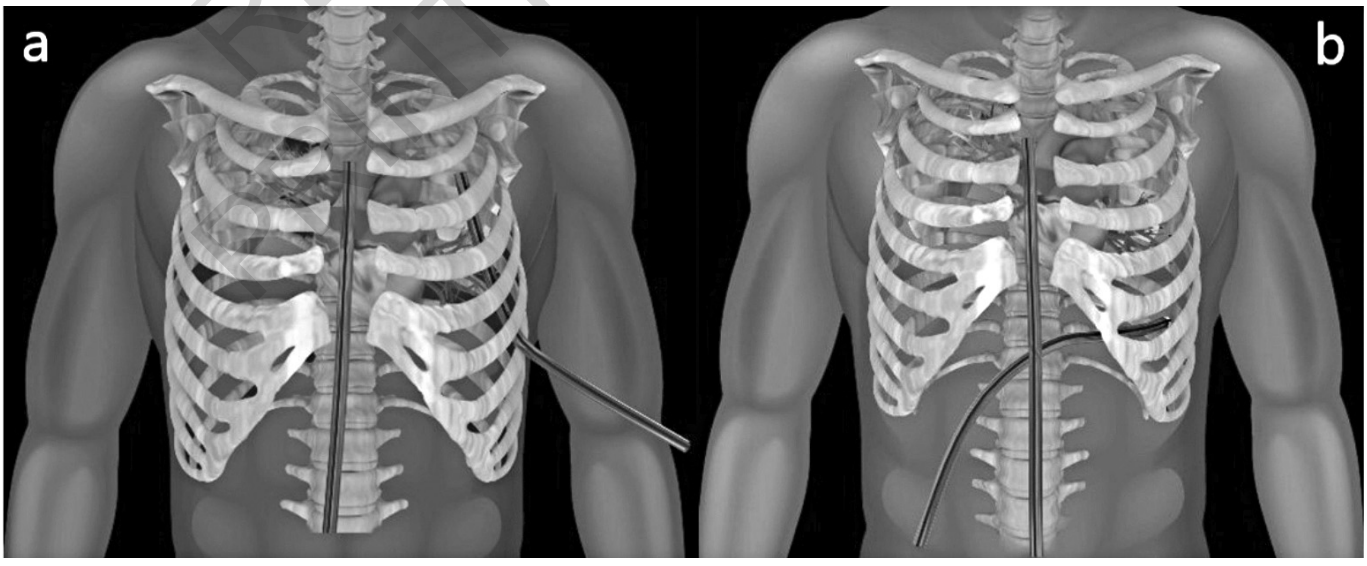

Fig. 1: A) View of the midaxillary thoracic tube; B) view of the subxiphoid chest tube.

Surgical Technique

All patients underwent median sternotomy. The same surgeon performed the study protocol with the same technique for all operations. Operations included preparation of the standard saphenous vein, opening of the left pleura, and removal of the LITA. LITA was prepared as a pedicle graft by cauterization using a chest retractor. CABG was performed on a standard pump with membran oxygenation and moderate hypothermia. Myocardial protection was achieved by intermittent administration of normothermic blood cardoplegic solution administered from the aortic root.
Two soft, 32F chest tubes were used to drain blood and air from the chest cavity in patients after surgery. In group-1 patients, a straight tube was placed along the mid-axillary line from the 6th intercostal space to the left hemithorax, and the tip of the tube was directed towards the left lung apex. Another straight tube was inserted through the subxiphoid space and placed in the anterior mediastinum (Fig. 1a).
In group 2 patients, an angled tube (L) was inserted from the subxiphoid area to the left hemithorax, and the tip of the tube was placed in the left costophrenic sinus above the diagphragm. A straight tube was also inserted through the subxiphoid space and extended into the anterior mediastinum (Fig. 1b). Chest drains in both groups were fixed with the same technique (u-suture).
The sternotomy was closed with eight seperate steel wires and the skin incision was sutured. Drains are connected to thee underwater drainage system.
We used suction on the chest drain with an average pressure of 10-15mmHg in all patients. The patients were then taken to the intensive car unit and fast-track protochol were used and all patients were extubeted as soon as possible if there was no bleeding. The drains were removed when they turned serous in appearande and fell below 100cc/day in both groups. There were no clots in ANY of the tubes.

