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Case Series

Indications and Outcome of Patients Managed with Tube Thoracostomy at AIC Litein Hospital: A Prospective Case Series

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Abstract

Background

Tube thoracostomy (TT) allows for the drainage of air or fluid from the pleural space. We aimed to describe the indications, management, and outcomes of patients managed with TT at AIC Litein Hospital in Southwestern Kenya.

Methods

This prospective study was undertaken between November 2020 and August 2022. All consecutive patients with TT were included. Data were collected on demographics, presentation, indications for TT, management, and outcome. Ethical approval was obtained from the Institutional Ethics and Research Committee.

Results

The study included 39 (33 male, 6 female) patients who had a mean age of 35 years (range 3-75) and 45 TTs placed for a median duration of 6 days (1-26). Hemopneumothorax (n=19), empyema thoracis (n=8), and pneumothorax (n=7) were the most common indications for TT. Trauma was noted in 28 cases presenting as assault (n=17), road traffic collision (n=8), fall (n=1), and barotrauma (n=1). Preadmission traumatic injuries led to four deaths, while fourteen (35.9%) patients developed TT-related complications, with three requiring TT replacement.

Conclusions

In this series, TT was mainly indicated for hemopneumothorax, empyema thoracis, and pneumothorax.

Introduction

Tube thoracostomy (TT) involves the placement of a drainage tube within the pleural cavity to remove accumulated air, fluid, blood, or pus.[1-3] They are commonly inserted in the "Triangle of Safety" at the fourth or fifth intercostal space in the anterior or mid-axillary line.[1,3,4] While the indications for TT might be similar for various health facilities, the distribution pattern of these indications may differ depending on the facility's size and catchment area, local trauma patterns, and management protocols.[2,5]

There is a paucity of published literature from Africa regarding the use of TT, especially in smaller health facilities.[2,5-8] The purpose of this study was to fill this identified gap in knowledge by reviewing our institution's experience with TT. Specifically, this prospective observational study aimed to describe the distribution of indications and pattern of complications of patients managed with TT at a single 220-bed capacity faith-based institution in Kericho County, Southwestern Kenya.

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Methods

This prospective case series was undertaken at AIC Litein Hospital from 1st November 2020 to 31st August 2022. Cases were defined as any consecutive patient managed with TT and consented to be included in the study. Those who declined to have TT, were referred, or died before TT were excluded. Informed consent was obtained by one or more of the general surgery residents prior to or after TT depending on the urgency of the procedure and the patient's overall condition. Patients were managed by general surgeons with experience, but not specialization in thoracic surgery, and complex thoracic cases are typically referred to a nearby tertiary referral center. This observational study did not influence the management of the patients; thus, no patient received any additional care or benefit for accepting to be included, nor did any have withheld or lower quality care for refusing to participate in the study.

Patients were managed based on their overall diagnosis, the attending surgeon's discretion, and a standardized tube thoracostomy protocol (appendix 1). Due to varied levels of clinicians in training (medical officer interns, junior and senior residents), TTs were preferentially placed within the triangle of safety at the fourth or fifth intercostal space utilizing the blunt dissection technique and supervised or performed by the attending surgeon. Chest tubes were connected to a three-compartment integrated disposable chest drainage unit. Due to resource limitations, these disposable units were reused after disinfection and disposed of when they were noted to malfunction or be broken. Suction was used only in patients with significant air leaks or poor lung expansion on chest radiography.

Data from the patients were collected using a prestructured questionnaire that included patients' demographics, clinical presentation, indications for TT, management, and outcome at discharge and at least four weeks post-TT. The outcome was defined as the resolution of the indication for TT, the presence or absence of complications related to TT placement, or inpatient mortality. Complications were categorized into five separate categories (insertional, positional, infective/immunologic, removal, and equipment-related) based on a validated classification methodology by Aho et al.[9] Follow-up was done through perusal of the patient's electronic medical records taken during clinic attendance and telephone review for those noted not to have attended clinic or whose last attendance date was less than four weeks post-TT.

Data were abstracted into a Microsoft Excel spreadsheet, and results were summarized using descriptive statistics. We compared the duration of TT for patients with traumatic and non-traumatic indications using Students t-test. We compared the percentage of complications for each TT placed by residents and consultants using Chi-square analysis. Ethical approval was obtained before the initiation of the study by the Institutional Ethics and Research Committee (IREC) (IREC/2020/4). This case series has been reported per the PROCESS guidelines.[10]

Results

Demographics

During the study period, 43 patients were noted to require TT; however, two declined to consent to be included in the study, one patient with empyema thoracis was referred prior to TT, and one patient with a large malignant pleural effusion died prior to TT placement. Thus 39 patients were analyzed, who comprised 33 males and 6 females with a median age of 35 years (range 3-75). It was noted that 16 (41.02%) had health insurance coverage. Eight (20.51%) cases were referred from a peripheral facility.

