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IS A CHEST TUBE NECESSARY PRIOR TO AIR MEDICAL TRANSPORT OF PATIENTS WITH PNEUMOTHORAX?

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Abstract

IS A CHEST TUBE NECESSARY PRIOR TO AIR MEDICAL TRANSPORT OF PATIENTS WITH PNEUMOTHORAX

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Objective: It is conventionally thought that patients with pneumothoraces (PTX) require tube thoracostomy prior to air medical transport (AMT), especially in un-pressurized rotor-wing aircraft, to prevent deterioration from expansion of the pneumothorax and possible development of tension pneumothorax. We hypothesized that patients with pneumothorax(ces) transported without prior tube thoracostomy tolerate AMT without serious deterioration.

Methods: We conducted a retrospective case-series of trauma patients transported via helicopter with radiographically confirmed PTX between September 2002 and September 2005. Charts were evaluated for signs of deterioration including hypotension, hypoxemia, respiratory distress, intubation, needle thoracostomy or cardiac arrest during transport. In addition, duration of flight and altitude change was recorded.

Results: During the study period, 55 patients with confirmed PTX underwent rotor-wing AMT with an average altitude gain of 1950 feet and average duration of 22 minutes (range 3 to 70). 12 of 55 (22%) were transported between hospitals with the remainder (43/55, 88%) coming from scenes or small clinics. 37 of 55 PTX (67%) were suspected and 3 (5%) confirmed prior to transport. 8/55 patients (15%) were intubated prior to transport. All patients received oxygen during AMT. Six of the 55 patients (11%) had needle thoracostomies placed prior to flight. Four of these 55 patients (7%) deteriorated during AMT: 1 patient suffered a cardiac arrest but was resuscitated before arrival at hospital without needle or tube thoracostomy, 1 patient developed hypotension and 2 patients developed increased respiratory difficulty for which 1 of the 2 required needle thoracostomy with good results. 3 of these 4 complications were likely or possibly due to PTX.

Conclusions: In this retrospective case-series, only 3/55 (5%) of patients with PTX deteriorated and no patients died during un-pressurized rotor-wing AMT despite long transport times and large altitude changes. Routine placement of tube thoracostomy before rotor-wing AMT may not be necessary.

Introduction

The treatment of pneumothorax (PTX) prior to air medical transport (AMT) remains controversial. It is conventionally thought that patients with PTX require tube thoracostomy prior to AMT, to prevent deterioration from expansion of the pneumothorax and possible development of tension pneumothorax. The concern is amplified for patients transported in unpressurized rotor-wing aircraft. Thoracic trauma remains responsible for one quarter of all trauma deaths and is a frequent component of multiple system trauma[1]. Pneumothorax is observed in 10-22% of blunt trauma cases[1]. In light of the volume of patients with PTX that are transported via AMT without tube thoracostomy, it is crucial to examine how well these patients are tolerating flight.

AMT presents a risk for patients with PTX due to changing altitudes and especially in un-pressurized rotor-wing aircraft. Increasing altitude result in decreasing pressure and increasing volumes in a closed system . According to Boyle's law, decreasing air pressure creates a proportional increase in volume within a closed space. An increase of 2000 feet in elevation, much like is seen during helicopter AMT, would be result in an increase in volume of a closed air space by approximately 8%.

Discriminating between patients with simple and tension pneumothorax is paramount prior to AMT. With a simple PTX there is an accumulation of air in the pleural space but it not under pressure and does not shift the mediastinum and impair hemodynamics and consequently, not considered to be life threatening[2]. Tension PTX does represent a life threatening condition with air under pressure rapidly accumulating in the pleural space shifting the mediastinum and compressing the great vessels in the thoracic cavity[2]. Whereas a patient is considered to be relatively stable with a simple

PTX, a tension PTX increases respiratory distress, increases central venous pressure, decreases venous return, cardiac output and blood pressure, and ultimately results in cardiovascular collapse.

Definitive treatment for PTX in the hospital setting is tube thoracostomy (chest tube) and in most cases is the only treatment necessary[3]. Needle thoracostomy is considered to be a temporary treatment for PTX and may be insufficient to relieve a tension PTX. In one study, the response rates to needle thoracostomy were lower than with tube thoracostomy (60% versus 75%)[4]. The main complication with needle thoracostomy is the inability of the needle to penetrate into the pleural space and vent an expanding PTX. This may minimized by using a longer catheter. Although a simple PTX can be stable enough to be managed without intervention, tube thoracostomy remains the gold standard for patients with tension PTX or a large simple PTX.

