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Muscle-sparing versus standard posterolateral approach for urgent thoracotomy in patients with traumatic thoracic injuries

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Abstract

Background: Muscle-sparing thoracotomy (MST) has been proposed as an alternative to standard posterolateral thoracotomy (sPLT) for elective thoracic procedures with limited use in urgent thoracotomies.

Objectives: The aim of this study was to compare the results of sPLT and MST during urgent thoracotomy for the treatment of chest trauma.

Methods: This case series study included patients who underwent urgent thoracotomies within the first 48 hours of admission for treatment of chest trauma, from January 2019 to July 2022. Patients were divided into two groups: sPLT and MST groups. In addition, the MST group was divided into partial (pMST) or complete (cMST).

Results: Seventy-five out of 1400 patients with chest trauma (5.3%) underwent urgent thoracotomy, and 30 of them (40%) had MST. Compared with the sPLT group, the MST group had a lower abbreviated injury scale (AIS) of the thoracic region, with a significant difference (4.09 ± 0.66 versus 3.77 ± 0.72, P = 0.052). There was no significant difference between the two groups with regard to the duration of tube drainage, ICU stay, hospital stay, and postoperative complications. The length of hospital stay was shorter in the MST group with no statistically significant difference (14.30 ± 3.01 vs. 15.5 ± 2.48, P = 0.08). The extent of MST, whether partial or complete, had no significant effect on postoperative outcomes.

Conclusions: If it does not impede access or chest exposure, MST can be performed with early recovery and therefore a shorter hospital stay than sPLT.

Keywords: Chest trauma, Thoracic injury, Thoracotomy, Muscle-sparing.

Introduction

Urgent thoracotomy is less frequently indicated to treat life-threatening thoracic injuries in patients with chest trauma.[1] Posterolateral thoracotomy (PLT) is the standard approach for most thoracic procedures due to excellent access and the ease of extending the incision if required.[2] However, it is associated with considerable postoperative pain, compromised lung function, and diminished shoulder girdle function. Muscle-sparing thoracotomy (MST) is a substitute for the standard PLT (sPLT) in patients who underwent elective thoracotomy for neoplastic and non-neoplastic lung diseases as it preserves serratus anterior and latissimus dorsi muscles that can provide better results than the sPLT in regards to postoperative pain, lung function, and postoperative complications.[3]

Despite the reported benefits of this procedure, evaluation of outcomes after MST in patients with chest trauma is still limited. MST requires more time which can compromise life-saving procedures in chest trauma patients. Therefore, chest trauma surgeons may prefer to perform PLT without division of the chest wall muscles. MST can be partial (pMST), when the serratus anterior muscle is spared with a division of the latissimus dorsi muscle, or complete (cMST) when both muscles are spared.

Objectives

The aim of this study was to compare the results of MST and standard PLT (sPLT) in chest trauma patients undergoing urgent thoracotomy.

Methods

This case series study evaluated the medical records of patients who had urgent thoracotomy for traumatic thoracic injury at our institution between January 2019 and July 2022. The collected data included: demographics, mechanism, injury severity score (ISS), Abbreviated injury scale (AIS), operative findings, mortality rate, use of opioids for postoperative analgesia, length of hospital stay, and postoperative complications. Patients were divided into two groups: one with sPLT and one with MST. The patients who underwent urgent posterolateral thoracotomy for thoracic injuries within the first 48 hours of admission were included in the study. The following were excluded: early death, video-assisted thoracoscopic surgery (VATS) procedures, prior treatment at other hospitals, cardiac injury, elective thoracotomy (after 48 hours), and incomplete data. During sPLT, the latissimus dorsi and the inferior border of the serratus anterior muscle were transected. MST was performed as previously described.[4] MST can be partial (pMST) when the serratus anterior muscle is spared with the simultaneous division of the latissimus dorsi muscle, or complete (cMST) when both muscles are spared. The serratus anterior muscle is spared by moving its posterior margin from the fascia beyond the tip of the scapula and toward the anterior aspect of the 6th rib. To spare the latissimus dorsi muscle, it is dissected out of the subcutaneous tissue and then its anterior edge is freed from the axilla toward the iliac crest, followed by freeing the deep aspect and posterior retraction of the muscle. In both techniques, the thorax was entered through the 4th or 5th intercostal space. For better exposure in MST, two retractors might be used instead of one. At the end of the procedure, we routinely inserted two chest drains. A basal chest drain was removed postoperatively if the drainage was <100 ml/day, while an apical drain was removed when there was no air leak or pneumothorax.