The most common symptoms noted before TT placement were chest pains, difficulty in breathing, and cough that were present for a median period of 6 hours (range, 1 hour to 60 days) and a mean duration of 4 days (95% CI 0.6-7.7). Trauma was noted in 28 patients secondary to assault (n=16 penetrating, n=1 blunt), road traffic collision (n=8), fall from a height (n=1), and ventilator-associated barotrauma (n=1). In addition, these patients had other associated injuries, most commonly to the ribs, diaphragm, or spleen (table 1).

Management

A total of 45 TTs were placed for a median duration of 6 days (range 1-26) and a mean duration of 7.62 +/- 6.43 days. The majority (n=41, 91%) of TT were inserted in theatre. Three were placed in the general surgical ward and one in the high dependency unit (HDU) for a patient with iatrogenic pneumothorax (barotrauma) on mechanical ventilation. Suction was selectively used in patients (empyema thoracis n=3, traumatic pneumothorax n=2) with significant air leak and poor lung expansion on chest radiography. Ultrasonography was not available during the study period. In patients with a history of trauma (n=28), TTs were placed for hemopneumothorax (n=19, 48.7%), pneumothorax (n=6, 15.4%), and hemothorax (n=3, 7.7%). In those who did not have trauma (n=11), TTs were placed for empyema thoracis (n=8, 20.5%), large pleural effusion (n=2, 5.1%), and pneumothorax (n=1, 2.5%). Most TTs were placed by the attending surgeon (n=34), while residents placed 11 TTs under supervision. The initial TT was unilateral in 36 patients and bilateral in three patients. In addition, three TTs required replacement due to blockage (n=2, all placed by the attending surgeon) or subcutaneous placement (n=1, placed by the resident). Three patients with empyema thoracis were noted to have persistent air leak with poor lung expansion that did not improve on suction. These patients were subsequently referred to a tertiary facility for thoracotomy (table 2). A malfunction of the integrated chest drainage unit was noted in four patients, and there was

Table 1. Associated injuries in patients with trauma (n=28)

Injuries	N (%)
Rib fractures	8 (28.6%)
Diaphragmatic injuries	8 (28.6%)
Splenic injuries	8 (28.6%)
Hollow viscus injury	8 (28.6%)
Extremity fracture	4 (14.3%)
Liver injury	2 (7.1%)
Pelvic fracture	1 (3.6%)
Sternal fracture	1 (3.6%)
Renal injury	1 (3.6%)
Closed head injury	1 (3.6%)
Tracheoesophageal injury	1 (3.6%)

Table 2. Complications related to TT placement

Complication category	Events	Resident placed TT (n=11)	Consultant placed TT (n=34)	All TT
Insertional	Injury to structure upon placement	0	0	0
Positional	Kinked or obstructed	0	2	2
	Subcutaneous placement	1	0	1
Removal	Post-removal pneumothorax requiring procedural intervention	0	0	0
	Spontaneous dislodgement	0	0	0
Infective	Site infection (SSI)	0	2	2
	Empyema	0	0	0
Equipment	Malfunction of equipment	2	2	4
	Improper equipment set-up	2	0	2
Total		5	6	11

an improper connection of the thoracostomy tube to the drainage unit (improper connection) in two cases. The system malfunction were noted within 12 to 24 hours of placement of the TT. The malfunction involved a leak in the water seal chamber in two patients, cracked connector in one patient, and one drainage system had two collection chambers that appeared separate, but one had to be sealed for proper function (as both were connected to the water seal and suction components). All these were noted early and corrected with no long-term or severe adverse effects to the patients.

Outcome

Patients were admitted for a median duration of 7 days (range, 1-32) and a mean duration of 8.69 +/- 5.65 days, with the end of hospitalization stratified as discharge (n=28, 71.8%), referral (n=7, 17.9%), or mortality (n=4, 10.2%). Referrals were for thoracotomy patients with a persistent air leak and poor lung expansion post-TT for empyema thoracis (n=3), isolation in a patient with COVID-19 post-TT (n=1), dialysis for worsening renal failure in a patient with blunt thoracoabdominal trauma (n=1), vascular injury in a patient with concomitant knee dislocation (n=1) and for bronchoscopy in a patient with tracheobronchial injury (n=1). Mortalities occurred within 1-3 days post-surgery in patients with blunt (n=2) or penetrating (n=2) thoracoabdominal trauma that led to irreversible hemorrhagic shock (n=2) or multisystem organ failure (n=2). Excluding patients who died, the duration of TT was shorter for patients who had trauma compared to those who did not (mean 5.71+/- 3.13 days, n=24 versus mean 13.82 +/-8.39 days, n=11, p 0.0002). Four patients scheduled for follow-up at the surgical clinic (n=28) did not show up, while five attended clinics less than four weeks post-TT. Four of these nine patients were successfully reached via phone and were doing well. The median number of clinic visits was 2 (range 1-6), while the median duration of follow-up post-TT was four weeks (range 2-23). Surgical site infection was noted in two patients during their clinic reviews within four weeks of discharge (Table 2). Overall, 14 morbidities were observed, with six occurring in 11 TTs placed by residents

