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Early Chest Drain Management in Trauma

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Abstract

Background: Tube thoracostomy is an essential skill, and in thoracic trauma can be lifesaving. Yet a complication rate of up to 30% has been widely reported in the literature. Our primary aim was to look at the complication rate associated with chest drain insertion in trauma patients at our institution. Our secondary objectives included indications for tube thoracostomy and the differences in complications across specialties.

Methods: Over a 24-month period we performed a retrospective analysis of all trauma patients admitted to Middlemore Hospital, a tertiary urban hospital in New Zealand. The study group included all patients who potentially required tube thoracostomy for trauma. Complications were deemed positional, infective or insertional. Indication for chest drain was identified by cross referencing a patient's radiological findings with clinical presentation.

Results: Of 127 patients in the study group, 59 chest drains were inserted in 56 patients. The complication rate was 22%; 12 were positional, 1 was infective, and there were no insertional complications. General Surgical Registrars inserted approximately one-third of the chest drains, and accounted for 62% of the complications. Patients with large PTX on initial CXR findings had much lower complication rates (4%) than those without (37%).

Discussion: Almost one in four patients that received a chest drain had a complication, and General Surgery accounted for the majority of these. When indications for chest drains are clinical, the complication rate is higher. A prospective study aiming to reduce complications, by implementing a checklist similar to the WHO surgical safety checklist is planned.

Keywords: Tube thoracostomy; Chest drain trauma; Pneumothorax; Occult Pneumothorax

Introduction

Tube thoracostomy (TT) is one of the essential skills required in the Emergency Department, and in chest trauma patients can often be life-saving. Due to the invasive nature of the procedure complications have the potential to be catastrophic. Good technique and knowledge is therefore vital. It is essential that the procedure is done safely, effectively, and for the right indications. Guidelines for TT in trauma have been based around the teachings from the Advanced Trauma Life Support (ATLS) course since its inception in 1978. More recently, trauma centers around the world have looked to standardize the approach to TT in trauma in an attempt to stem the high rate of complications [1,2].

Although most doctors will advocate having some experience with chest drains, trauma TT has been a mainstay of Emergency Medicine and Trauma Surgery for the better part of a century and is considered an essential skill in these specialties. Furthermore in the surgical domain it is a pre-requisite for all trainees to undergo the ATLS course, again underlying the importance placed on trauma management. The primary aim of this study was to assess the complication rate for TT in trauma patients at Middlemore Hospital, a tertiary urban hospital in Auckland, NZ. Our secondary aims included looking at the indications for TT and comparing complication rates across specialties.

Methods

The University of Auckland Human Participants Committee approved this retrospective study prior to commencement, and ethics approval was obtained. The overall study population consisted of all adult trauma patients (≥ 16 years old) who presented to Middlemore Hospital with a diagnosis potentially requiring TT between December 1st 2012 to November 30th 2014. These were pneumothorax (PTX), haemothorax (HTX), haemo-pneumothorax (HPTX), and tension pneumothorax (TPTX). Patients were identified by the audit department's computerized retrieval system by searching for the above conditions. Electronic patient records (Concerto, trauma database 'Collector') were then cross referenced with the physical patient notes for data collection. We excluded

patients who already had a chest drain in situ on arrival, and those whose presentation was not the result of trauma (ie spontaneous pneumothorax) (Figure 1).

The primary data collected was diagnosis at admission, whether a TT was performed, and any associated complications. Complications were categorised as positional (inserting tube too far/not far enough requiring repositioning, not bubbling/swinging requiring replacement, extra-thoracic tube placement), insertional (neurovascular injuries, intra-parenchymal insertion) or infective (wound infection, empyema). Indication for TT was investigated by cross-referencing CXR and CT reports with initial presentation (i.e. respiratory distress). Other data collected included patient demographics, injury severity scores (ISS), timing and use of radiology, specialty and seniority of the doctor inserting chest drain, and mechanism of injury.

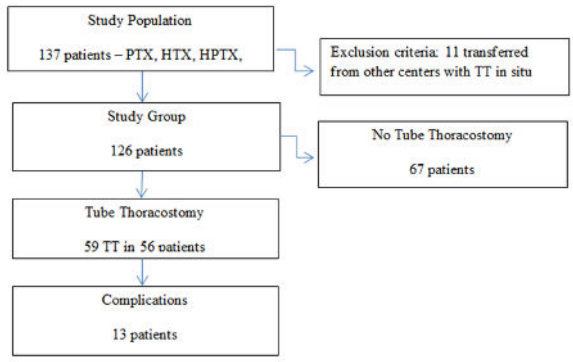

Figure 1: Study Design.