AMT in un-pressurized aircraft for patients with PTX, presents many concerns. Foremost is the assumption that patients transported with an unvented PTX at altitude will deteriorate due to the increasing volume of the PTX as air pressures drop. In some texts, the mere presence of an unvented is an absolute contraindication for AMT[5]. In other texts, the belief that all simple PTX should be vented prior to AMT is an over reaction though this has never been subjected to scientific scrutiny[6,7]. In fact, it is not understood how much flight physiology comes into play during AMT for patients with a PTX.

We hypothesized that patients with pneumothorax(ces) transported without prior tube thoracostomy would tolerate AMT without serious deterioration. This question has not been answered by previous studies[3, 4, 8]. New Mexico presents an opportunity to

study a population of trauma patients with PTX that are transported without tube thoracostomy. Two local AMT providers, PHI Air Medical of New Mexico and Lifeguard Air Emergency Services have clinical policies that state that unvented pneumothoraces are not an absolute contraindication to air transport. Therefore, a retrospective review of trauma patients transported with unvented pneumothoraces may begin to answer the question whether these patients are able to tolerate AMT without serious deterioration.

Methods

We conducted a retrospective case-series of trauma patients transported via helicopter with radiographically confirmed PTX between September 2002 and September 2005. The case series was selected from a computerized dispatch and charting database, GoldenHour, provided by PHI Air Medical of New Mexico and Lifeguard Air Emergency Services. 316 charts were selected by the search terms of "pneumothorax," "chest trauma," or "multi-system trauma" for evaluation for inclusion in the study. 55 charts were selected for inclusion. Of those that were excluded, 152 patients did not have a PTX, 10 patients were not transported, 32 patients did not have a confirmed PTX, 12 patients were medical and not trauma patients, and 21 were not transported by rotor wing. Of the 89 patients left, 34 received chest tubes and were excluded.

Charts were evaluated for signs of deterioration including hypotension, hypoxemia, respiratory distress, new intubation, needle thoracostomy or cardiac arrest during transport. In addition, altitude change, maximum altitude, and flight duration

were recorded. Other information recorded from the chart review included oxygen delivery type, PTX mechanism, and initial and arrival vital signs.

PTX was confirmed by chest x-ray or chest computed tomography either by the sending or receiving facility. Sending facilities were typically rural New Mexico hospitals or clinics. The receiving facility was usually University of New Mexico hospital, the regional Level I trauma center.

Results

From September 2002 to September 2005, 55 patients with a confirmed PTX underwent rotor-wing AMT. 37/55 patients (67%) were male. The average age of the patients was 40.5 years (range 14 to 84) (Table 1).

These patients were transported with an average altitude gain of 1950 feet and an average duration of 22 minutes (range 3 to 70). 12 of 55 (22%) were transported between hospitals with the remainder (43/55, 88%) coming from scenes or small clinics. 37 of 55 PTX (67%) were suspected prior to transport and 3 (5%) were confirmed radiologically prior to transport. 8/55 patients (15%) were intubated prior to transport. All patients received oxygen during AMT with delivery devices that included endotracheal tube (ETT), laryngeal mask airway (LMA) nasal cannula, non-rebreather mask, and bag-valve mask. Six of the 55 patients (11%) had needle thoracostomies placed prior to flight.

Traumatic mechanisms for PTX included 38/55 (69%) blunt trauma from motor vehicle accident (MVA), 6/55 (11%) blunt trauma from fall, 4/55 (7%) blunt trauma, vehicle versus pedestrian. Penetrating trauma included 2/55 (4%) gunshot wounds (GSW), 4/55 (7%) from stab wounds, and 1/55 (2%) with a puncture wound from MVA.

Four of the 55 patients (7%) deteriorated during AMT. One patient suffered a cardiac arrest during flight but was resuscitated before arrival at hospital without needle or tube thoracostomy. One patient developed mild hypotension and two patients developed increased respiratory difficulty for which one required needle thoracostomy with good results. Three of these four patients with complications were deemed likely or possibly due to PTX. The forth patient (cardiac arrest) was determined to have likely deteriorated from other causes not related to PTX since they were successfully resuscitated without intervention for PTX. No patient was felt to have suffered serious morbidity or mortality due to lack of a chest tube prior to transport.

