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Comparative Evaluation of Complications Associated with Sharp-Tipped and Blunt-Tipped Chest Tubes in Thoracostomy

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A B S T R A C T

Background: Although the emergency insertion of a tube into the chest has the potential to save lives, up to 30% of patients experience organ damage and misplacement. Trocar or non-trocar procedures may, in theory, be used to place a chest tube. There are now two distinct chest tubes on the market, both with blunt or sharp tips, for use in the trocar method.

Objective: The purpose of this research was to find out anatomic variations of chest wall and complications of two different chest tubes with either a sharp or blunt tip for thoracotomy.

Methodology: In 110 thoracic trauma patients, twenty emergency doctors performed 5 tubes thoracostomies employing kits with blunt and sharp tips. Time to tube insertion was the main result. Different investigation tools like computed tomography, chest X-ray and ultrasound were used to assess complications and success rate, which functioned as additional outcome measures.

Results: The mean time difference before tube insertion did not reach statistical significance. From the first to the fifth try, both groups' insertion times decreased and indicated a dependence on the BMI of the patients as well as the particular doctor. The two groups' success rates were different (94% for blunt vs. 90% for sharp-tipped kits), and the use of sharp-tipped chest tubes was much more likely to result in injuries and misplacements ($p = 0.04$).

Conclusion: According to data, there is complication rate after anatomic variation of chest and chest drain placement using trocars. There was no discernible variation in the mean duration. Sharp tips did, however, result in more frequent mishaps and organ damage. Therefore, it is advised to utilize blunt-tipped kits when using a trocar method.

Keywords: Chest Tubes; Thoracostomy; Chest Trauma; Empyema

Introduction

Among various pleural complications, 5–41% progress to pneumothorax, with trauma patients experiencing pneumothorax as the most common reason for chest tube insertion, second only to hemothorax.[1] Notably, up to 25% of attempted chest tube insertions encounter issues, including incorrect tube positioning.[2,3] In emergency situations, needle decompression is often employed to address tension pneumothorax, yet this method is both potentially risky and imprecise, with a high rate of unsuccessful attempts necessitating subsequent chest tube placement. Consequently, needle decompression is primarily valuable as a diagnostic tool. For the treatment of tension pneumo-thorax in sophisticated pre-hospital urgent care, tube thoracostomy stands as the accepted standard.

Thoracostomy, the insertion of a chest tube into the pleural space, is a commonly performed procedure for managing various thoracic conditions such as pleural effusion, pneumothorax, and hemothorax. The choice between using a sharp-tipped or a blunt-tipped chest tube is a crucial aspect of this procedure, impacting drainage success, patient outcomes, and the occurrence of complications. Traditionally, sharp-tipped chest tubes with trocars or cutting mechanisms have been employed to ease penetration through the chest wall and parietal pleura, reducing resistance during insertion. However, this approach comes with potential drawbacks, including an increased risk of tissue injury, vascular damage, and visceral organ perforation.

In emergency pre-hospital scenarios, the success rate for chest tube placement varies between 79 and 95%.[4] Two alternative methods for chest tube insertion include the ventral route (2nd–3rd intercostal space) and the lateral approach (4th–6th intercostal space in the mid-axillary line, known as the triangle of safety according to Bülau).[5,6] The lateral approach is considered optimal for trauma patients. Different methods exist for chest tube insertion, including the trocar method, which reduces guidance compared to non-trocar methods but may have a higher complication rate. A recently reported method combining trocar guidance with simultaneous finger probing has shown enhanced safety and lower complication rates compared to non-trocar operations.

The trocar and non-trocar approaches represent the fundamental methods for chest tube placement, with a recently reported technique combining trocar guidance with simultaneous finger probing showing enhanced safety and lower complication rates compared to non-trocar operations. The choice between these methods warrants careful consideration to optimize the safety and efficacy of chest tube insertion.

Blunt-tipped chest tubes have gained popularity due to their perceived safety benefits, designed to dissect tissues rather than cut through them, potentially minimizing trauma risk. Despite these perceived advantages, a comprehensive evaluation of the efficacy and safety of blunt-tipped tubes compared to sharp-tipped ones is needed.