Management of trauma in our institution follows ATLS guidelines. TT was at the discretion of the attending team of doctors (General Surgery, and Emergency Department) and was based on clinical and radiological findings. CT scans are not mandatory in all trauma patients at Middlemore, and were again at the discretion of the attending team. Currently there is no protocol for TT at Middlemore Hospital, although a guideline is available. Drain size, method of securing, and insertion site were all decided by the operator. All drains were inserted using the blunt dissection or Seldinger techniques and connected to a standard under-water-seal drainage system (single or triple chamber), and a CXR was obtained to evaluate position.

Data was analyzed using online statistical software SISA. All analysis was done using Fishers Exact Test, with a significance level set at 0.05.

Results

There were 137 adult trauma patients admitted over this period with a diagnosis of PTX, HTX, HPTX, or TPTX. Eleven were excluded for having drains in situ at presentation, leaving 126 patients (94 Male, 32 Female) to be included in the study group.

There were fifty-nine chest drains placed in 56 patients (Fig. 1). There were thirteen complications (22%). Of these, 12 were positional requiring either drains to be repositioned or replaced, and there was one infective complication where a patient developed an empyema. There were no insertional complications.

The majority of patients presented as a result of blunt trauma (81.7%). Compared with penetrating trauma, they were less likely to require a chest drain (35.9% *vs* 78.3% FET, p=0.0003) and had a much higher TT complication rate (27.0% *vs* 16.7%, p=0.5).

The median ISS for the study was 14 (Table 1). Patients who developed a complication had a median ISS of 8 points greater than those without complications.

Table 1: Tube Thoracostomy by Operator.

	Number of patients		
	TT	**Complications**	**% of complications**
Emergency - Physician	12	0	-
- Registrar	26	4	30.8
- House Surgeon	1	0	-
General Surgery - Surgeon	1	0	-
- Registrar	17	8	61.5
- House Surgeon	1	0	-
Intensive Care - Registrar	1	1	7.7

TT operator was divided by specialty and seniority (Table 2). General Surgery were significantly more likely to have a complication compared with their Emergency Department colleagues (42.1% *vs* 10.3%, p<0.02).

Surgical registrars accounted for eight (61.5%) of the complications whilst performing seventeen (30.4%) of the TT's. ED registrars inserted 26 (58.6%) chest drains, with four complications noted. Intensive care accounted for the final complication with a single tube thoracostomy performed (in

ICU). There was no association between TT complications and age, sex, ethnicity, technique, or drain size.

Indication for TT was a combination of radiological and clinical findings. Of the fifty-nine TT's performed 25 had a PTX>2 cm on initial CXR (with 1 complication) whilst nineteen had a PTX<2 cm (7 complications), with the latter nine times more likely to encounter a complication (4.0% *vs* 36.8%, p<0.02).

There were 12 TT's based on clinical grounds alone (i.e. prior to any imaging); this group accounted for five of the complications (38.5% of total complications). Three TT's were based on evidence of a haemothorax on CXR, and there were no complications. The 67 patients without TT included six with significantly large radiological findings (>2 cm on CXR); drains were not inserted as they were asymptomatic.

Table 2: Patient characteristics by group.

	Overall	*Complications	*No complications	No TT
Total patients	126	13	47	66
Median age (yrs)	45	46	48	45
Sex (male)	94	11	28	55
Median ISS	14	18	10	13
Blunt trauma	103	10	27	66
Penetrating trauma	23	3	15	5
*Patients with chest drains				

There were 47 occult presentations picked up on CT alone (i.e. not seen on CXR) with only four patients requiring TT; three were symptomatic, whilst one was asymptomatic. Of the remaining group of 43 patients who were observed, no patient required a chest drain to be inserted later in their admission.

Discussion

In our study, there was an overall complication rate of 22% for tube thoracostomy in trauma. This was in line with several similar studies done previously [3-5]. This rate would seem remarkably high. Although most complications were positional and remedied quickly, there was one major complication where a patient developed an empyema that led to a very prolonged admission, and there were multiple occasions where drains had to be replaced entirely. There were no insertional complications (again similar to other studies), and this has been linked to the move away from traditional trocar insertions of chest drains [6].

Of note General Surgery had a vastly disproportionate rate of complications compared with their Emergency Department colleagues. Surgical registrars in performed around one third of all tube thoracostomies, yet accounted for 61.5% of the complications. Compared with their ED counterparts they were three times more likely to encounter a problem (47.1% *vs* 15.4%, p<0.04). Our results are in contrast to Ball et al. [7] who performed a similar study on 61 patients of similar demographics – General Surgery accounted for 7% of all complications, c.f. 40% for Emergency Medicine. It is difficult to say what the cause for these differences is (e.g. level of training, ATLS) in our group without knowing further variables, with Ball also noting no association between complications and seniority of operator or ATLS training, and further study could be done including these data. In our study 13 drains were inserted by specialists with no complications, compared with 13 complications in 46 drains for junior staff (registrars and house surgeons). This would suggest an element of experience affecting outcome, however due to the small numbers in specialist TT's performed this did not reach statistical significance.