and eight occurring in 34 TTs placed by the general surgery consultants (p=0.053).

Discussion

This study aimed to describe the distribution of indications and pattern of complications of patients managed with TT at a single health facility in Kenya. The findings suggest that TT is predominantly used for trauma-related indications, and the most common complication is equipment malfunction. We included 39 patients with a median age of 35 years, who had 45 TTs placed for a median duration of 6 days. A history of trauma was noted in most cases (n=28, 71.8%), with the predominant type being penetrating trauma from assault (n=16, 41%). The most common indications for TT were hemopneumothorax (48.7% of all cases and 67.8% of those with trauma), empyema thoracis (20.5% of all cases and 72.7% of those without trauma), and pneumothorax (17.9% of all cases and 21.4% of patients with a history of trauma). Four patients died due to pre-tube thoracostomy injuries, 14 (35.9%) morbidities were noted up to one-month post-discharge, while 5 (14.2%) patients were lost to follow-up.

Significant variation was noted regarding the indications for TT from various studies within Africa. In a Nigerian study reviewing the use of TT in trauma patients at three major teaching hospitals, Makama et al. noted that the most common indications for TT were hemopneumothorax (43%), pneumothorax (30%), and hemothorax (27%). Seventy-five percent of the cases had blunt trauma.[6] Likewise, in a study conducted at a high-volume trauma center in South Africa, Kong et al. noted that 75% of cases had penetrating trauma, and the TT indications were pneumothorax (38%), hemopneumothorax (30%) and hemothorax (30%).[7] On the other hand, Edaigbini et al., in their review conducted at a facility in Nigeria that involved 26% of patients with trauma, noted malignant pleural effusion (27.5%), parapneumonic effusion (12%) and empyema thoracis (7%) as the most common indications for TT.[2] Mefire et al., in their study from a regional facility in Cameroon, noted that 91% of the cases where TT was inserted had no history of trauma and non-purulent pleural effusion (69%) and empyema thoracis (12.69%) as the most common indications for TT.[5] Makanga et al., in their review from Kenya, noted pleural effusion (70%), pneumothorax (14%), and empyema thoracis (5%) as the most common TT indication. Patients with trauma comprised only 15% of cases.[8] The findings in this study of the predominance of hemothorax, pneumothorax, or hemopneumothorax in patients with trauma, empyema thoracis, and pleural effusion in patients without a history of trauma as indications for TT is in keeping with prior studies, but highlights the importance of understanding local and regional indications for TT.

The reported mean duration of TT from various African studies is 5-13 days.[2,4-6,8] Nwofor et al. correctly pointed to the difference in the resolution time of various pleural pathologies that impact the duration of TT.[4] Thus, the duration of TT for post-traumatic pneumothorax or hemothorax is expected to be shorter than for empyema thoracis. Indeed, patients with post-traumatic indications for TT in this study had a shorter mean duration of TT compared to those who had a non-traumatic indication (5.71 days vs. 13.82 days, p=0.0002)

This study utilized the classification methodology developed by Aho et al.[9] This enabled us to have a uniform complication reporting system and evaluate the impact of equipment malfunction as the surgical department reused the single-use disposable commercial chest drainage unit to reduce the overall cost to the patients. We have implemented a standardized check of the system with uniform testing prior to each use to limit equipment malfunction. It was noted that equipment malfunction contributed to 28% of the overall complication, but this may have been underreported. Residents were noted to have a higher rate of complications than the attending surgeons (54.5% vs. 23.5%), with subcutaneous placement and improper equipment set-up being the most preventable complications. As a teaching hospital, it is important that trainees receive proper supervision and autonomy to achieve adequate case volumes to become competent surgeons.[11,12] Improved complication recognition during critical time points and improved education on the performance of TT as well as proper equipment set-up will be beneficial.[13] We recommend future emphasis on training residents to ensure they are trained and certified as competent in the set-up of the equipment in a dry lab simulation before using the equipment The overall complication rate in this study (35.9%) is much higher than reported by Edaigbini et al., at 17%, and by Mefire et al., at 19% but lower than reported by Nwofor et al., at 45%.[2,4,5] The higher rate may be attributed to the addition of equipment malfunction and set up to complications that were not present in the other reviews.