Statistical Analysis

Statistical analysis was performed using IBM-SPSS statistical software, version 25 (IBM, Armonk, NY, USA). Categorical data were expressed as numbers and percentages, while quantitative data were expressed as mean ± standard deviation. Comparisons between groups were made using the chi-square test for categorical data and the t-test for quantitative data. A P value of less than 0.05 was considered statistically significant.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki. The study protocol was approved by our Review Institutional Board (RIB) under approval number (617/2023). Patient consent is not required for retrospective studies.

Results

Of the 1400 patients with thoracic trauma during the study period [Figure 1], 75 patients (5.3%) underwent urgent thoracotomy. Of the 75 thoracotomies, MST was performed in 30 cases (40%) and sPLT in 45 cases (60%). Most of our patients who underwent urgent thoracotomy were male (80%), had blunt chest trauma (82.7%), and were indicated for thoracotomy because of high chest drainage (80%). Comparison of initial characteristics between the sPLT and MST groups [Table 1] revealed no significant differences in age, sex, mechanism of injury, initial imaging findings, indications for thoracotomy, and ISS, whereas the sPLT group had a slightly higher AIS of the thoracic region than the MST group with a significant difference (4.09±0.66 vs 3.77±0.72, P=0.052).

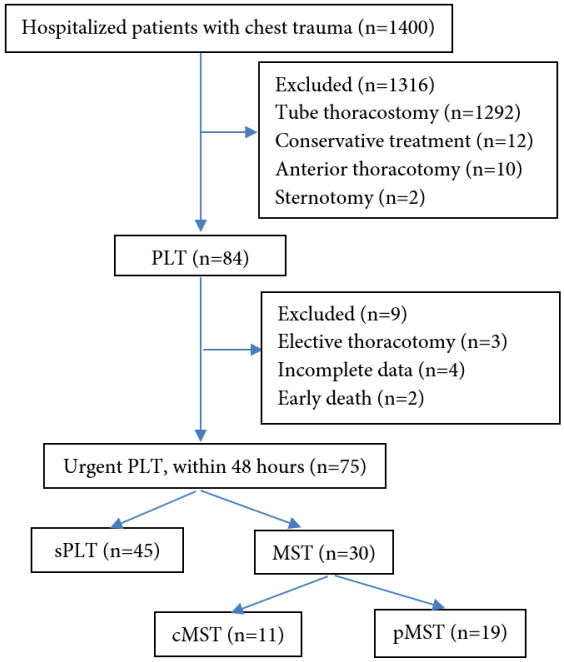

Figure 1. Flow chart for patients' enrollment into the study. PLT: posterolateral thoracotomy. sPLT: standrard posterolateral thoracotomy. MST: muscle-sparing thoracotomy. cMST: complete muscle-sparing thoracotomy. pMST: partial muscle-sparing thoracotomy.

Regarding operative data and postoperative outcome [Table-2], most patients underwent left-sided thoracotomy (57.3%) had a pulmonary laceration on exploration (57.3%), and no pulmonary resection was performed (78.7%). There was no significant difference between the two groups in the side of thoracotomy, operative findings, type of the surgical procedure, duration of chest drainage, and length of stay in the

intensive care unit. The length of hospital stay was shorter in the MST group without a significant difference (14.3±3.01 vs. 15.5±2.48, P=0.08). The majority of patients in both groups had no postoperative complications (93.3% in the MST group compared to 91.1% in the sPLT group, P=0.72), with no significant difference in the incidence of pneumonia, wound seroma, and prolonged air leakage. A comparison of postoperative outcomes between the partial and complete MST subgroups [Table 3] revealed no significant difference in the duration of chest drainage, length of ICU and hospital stay, and postoperative complications.