Assessing indications for TT showed that when there are significant radiological findings on initial CXR (symptomatic or asymptomatic), then the complications rate is very low (4%). The rate of complications increased dramatically (36.8%) when radiological evidence, in particular the size of PTX on CXR, was small. The reference value of greater than 2 cm to define a large pneumothorax was taken from the British Thoracic Society Pleural Disease Guidelines 2010 [8]. This would seem to be the grey area where interpretation of clinical findings plays a larger role in deciding whether a patient needs a chest drain, and relies more heavily on the clinicians experience and decision making. It may suggest that putting in chest drains for smaller traumatic PTX in the Emergency Department could be delayed and a period of observation could play a role in management instead. The role of observation in primary spontaneous PTX, secondary spontaneous PTX, and occult pneumothorax has been reviewed recently [9]. However we could find no literature for expectant management of traumatic PTX. This could be a topic for further study, however we acknowledge that this may be difficult in this patient group given the nature of their presentations and risk of deterioration without intervention.

More than a third of the complications were attributed to TT that was performed on clinical grounds alone. It is difficult to draw a line on when a CXR should be performed prior to TT (unstable *vs* stable) however there were no tension

pneumothoraces in this group. We can only speculate as to why complications were much higher in this group as the documentation available could not shed light on the relative stability of the patients, however the presence of a CXR prior to chest drain insertion for the most part should not alter operator technique. Compared with patients who received prior imaging there was no statistical significance in complications, however the numbers involved were relatively small. We feel that imaging should always be considered a first line priority before chest drain insertion (unless an unstable patient), as this could prevent unnecessary TT and the potential complications that could ensue.

Occult diagnoses picked up on CT alone accounted for 37% of all cases; only four required drains (10%) within the first 24 hours, and no patient required TT at a later date. This would suggest that most occult cases can be successfully managed conservatively with a period of observation. This is in line with Mahmood et al. [10] who found that in a study of 73 haemopneumothoraces diagnosed occultly on CT, chest drains were avoided in 83% without further morbidity.

Our data supports absolute indication for tube thoracostomy in all patients with >2 cm PTX on CXR and symptomatic. Relative indications are <2 cm PTX and symptomatic, and >2 cm PTX and asymptomatic; decision needs to be made by clinicians involved, and when TT not performed patient requires close observation for deterioration. All occult pneumothoraces should be observed initially.

There were limitations in our retrospective study. Firstly our study group size was very small, and another study could be done in the future with larger numbers to support our findings. Also we only looked at early TT insertion in trauma, whereas complications can often occur later in admission e.g. during or after removal of TT. Additionally the retrospective design of the study has many inherent problems. Our data was collected by analyzing medical records, which intrinsically lends itself to being affected by systematic bias. The validity of data relating to such things as procedure and operator competency can therefore not be fully guaranteed. The nature of the study also lends itself to significant selection bias.

The main finding in our study was to find that the complication rate for TT in trauma is high, but in line with other previously reported studies from similar institutions. Recently, trauma centers have looked at reducing this rate by introducing standardized approaches to TT in trauma. Anderson et al. implemented a quality control checklist for TT, similar to the WHO surgical safety checklist, into their trauma service at an Adult Level 1 Trauma Centre in Melbourne, Australia [1]. They were able to show a reduction in empyema rates by almost 2/3 (0.57% c.f. 1.44%) over a 2 year period, although did not look specifically at other complications associated with TT. Martin et al. developed an algorithm for TT management in all trauma patients that presented to a Level 1 Trauma institution in Michigan, USA [2] then retrospectively reviewed all patients for complications over the 4.5 year period. Their overall complication rate was 4.8%, although the pre-algorithm rate was not known. Both of these studies support a more standardized approach to TT in trauma, and further prospective studies could be done looking at the effect of checklists and algorithms on complication rates for TT to support this evidence.

Conclusion

The initial management of chest drains in trauma has not changed much since the adoption of ATLS guidelines more than 30 years ago, and complication rates remain remarkably high. Similar to other areas of medicine where protocols have been introduced, such as the WHO Surgical Safety Checklist, a more standardized approach to tube thoracostomy in trauma could be the answer, and further research in this area is needed.

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