Discussion

In this retrospective case-series, only 3/55 (5%) of patients with PTX deteriorated and no patients died during unpressurized rotor-wing AMT despite long transport times and large altitude changes. Altitude changes of an average of 1950 feet during AMT theoretically should result in an almost 8% volume increase in an unvented PTX. This volume increase from lower atmospheric pressures does not appear to precipitate deterioration. In fact, given that this patient population of trauma patients with PTX often is transported with other severe injuries, the deterioration rate we observed was remarkably low. It appears that the transport of PTX patients without tube thoracostomy at altitude changes of up to 2000 feet may be less risky than traditionally thought.

Some limitations of this retrospective case-series should be discussed. First, we were unable to statistically compare this population of patients transported without tube thoracostomy with patients with tube thoracostomy due to differences in the two groups.

A much larger population sample would be required to overcome these differences. Of the patients with PTX transported without tube thoracostomy, they were more likely to be transported from the scene or small clinic (88%) where it would be impossible to confirm a PTX and to place a chest tube. Indeed, this population of patients had a low pre-flight confirmation rate of 5%, although 67% of these patients were suspected by the fight crew to have a PTX. Radiological confirmation of PTX prior to AMT, given the conventional thinking of the risk of transporting patients with unvented PTX, would have increased the number of tube thoracostomies. Finally, this patient population had a low rate of endotracheal intubation (ETT) and consequent positive pressure ventilations. Positive pressure ventilations are a known risk generating a tension PTX from a simple PTX[3,4]. This group of patients may have been less acute and not requiring ETT or the flight crews, aware of the risk of positive pressure ventilations, may have elected to provide passive oxygen over ETT.

Given the low deterioration rate observed in this retrospective case-series, routine placement of tube thoracostomy before rotor-wing AMT may not be necessary. Tube thoracostomy certainly does delay transport[3, 4] prolonging the time until definitive treatment. Obviously, a patient that requires tube thoracostomy for treatment of tension PTX or a patient with PTX that requires positive pressure and is at a facility that can provide it, should have the procedure. However with a patient with a simple PTX, should consider the risk of delay versus the relatively low deterioration rate observed in this study.

Obviously, more study is required to develop evidence based clinical practice guidelines for the AMT of patients with PTX. A larger retrospective study could

approach statistically significant results. A prospective study comparing PTX patients transported with thoracostomy versus without tube thoracostomy would likely be definitive but would require careful construction to ensure patient safety. Animal models utilizing hypobaric chambers may be another possibility and would allow for more controlled study of the evolution of PTX in low pressure environments.

Conclusion

After review of the results of this retrospective case series, we observed that very few patients with PTX deteriorate during un-pressurized rotor wing AMT despite long transport times and large altitude gains. Transporting patients with PTX without tube thoracostomy at altitude changes up to 2000 feet may present less of a risk to the patient than traditionally thought. Ultimately, physicians and air medical crews should consider carefully the delay in transport to perform tube thoracostomy to prevent deterioration in patients with PTX in light of the low deterioration rate observed in this study.

Table 1. General Characteristics		Overall (n=89)	PTX with Chest Tube (n=34)	PTX without Chest Tube (n=55)
General				
	Male	59	22	37
	Mean age (years)	39.3	37.3	40.5 (14-84)
	Mean flight time (minutes)	29.2	40.4	22.3 (3-70)
	Mean flight alt (feet)	7860	8162	7673
	Mean alt change (feet)	1854	1705	1945
Mechanism of injury				
	Blunt, fall	8	2	6
	Blunt, MVA	60	22	38
	Blunt, blow to chest	1	0	0
	Blunt, vehicle v. pedestrian	7	3	4
	GSW	3	1	2
	Puncture, MVA	1	0	1
	Puncture, stabbing	9	5	4
O2 Delivery type				
	ETT	24	17	7
	LMA	1	0	1
	BVM	2	0	2
	Mask	51	10	41
	NC	11	7	4
PTX confirmed				
	Preflight	35	32	3
	Postflight	54	2	52
PTX confirmation method				
	CT	50	4	46
	Xray	39	30	8
Deterioration in flight		7/89 (8%)	3/34 (9%)	4/55 (7%)

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