Table 1. Baseline characteristics of patients undergoing standard posterolateral thoracotomy or muscle-sparing thoracotomy

Variables		MST (n=30)	sPLT (n=45)	P value
Age (years)	Mean±SD	26.9±11.8	28.5±11.7	0.56
Gender	Male, N (%)	26 (86.7%)	34 (75.6%)	0.23
	Female, N (%)	4 (13.3%)	11(24.4%)	
ISS (units)	Mean±SD	25.37±6.98	27.98±8.46	0.16
AIS thoracic region (units)	Mean±SD	3.77±0.72	4.09±0.66	0.052
Mechanism of injury	Blunt, N (%)	27(90%)	35(77.8%)	0.17
	Penetrating, N (%)	3(10%)	10(22.2%)	
Indications of thoracotomy	High chest tube output, N (%)	25(83.3%)	35(77.8%)	0.70
	Massive air leak, N (%)	3(10%)	5(11.1%)	
	Diaphragmatic rupture, N (%)	2(6.7%)	3(6.7%)	
	Bullet in the pleural space, N (%)	0(0%)	2(4.4%)	

sPLT: standard posterolateral thoracotomy. MST: partial muscle-sparing thoracotomy.

Table 2. Comparing operative data and postoperative outcome between standard posterolateral thoracotomy and muscle-sparing thoracotomy

Variables		MST (n=30)	sPLT (n=45)	P-value
Side of thoracotomy	Left, N (%)	13(43.3%)	28(62.2%)	0.10
	Right, N (%)	17(56.7%)	17(37.8%)	
Operative finding	Lung laceration, N (%)	21(70%)	22(48.9%)	0.20
	Vascular bleeding, N (%)	3(10%)	13(28.9%)	
	Diaphragmatic rupture, N (%)	4(13.3%)	5(11.1%)	
	Bronchial injury, N (%)	2(6.7%)	3(6.7%)	
	Bullet in the pleural space, N (%)	0(0%)	2(4.4%)	
Procedure	No lung resection, N (%)	22(73.3%)	37(82.2%)	0.35
	Lung resection, N (%)	8(26.7%)	8(17.8%)	
Chest tube duration (days)	Mean±SD	4.20±1.97	4.73±1.60	0.20
Length of ICU stay (days)	Mean±SD	9.53±2.90	10.42±2.50	0.16
Length of hospital stay (days)	Mean±SD	14.30±3.01	15.5±2.48	0.08
No postoperative complications	N (%)	28(93.3%)	41(91.1%)	0.72
Pneumonia	N (%)	1(3.3%)	2(4.4%)	0.81
Prolonged air-leak >7 days	N (%)	0(0%)	1(2.2%)	0.41
Wound seroma	N (%)	2(6.7%)	1(2.2%)	0.33

sPLT: standard posterolateral thoracotomy. MST: muscle-sparing thoracotomy. *(One patient in the MST group had both postoperative pneumonia and wound seroma).

Table 3. Comparing postoperative outcome between partial and complete muscle-sparing thoracotomy

Variables		pMST (n=19)	cMST (n=11)	P-value
Chest tube duration (days)	Mean±SD	3.95±1.95	4.64±2	0.36
Length of ICU stay (days)	Mean±SD	9.32±2.82	9.91±3.14	0.59
Length of hospital stay (days)	Mean±SD	14.26±2.99	14.36±3.20	0.93
Postoperative complications	N (%)	1(5.3%)	1(9.1%)	0.68
Pneumonia	N (%)	1(5.3%)	0(0%)	0.43
Wound seroma	N (%)	1(5.3%)	1(9.1%)	0.68

cMST: complete muscle-sparing thoracotomy. pMST: partial muscle-sparing thoracotomy. *(One patient in the the pMST group had both postoperative pneumonia and wound seroma).

Discussion

The main results of this study showed that MST is suitable for urgent thoracotomy in patients with thoracic trauma and a low injury scale. Although there is no significant difference between MST and sPLT, MST has the advantage of shorter recovery time and fewer postoperative complications.