Complications from chest tube insertion can have significant clinical implications, ranging from increased postoperative pain to life-threatening situations like major vessel injury. Understanding and comparing complications associated with sharp-tipped and blunt-tipped chest tubes are crucial for informed clinical decision-making and improving patient outcomes in thoracostomy procedures.

The trocar method reduces guiding in comparison to non-trocar methods, however there may be a higher chance of complications. Nonetheless, a newly reported method that guides the trocar while concurrently probing the pleural region with the fingers enhances safety & has shown comparatively low complication rates to non-trocar operation. There are now two primary kinds of chest tube devices available for thoracic drainage when utilizing a trocar technique: one with a blunt tip and the other with a sharp tip. It is unknown, therefore, how these various trocar points vary in terms as safe, successful, and effective lung tube insertion. Therefore, the purpose of this research was to look into the assumption that there is no difference in the success rate of setup, complications, and procedure time comparing blunted and sharp tip devices.

Objective

The purpose of this research was to find out anatomic variations of chest wall and complications of two different chest tubes with either a sharp or blunt tip for thoracotomy.

Methodology

This randomized single center study was conducted at the department of Emergency and trauma at Lady Reading teaching hospital from January 2020 to December 2021 after taking approval from the ethical board of the institute. For this study, 110 chest trauma patients who were admitted to the emergency department were employed.

All chest trauma patients who needed chest tube insertion were included in the study, with the exception of those with evident chest pathology, or any kind of infection (HIV, hepatitis C, or TB).

All chest trauma patients who didn't need chest tube insertion and those who had evident chest pathology along with chest trauma were excluded from the Study.

A total of 20 doctors took part in this study who implanted 100 tubes in the chest with every kit. In order to prevent

Table 1. Demographical data of the individuals

Characteristics	Mean ± Standered Deviation	Minimum	Maximum
Age in years	63.56 ±13.41	24	87
Gender			
Male Female	71 39		
Hight in cm	170.64 ± 9.23	155	197
Weight in kilogram	83.97 ± 22.85	40	151
Body mass index kg /m^2	29.09 ± 6.66	16.23	47.92

Figures are exhibited as Mean ± Standard Deviation correspondingly and absolute values

any bias or learning impact from observational instruction, doctors were prohibited from observing one another. Two kits were used for chest tube installation one was with a blunt tip that includes a thoracic trocar 24 F (eight millimeter × 332 millimeter) inside a drain and the 2nd was a chest tube with a sharp tip. It includes a chest trocar 24 F (eight millimeter × 280 mm) that is housed within a drain. The subsequent thoracostomy insertion method was used with both kits; it has just been published by Dural[7] as an innovative and secure method for closed tube thoracostomy. In the mid-axillary line, a two - incision is made into the subcutaneous tissue and skin directly superior to and parallel with the tail rib of the 4th or number five intercostal gap. The incision is felt and widened with the index finger. With the index finger, the chest tube is bluntly guided through the wall of the chest and extended over the trocar to the thoracic area. Each kit and study subject (chest trauma patient) was limited to one try per physician. For every emergency physician, there were 10 reported efforts to implant a chest tube. Every study subject (chest trauma patient) was examined by emergency doctor to inspect internal organ damage, and injury to the lungs, heart, the liver, great vessels or the pleura, or damages after the insertion of a chest tube. Gender, age, physique, mass index (BMI), and intercostal puncture location(anatomic variations) of the individuals

Table 2. Chest Tube Insertion Time for each Trial

Trials	Blunt Tip	Sharp Tip	P- value
Ist	71 (46)	71 (33)	0.99
2nd	62(28)	65 (35)	0.55
3rd	77 (65)	61 (36)	0.34
4th	58 (28)	51 (23)	0.24
5th	53 (26)	51 (26)	0.49
6th	64 (26)	60 (23)	0.58

Meantime, Standard Deviation until chest tube settlement in body for 20 doctors, by means of tube set with blunt or sharp tip were noted. . The duration of the procedure—that is, how long it takes from incising the skin to effective tube insertion—was the main outcome criterion that measured the efficacy of tube insertion.