Postoperative Analgesia Protocol

Patient-controlled analgesia (PCA) device and intravenous tramadol were used for postoperative pain control. Pain control was achieved with tramadol PCA until the postoperative 48th hour. PCA was adjusted to deliver intravenous tramadol 0,3 mg/kg/hr continuously, 0.3 mg/kg bolus when the patient presses the buton. Patients were taught to pres the buton of the PCA system to receive bolus medication each time pain occurs. PCA locked for 20 minutes when button is pressed for bolus dose. Intravenous ondansetron (4mg) was administered to those who complained of nausea and vomiting. As an additional analgesic, 1 gram IV paracetamol was administered routinely to all patients every 8 hours for the first 48 hours. The total amount of tramadol consumed in the PCA device during the posoperative 48 hours of the patients was recorded.

Pulmonary Morbidities

In the intensive care unit, the bed was held at a 45° angle to prevent pleural and pericardial effusion.
Blood gas was taken regularyly at 6 hours intervals. PO_2 and PCO_2 values were checked in blood gas. The respiratory rate per minute and hourly chest tube drainage were recorded.
The patients underwent short-term repetitive mobilization to minimize the accumulated pleural effusion before drain removal. Chest radiographs were taken on the first and fourth days to evaluate postoperative pleural effusion, atelectasis and pneumothorax. Chest radiographs was also taken on the day of discharge, at the 1st week and 1st month control examination. Pleural effusion was considered significant when the costophrenic angle was exceeded, and atelectasis was considered significant when the radiological shadow width exceeded 15 mm. The patients were evaluated in terms of PO^2, PCO_2, respiratory rate per minute, chest tube drainage amount, pleural effusion, atelectasis and pneumothorax.

Statistical Reviews

While evaluating the findings obtained in the study, IBM SPSS Statistics 22 program was used for statisctical analysis. The suitability of the parameters to the normal distribution was evaluated by Kolmogorov- Smirnov and ShapiroWilks tests. While evaluating the study data, in addition to descriptive statisctical methods (Mean, Standard deviation), Student's t-test was used fort he comparison of normally distributed parameters between two groups, and Mann Whitney U test was used for the comparison of non-normally distributed parameters between two groups. Wilcoxon sign test was used for in-group comparisons of parameters that didn't show normal distribution. Fisher's Exact Chi-Square test and Continuity (Yates) Correction were used to compare qualitative data. Significance was evaluated at the $p<0.05$ level.

Results

The study was conducted with a total of 40 subjects, 17(%42,5) female and 23(%57.5) male, aged between 48 and 77 years. The mean age is 63.58±7.92 years. There was no significant difference between the groups in terms of demographic data (Table I).There was no infection or surgical mortality in the early postoperative period in either group.
There was no significant difference between the two

Table I - *Evaluation of groups in terms of demographic and preoperative data*

	Group 1	Group 2	p
Age mean±SD	64.6±8.08	62.55±7.84	0.420*
Weight mean±SD	80.25±8.4	80.35±10.93	0.974*
Height mean±SD	167.85±8.57	168.4±9.44	0.848*
BMImean±SD	28.49±2.14	28.24±1.94	0.707*
EF (%)mean±SD	47.05±6.24	46.65±5.78	0.834*
Sex n (%)			
Female	8 (40%)	9 (45%)	1.000**
Male	12 (60%)	11 (55%)	
Diabetes mellitus n (%)	9 (45%)	8 (40%)	1.000**
Hypertension n (%)	11 (55%)	12 (60%)	1.000**
COPD n (%)	4 (20%)	5 (25%)	1.000**

*Student t-test; **Continuity (Yates) correction; BMI: Body mass index; EF: ejection fraction; COPD: chronic obstructive pulmonary disease

Table II - *Evaluation of the groups in terms of perioperative and postoperative data*

	Group 1 Mean±SD	Group 2 Mean±SD	p
CPB duration (min)	84.65±11.65	83.1±12.35	0.685*
Cross-clamp time (min)	56.75±8.91	57.1±11.92	0.917*
Total surgery time (min)	223.95±21.01	221.05±26.93	0.706*
Total fentanyl consumption (µg) (Median-IQR)	491.25±58.64 (487.5-87.5)	503.75±91.86 (500-125)	0.891**
Intubation time (h) (Median-IQR)	7.05±1.9 (7-2.75)	7.4±2.21 (7-2.5)	0.640**
Drainage (mL) (Median-IQR)	315±77.97 (300-100)	310±47.57 (300-50)	0.768**
Postop. tramadol (mg) (Median-IQR)	239±65.53 (260-85)	116.5±43.68 (120-60)	0.000°/**
Discharge time (days) (Median-IQR)	6±0.92 (6-1)	6.25±1.16 (6-2)	0.548**
Pleural effusion n (%)	2 (10%)	5 (25%)	0.407***
Atelectasis n (%)	2 (10%)	5 (25%)	0.407***
Pneumothorax n (%)	1 (5%)	0 (0%)	1.000***