Thoracic trauma is directly or indirectly responsible for approximately half of all traumatic deaths due to the severity of thoracic trauma and associated life-threatening conditions. However, most patients with thoracic trauma are treated with a tube thoracotomy and conservative measures.[5,6] Urgent thoracotomy is rarely required for the treatment of patients with thoracic trauma. Known indications include massive initial drainage, permanent air leak, tracheobronchial injury, and cardiovascular injury.[7]

Consistent with other studies in the literature,[8,9] urgent thoracotomy in our study was mainly indicated for massive hemothorax detected by chest drainage. The cutoff value for blood loss to define a massive hemothorax was initial drainage of more than 1500 ml of fresh blood or drainage of more than 200 ml/hour for four consecutive hours. However, the optimal blood loss limit for urgent thoracotomy remains controversial. Some investigators reported a threshold of more than 400 ml/hour in blunt trauma[8] and others reported a threshold of 1500 ml/24 hours[10] as an indication of urgent thoracotomy in traumatized patients.

The most common approach for thoracic surgery is PLT. Traditionally, PLT is performed by transecting the serratus anterior and latissimus dorsi muscles, which can result in significant postoperative pain, impaired pulmonary function, and limited shoulder mobility. Therefore, since the description of MST by Bethencourt and Holmes in 1988,[4] many studies have compared the performance of both techniques in elective thoracic surgery regarding postoperative pain, shoulder mobility, pulmonary function, and postoperative complications. The existing results in the literature are controversial, either supporting MST for some parameters or showing no difference between the two techniques.[11-13] Despite the possibility of inadequate accessibility during surgery, the main advantages of MST over PLT are 1) preservation of muscle strength with rapid recovery of shoulder function, 2) preservation of chest wall muscles that can be used for rotating muscle flaps, and 3) cosmetic advantages.[2,13-15]

Muscle-sparing is rarely performed for urgent thoracotomy to treat thoracic trauma because it requires a longer opening time than sPLT and a smaller surgical field, which may discourage MST during life-saving procedures. However, in trauma surgery, surgical techniques with minimal postoperative pain and minimal disability are preferred when possible. Thus, the decision to spare chest wall muscles during an urgent thoracotomy depends on the surgeon's preference, which prioritizes control of intrathoracic hemorrhage and preservation of hemodynamic status and thus patient survival. These factors may explain why MST was performed in less than half of our patients (40%). Moreover, MST was performed in patients with a lower chest score AIS than sPLT, reflecting the priority to rapidly penetrate the thoracic cavity in patients with more severe chest injuries.

In our traumatized patients with MST, there was no significant difference in the length of postoperative hospital stay, but it was significantly shorter than that in a group of patients with sPLT, which may be due to the advantages of MST in terms of lower postoperative pain and complications. No significant difference was found between the MST and sPLT groups regarding the incidence of postoperative complications. However, MST is known to increase the incidence of wound seroma due to the extensive mobilization of the latissimus dorsi muscle to create a subcutaneous flap.[3,16] We did not find a significant difference in the incidence of seromas during MST as we spared the serratus anterior muscle and transected the latissimus dorsi muscle without creating a flap in most cases.

Our study has potential limitations because of its retrospective nature, limited use of complete MST in urgent thoracotomy, and lack of prospectively collected data on pain scores and pulmonary function tests in trauma patients. Therefore, further prospective studies are needed to obtain more accurate results.

Conclusions

If possible, MST may be an additional option to improve recovery and shorten hospital stay in trauma patients undergoing thoracotomy within the first 48 hours after hospital admission.

Acknowledgment

None.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

Posterolateral thoracotomy: PLT;

Standard posterolateral thoracotomy: sPLT;
Muscle-sparing thoracotomy: MST;
Complete muscle-sparing thoracotomy: cMST;
Partial muscle-sparing thoracotomy: pMST;
Injury severity score: ISS;
Abbreviated injury scale: AIS;
VATS: Video-assisted thoracoscopic surgery.

Authors' contributions

All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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Availability of data and materials

The data used in this study are available from the corresponding author on request.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. The study protocol was approved by our Review Institutional Board (RIB) under approval number (617/2023).

Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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