Secondary outcome measures included the learning effect (change in procedure time between the first and fifth tries), the frequency of complications (harm to internal organs) and how often they occurred, the treating surgeon, and the particular try. Based upon what was deemed feasible and practicable within a given time period, this amount of samples was deemed appropriate

The mean and standard deviation (SD) of the demographic data of the study subjects were totaled for statistical purposes. We conducted a pair of t-tests for each of the trials separately and a multivariate analysis of variance (trial number, BMI, individual physician) for the key end-point, which is the overall duration of the operation. Fisher's exact test or the chi-square test were used to analyze the contingency table for the supplementary end-points (complications, failures, and the patient's classified BMI). SAS, Cary, NC, Version 9.1 was employed. When the two-sided significance threshold was less than five, the null hypothesis was rejected.

Results

Since each surgeon implanted both kinds of tubes in the same patient each day, the demographics of the two groups are identical (table 1). Due to a material fault, 10 of the kit 1 experiments had to be canceled and were not included in the study. All other 10 thoracic tube placing results were included into the study.

The average duration for inserting chest tubes with blunt tips was 65 s (± 26), whereas the same procedure with sharp tips took 61 seconds on average (± 23) ($p = 0.41$). Furthermore, there was no discernible variation in mean time across kits when comparing each trial from the first to the final fifth. However, from the first to the fifth try, the mean time in insertion reduced similarly for both kits (19 ± 40 s (p value = 0.05) for kit one and twenty ± 20 s ($p = 0.003$) with kit 2) (Table 2).

Chest tubes were correctly inserted into the pleural cavity keeping anatomical landmarks in mind in 94 out of 110 (85%) chest trauma patients using equipment 1, as well as 90 out of 110 (81 percent) using kit 2 (table 3). There was no discernible difference in injuries or misplacement between the right and left sides.

When using kit 2, which has a sharp-tipped trocar, injuries and misplacements were more common ($p = 0.04$). Due to improper application by the operators, internal organ damage occurred when a tube was put into the seventh or eighth intercostal space. Due to the trocar causing damage to the thoracic drain, both experiments utilizing kit 1 needed to be stopped since the chest tube could not be inserted.

There were no stomach problems, lung lacerations, or heart issues in any group. The usage of kit 2 was linked to organ damage, according to the contingency table calculation ($p = 0.043$). Throughout all trials, the same pair of operators misplaced their chest tubes using kit 2, leading to operator misplacement ($p = 0.001$) (equipment1: $p = 0.62$). On the other hand, neither the number of previous efforts nor the rate of misplacement were associated with the BMI of the patients (kit 1: $p = 0.62$; kit 2: $p = 0.28$). It seemed that mistakes may happen at any stage throughout a certain surgeon's training.

The results of the these factor analysis of variance (BMI,anatomic variations of chest, performing surgeon, and number of trials) indicated that the patient's BMI (kit1: $p<0.002$, kit2: $p<0.03$) and the performing surgeon ($p < 0.001$ in both groups) had an impact on the insertion time.

Table 3. Summary of correct position correspondingly misplacements/damages

Characteristics	Blunt Tip (n = 110)	Sharp tip (n = 110)
Interpleural space	94	90
Subphrenical	4	5
Extra thoracic misplacement	4	6
Injury of liver	3	3
Injury of heart	1	5
Aborted	4	1

Discussion

To the best of our understanding, this is the first controlled, randomised research conducted in Pakistan that has been published to assess the effectiveness, training impact, as well as the security of tube thoracostomy by comparing kits that have blunt or sharp ends on a sample of chest trauma patients. Sharp-tipped trocars were about quicker during chest thoracostomy than blunt-tipped trocars; nevertheless, the distinction appears to be clinically unimportant. Obese patients with anatomic variations of chest wall had longer implantation times; this was operator-related and may be lowered with training.Both kits resulted in high rates of complications, with sharp-tipped trocars causing a noticeably higher frequency of organ damage than blunt-tipped trocars.