CPB: Cardiopulmonary bypass; *Student t-test; ** Mann-Whitney U test; ***Fisher exact test; °p<0.05

Table III - *Post-extubation blood gas parameters of the groups*

	1st	4 th	8 th	12 th	18 th	24 th	48 th
PO2 Mean±SD							
Group 1	103.7±13.24	101.4±12.5	95.95±10.26	92.2±9.84	92.8±9.68	90.7±9.7	85.95±9.9
Group 2	104.85±11.8	101.25±11.5	97.3±9.51	93.4±9.41	93.7±9.02	91±9.19	86.7±9.88
p*	0.773	0.969	0.669	0.696	0.763	0.921	0.812
PCO2 Mean±SD							
Group 1	37.1±2.61	36.75±2.57	35.7±2.2	35.1±1.89	36.75±1.71	38.3±2.0	39.1±1.48
Group 2	37.9±1.92	37.35±1.98	36.1±1.68	35.9±1.59	37.85±1.93	39.2±1.64	39.7±1.59
p*	0.277	0.414	0.523	0.155	0.064	0.128	0.225
Respirat. rate Mean±SD (Median-IQR)							
Group 1	17.9±2.22 (17-4)	18.35±1.57 (18.5-2.5)	18.25±1.92 (18-3)	18.4±1.6 (18.5-2.75)	17.75±1.68 (18-3)	17.3±1.3 (17.5-2)	16.85±1.18 (17-2)
Group 2	17.3±1.72 (17-2)	17.8±1.51 (18-2.75)	17.5±1.7 (17-3)	17.5±1.7 (17-3)	17.15±1.69 (16.5-2.75)	17.1±1.65 (16-2.75)	16.85±1.53 (16-1)
p**	0.492	0.210	0.149	0.086	0.241	0.447	0.617

*Student t-test; **Mann-Whitney U test; °p<0.05; PO_2: Partial Pressure of Oxygen, PCO_2: Partial Pressure of carbon dioxide

groups in terms of peri-operative data (cardiopulmonary bypass, aortic cross-clamp, duration of total surgery and mechanical ventilation, amount of drainage) (p>0.05). The incidence of pulmonary morbidity in group-1 and group-2 approaches was similar for both groups and respectively; pleural effusion (2 versus 5 patients p=0.4), atelectasis (2 versus 5 patients p=0.4), and pneumothorax after drain extraction (1 versus 0 patient p=1.00) was

TABLE 4 - *Evaluation of NRS levels in the groups*

	Group 1 mean±SD (Median-IQR)	Group 2 mean±SD (Median-IQR)	p
In terms of rest NRS levels			
6th h	5.6±0.8 (6-1) ‡	5.2±1 (5-1.75)	0.237
12th h	5.6±1.1 (6-1) ‡	5.3±1 (5-1.75)	0.257
18th h	5.4±1 (5-1) ‡	5±0.8 (5-1.5)	0.200
24th h	3.5±0.7 (3.5-1) ‡	3.3±0.5 (3-1) ‡	0.263
In terms of mobilization, NRS levels			
1st m	7.2±1.3 (7.5-1)	5.1±0.7 (5-1)	0.000*
2nd m	6.6±1.1 (7-1) ‡	4.7±0.9 (5-1)	0.000*
3rd m	6.4±1 (7-1) ‡	4.6±0.8 (4.5-1) ‡	0.000*
4th m	6.1±1.1 (6-2) ‡	3.9±0.7 (4-1) ‡	0.000*
Drain extraction NRS levels			
Drain extraction	8.8±0.8 (9-1)	5.9±0.9 (6-1)	0.000*
1st hour after extraction	4.5±0.5 (4-1) ‡	4.3±0.7 (4-1) ‡	0.260

NRS; numerical rating scale, h; hour, m; mobilization; Mann-Whitney U test; * p<0.05
‡ When evaluated according to the first mobilization within the group, this was significant at the p<0.05 level