This series had a mortality rate of 14.2% in patients with thoracic trauma (n=28) and was attributed to trauma-related injuries and not TT itself. Similarly, Dayananda et al. note that thoracic trauma can lead to an overall mortality rate of up to 20% and higher with penetrating thoracic stab wounds.[14]

Limitations

Our findings are limited by the relatively small sample size, a potential selection bias that may not represent the broader population of the region, and challenges in patient follow-up. In addition, the equipment malfunction may have been underreported. A multi-institutional study involving various hospitals from different regions in Kenya may better reflect the indications and outcomes.

Conclusions

In this series, most patients had blunt or penetrating chest trauma, with hemopneumothorax being the most common indication for TT. Reuse of chest drainage systems contributed significantly to equipment failure, but the potential consequences on patient outcomes should be further explored and compared to the costs of not reusing drainage systems.

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References

1. Kantar Y, Durukan P, Hasdıraz L, et al. An Analysis of Patients who Underwent Tube Thoracostomy in the Emergency Department: A Single Center Study. *Turk Thorac J*. 2019;20(1):25-29. doi:10.5152/TurkThoracJ.2018.18056

2. Edaigbini SA, Delia IZ, Aminu MB, Orogade AA, Anumenechi N, Aliyu ID. Indications and complications of tube thoracostomy with improvised underwater seal bottles. *Niger J Surg*. 2014;20:79-82. doi:10.4103/1117-6806.137305

3. Kuhajda I, Zarogoulidis K, Kougioumtzi I, et al. Tube thoracostomy; chest tube implantation and follow up. *J Thorac Dis*. 2014;6(Suppl 4):S470-S479. doi:10.3978/j.issn.2072-1439.2014.09.23

4. Nwofor AM, Ekwunife CN. Tube thoracostomy in the management of pleural fluid collections. *Niger J Clin Pract*. 2006;9(1):77-80.

5. Mefire AC, Fokou M, Dika LD. Indications and morbidity of tube thoracostomy performed for traumatic and non-traumatic free pleural effusions in a low-income setting. *Pan Afr Med J*. 2014;18:256. doi:10.11604/pamj.2014.18.256.3963

6. Makama JG, Yusuf N, Edaigbini S, Ekpe EE. Thoracostomy tube in trauma surgery: Does position really matter? *Arch Int Surg*. 2018;8:166-170. doi:10.4103/ais.ais_17_19

7. Kong VY, Oosthuizen GV, Clarke DL. Selective conservatism in the management of thoracic trauma remains appropriate in the 21st century. *Ann R Coll Surg Engl*. 2015;97(3):224-228. doi:10.1308/003588414X14055925061559

8. Makanga WO, Nyagau AN, Njihia BN. The Heimlich Valve for Pleural Cavity Drainage. *Ann Afr Surg*. 2016;13(2):45-48. doi:10.4314/aas.v13i2.2

9. Aho JM, Ruparel RK, Rowse PG, Brahmbhatt RD, Jenkins D, Rivera M. Tube Thoracostomy: A Structured Review of Case Reports and a Standardized Format for Reporting Complications. *World J Surg*. 2015;39(11):2691-2706. doi:10.1007/s00268-015-3158-6

10. Agha RA, Sohrabi C, Mathew G, et al. The PROCESS 2020 Guideline: Updating Consensus Preferred Reporting Of CasE Series in Surgery (PROCESS) Guidelines. *International Journal of Surgery*.

11. Parker RK, Topazian HM, Parker AS, et al. Operative case volume minimums necessary for surgical training throughout rural Africa. *World Journal of Surgery*. 2020;44(Oct):3245-3258. doi:10.1007/s00268-020-05609-9

12. Parker RK, Mwachiro M, Sylvester K, et al. Achieving progressive operative autonomy at a teaching hospital in Kenya. *Global Surgical Education-Journal of the Association for Surgical Education*. 2023;2(1):19. doi:10.1007/s44186-022-00095-0

13. Hernandez MC, El Khatib M, Prokop L, Zielinski MD, Aho JM. Complications in tube thoracostomy: Systematic review and meta-analysis. *J Trauma Acute Care Surg*. 2018;85(2):410-416. doi:10.1097/TA.0000000000001840

14. Dayananda K, Kong VY, Bruce JL, et al. A selective non-operative approach to thoracic stab wounds is safe and cost effective - a South African experience. *Ann R Coll Surg Engl*. 2018;100(8):1-9. doi:10.1308/rcsann.2018.0118