A study in 2009 that emphasized the importance of site selection, proper training, and equipment issues in ensuring a safe and successful chest drain placement procedure.[8] Techniques for pleural drainage are not simple and may result in potentially fatal injuries.[5] Sharp-tipped chest trocar procedures are still frequently performed, despite continuous discussion over their safety. In contrast to a surgical method, a recent research reveals greater success rates without a change in the complication rate when using a sharp-tipped trocar in human patients.[7] The standard trocar procedure was altered for this research like that the pleural trocar and drain were advanced after the pleural space was cleaned and adhesion rates were divided roughly with a finger. Put differently, the purpose of the trocar was to guide drainage into the pleural area rather than to dissect. This method and the one that is outlined in this paper are similar. According to reports, the rates of misplacement or inadequate drainage for these skilled cardiothoracic surgeons were 7.8% when using the trocar approach and 13.3% when using the surgical procedure.[7] The kit employed by the authors is comparable to kit 2, which was reported in this research and produced an overall significant issue rate in our training regimen. However, given the relative inexperience of the doctors who took part in our investigation in comparison to the skilled surgeons who took part in Dural's trial, it couldn't have come as a surprise that our incident rate was greater than that reported by previous study. Nonetheless, the non-trocar approach is still recommended as a safer way to implant a chest tube in the Early Management of Severe Trauma training and current recommendations. Our study's comparably high rates of complications, however, contradict the conclusions of previous research. that the trocar procedure is as safe and do not suggest changing that policy. We assessed the usage of medium diameter tubes (24 F), even though smaller tubes (< 14 F) are becoming more common.[9] This is because these tubes are advised for the management of hematothorax, mechanically ventilated barotrauma, and some pneumothorax patients. Surprisingly, our study's sample size of 110 trials per group did not reveal any meaningful variation in thoracostomy insertion times across kits. Without first conducting a pilot research to determine the study's power, we chose a random sample size. It is possible that the likelihood of rejecting the null hypothesis would have risen with a larger sample size. Nonetheless, we think our data adequately shows that the insertion efficiency of the kits does not vary in a way that is clinically significant. It's interesting to note that there was a 20-second drop in insertion time from the first to the fifth try, suggesting a training effect. The first effort at insertion took an average of 86 seconds, whereas the fourth try took just 34 seconds. One possible explanation for this significant training impact is because during a single session, students executed four processes consec-utively. In contrast, every thoracostomy in our context was done once a month. Thus, despite a little variation in mean values among trials, our findings support an instructional impact and highlight the importance of this training strategy.[10] Our research showed that insertion time was longer in patients with greater BMIs, indicating that fat is a barrier to chest tube implantation. There was no correlation between higher BMI and tube malposition, which is consistent with research done on very sick individuals. The association between BMI & chest tube malposition, however, has only been reported as a secondary outcome in both investigations and was not strong enough to provide a definitive conclusion. Despite, many drawbacks, we were able to show that the use of sharp-tipped trocars greatly increases the likelihood of misplacement or organ damage. Because the diaphragm may elevate to the level of the 4th intercostal space during complete expiration, we instructed trainees to place their chest tubing via the forth or 5 intercostal gap in the mid-axillary line.[11] But as previously mentioned, the primary reason for misplac-ements and organ damage was the insertion of chest tubes via the seventh and 8 intercostal gap. This supports the finding of Lamont et al. that challenges in recognizing intercostal structures obstruct proper implantation.[8] It's interesting to note that, despite the fact that every participant received the same amount of instruction, loss occurred by the operator rather than the quantity of earlier instruction sessions. This indicates that the length of training could require to be adjusted based on the unique learning rate of each pupil. Additionally, it highlights general suggestions that the occurrence of chest tube problems is mostly influenced by sufficient training.[12-15] Even with at least two years of training, emergency doctors' lack of expertise installing chest drains may surprise some. There are two departments for emergency treatment at our research site, at the General Hospital of Vienna (AKH-Wien, Vienna, Austria): one for medical situations and another for trauma emergencies. We only hired doctors from the medical department because we thought that doctors with less surgical knowledge would be better able to illustrate the impact of training.

Conclusion

In summary, this research shows that the insertion of a chest drain using trocars at proper anatomical landmarks is linked to an operator-related complication risk. The use of trocars with sharp tips raises the risk of problems without expediting the process. Trocars with sharp tips should thus not be utilized in standard clinical settings. Advanced training may shorten the insertion time, although this depends on the operator and the patient's BMI.

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