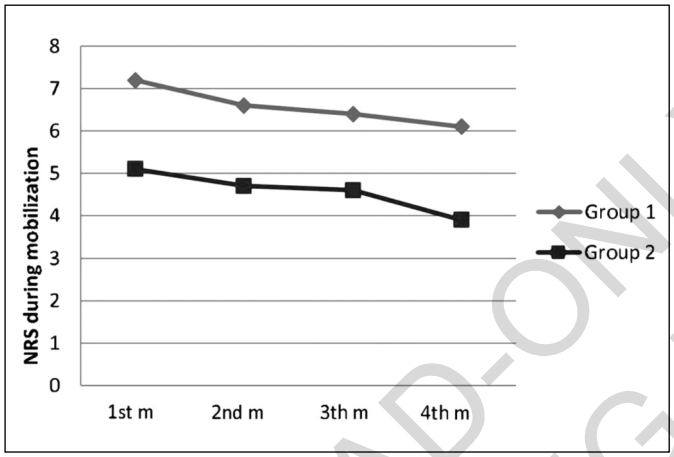

Fig. 2: NRS scores of the groups during mobilization, m; mobilization.

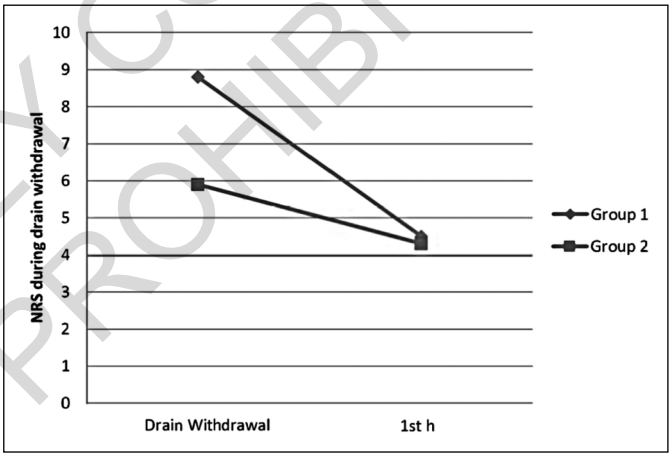

Fig. 3: NRS scores of the groups during chest drain withdrawal and at the 1st hour after chest drain withdrawal.

detected. In group 2, thoracentesis was applied to two patients due to pleural effusion, while the other five patients were followed up medically. Patients with atelectasis in both groups benefited from effective respiratory phsiotherapy. Pleuroken was inserted in one patient who developed pneumothorax. Chest radioghraphs of these patients were normal at the 1 month follow-up examination. In addition, there was no difference between two groups in terms of cumulative doses of analgesic agents and length of hospital stay (p>0.05) (Table II).

There was no statistical difference between respiratory values or rates obtained by blood gas analysis (Table III). There is no statsictically significant difference betweeen the groups in terms of NRS scores describing pain in all phases of rest (p>0.05). However, the decrease in the 24th hour resting NRS score was statistically significant in the within group evaluation in both groups (p<0.05) NRS scores during mobilization and drain removal were statistically significantly higher in Group 1 (p<0.05) (Table IV). The statistical significance seen in group-1 during drain removal was lost in the 1st hour NRS scores (p>0.05) (Fig. 2).

Discussion

In this study, we examined the relationship between chest drain tube application with subxiphoid and mid-axillary approach and postoperative pain and pleural morbidity in patients who underwent conventional CABG with pedicled LITA. Pain in the mid-axillary approach was statistically significantly higher during mobilization and drain removal than in the subxiphoidal approach. However, pain at rest was similar between groups. In addition, pleural effusion, atelectasis, pneumothorax, arterial blood gas analysis and respiratory rates were found

to be similar in both groups. Mechanical trauma from chest tube insertion in CABG patients can cause a local inflammatory reaction with increased levels of proinflammatory cytokines and cause severe post-operative pain. In the postoperative period, the degree of pain increases due to friction in the intrathoracic structures, especially due to the drain movement [7]. In our study, it was statistically significanty higher in group 1 during pain, mobilization and drain removal ($p<0.05$), and it was found to be similar between groups during rest ($p>0.05$). Scores We think that the high pain during mobilization and drain removal between the groups is due to friction in the intrathoracic structures due to the movement of the chest drain. In our study, analgesic consumption was also similar between the groups($p>0.05$). We interpreted this finding as the fact that the mobilization of both groups in the arly postoperative period was short, and the pain at rest was similar. In addition, the decrease in the NRS score at the 24th hour at rest and at the 1st hour after drain removal was statsictically significant in the intragroup evaluation in both groups ($p <0.05$). These results show that patients' pain return to normal in a short time after drain removal. There are studies indicating that prolonged pain at the drain site may lead to shallow breathing, impaired ventilation of the lungs, and non-optimal values in blood gases (PO_2 and PCO_2) [2,3]. However, short-term exposure to pain has no effect on respiratory parameters. In our study, there was no significant difference between the groups in terms of arterial blood gas analysis, respiratory rates and pulmonary morbidity, as there was only severe pain exposure during mobilization and drain removal ($p>0.05$).

There are differences in the results of studies comparing pain and pulmonary morbidity after pedicled LITA in the literature. While Guden et al [1] stated that postoperative pain and pulmonary morbidity were similar with the subxiphoid and mid-axillary approach, Hagl et al [5,8] stated that it was lower in the subxiphoid approach. In our study, on the other hand, in the midaxillary approach, pain during mobilization and drain extraction was statistically significantly higher, similar at rest, and pulmonary morbidity was similar in both groups.

In patients after CABG, safe and effective drainage of the chest is required to prevent cardiac tamponade and reduce the incidence of pleural efusion. In our study, there was no statisctically significant difference between the groups in terms of the amount of thoracic drainage ($p=0.76$) This showed us that both methods can be used for postoperative thoracic drainage in CABG patients using LITA.

There are studies in the literature indicating that the method of chest drain tube placement after CABG has an effect on pulmonary morbidity in the postoperative period [9-12]. In our study, it was observed that postoperative chest drain tube placement method didn't make a significant difference in lung function in the early period. It was observed that postoperative pneumothorax was higher in patients in group 1, and the need for pleural effusion, atelectasis and thoracentesis was higher in patients in group-2, but these differences were not statistically significant ($p=0.4$).

Conclusion

In our study; Pulmonary morbidity after CABG was similar in the mid-axillary and subxiphoid approach. Pain was higher during mobilization and drain extraction in the mid-axillary approach, but had no effect on pulmonary function. With these results, both methods can be used safely in chest drain tube placement after CABG. Although we included all patients who met the criteria at the time of the study, we predict that more precise results will be obtained in studies with larger volumes.

Riassunto

Introduzione: Abbiamo studiato gli effetti dell'apposizione dei tubi di drenaggio toracico sul dolore postoperatorio acuto e sulla morbilità polmonare nei pazienti sottoposti a bypass coronarico (CABG) mediante innesto di arteria mammaria interna sinistra (LITA).

Materiali e Metodi: Si tratta di uno studio prospettico che include 40 pazienti sottoposti a CABG isolato elettivo con innesti LITA peduncolati. I pazienti sono stati divisi in due gruppi in base al metodo utilizzato per posizionare i tubi di drenaggio toracico. Il gruppo 1 (n=20) aveva il tubo di drenaggio toracico sinistro inserito attraverso il sesto spazio intercostale lungo la linea ascellare anteriore (approccio medio-ascellare) e il Gruppo 2 (n=20) aveva il tubo di drenaggio toracico sinistro inserito attraverso la linea mediana inferiore al processo xifoideo (approccio subxifoideo). Abbiamo valutato i gruppi in termini di dolore postoperatorio, morbilità polmonare, quantità di drenaggio del tubo toracico, necessità di agenti analgesici e durata della degenza ospedaliera.

Risultati: Nel gruppo 1, il dolore era significativamente più alto durante la mobilizzazione e la rimozione del drenaggio ($p<0,05$), ma era simile a riposo. Nel Gruppo 1 e nel Gruppo 2, i tassi di morbilità polmonare erano statisticamente simili per versamento pleurico (2 contro 5; $p=0,40$), atelettasia (2 contro 5; $p=0,40$) e pneumotorace dopo la rimozione del drenaggio (1 contro 0; $p=1,00$). Due dei pazienti con versamento pleurico nel gruppo 2 sono stati sottoposti a toracentesi. Non c'era differenza tra i due gruppi per quanto riguarda la quantità di drenaggio del tubo toracico, le dosi cumulative di un agente analgesico e la durata della degenza ospedaliera ($p>0,05$).

Conclusioni: In base posizionamento del tubo di drenaggio toracico dopo a questi risultati, entrambe le procedure possono essere utilizzate in sicurezza per il CABG.

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