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Is routine tube thoracostomy necessary after prehospital needle decompression for tension pneumothorax?

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Abstract

BACKGROUND: Thoracic needle decompression is lifesaving in tension pneumothorax. However, performance of subsequent tube thoracostomy is questioned. The needle may not enter the chest, or the diagnosis may be wrong. The aim of this study was to test the hypothesis that routine tube thoracostomy is not required.

METHODS: A prospective 2-year study of patients aged ≥18 years with thoracic trauma was conducted at a level 1 trauma center.

RESULTS: Forty-one patients with chest trauma, 12 penetrating and 29 blunt, had 47 needled hemithoraces for evaluation; 85% of hemithoraces required tube thoracostomy after needle decompression of the chest (34 of 41 patients [83%]).

CONCLUSIONS: Patients undergoing needle decompression who do not require placement of thoracostomy for clinical indications may be assessed using chest radiography, but thoracic computed tomography is more accurate. Air or blood on chest radiography or computed tomography of the chest is an indication for tube thoracostomy.

Prehospital needle decompression is a lifesaving procedure in tension pneumothorax. Physical examination findings include absent breath sounds, increased resonance to percussion, hypotension, and tracheal deviation toward the contralateral side. Because tension pneumothorax can be rapidly fatal, clinical diagnosis is emphasized, and prompt intervention is mandatory. In patients with clinical suspicion of tension pneumothorax and physiologic instability, a 14-gauge angiocatheter is inserted (2 in [5 cm] long) in the second intercostal space at the midclavicular line.[1] The catheter is passed into the pleural space and the needle removed, venting the elevated intrathoracic pressure. A flap valve, Luer-Lock (Becton Dickinson, Franklin Lakes, NJ), or other type of seal may be used to prevent pneumothorax.

However, patients undergoing prehospital needle thoracostomy in crisis situations may not actually have tension pneumothorax, with a reported error rate of 26%.[2] A possible anatomic explanation may be that chest wall thickness, as assessed by computed tomography, may exceed the length of the catheter used for decompression.[3] However, studies using ultrasound imaging have shown chest wall thickness to be <4.5 cm in all patients.[4] The possibility of iatrogenic injury complicates the procedure and may increase as longer catheters are introduced to address the

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concerns of some authors about chest wall thickness. A case report of injury to the pulmonary artery and cardiac tamponade is particularly unnerving.[5] Some authors have suggested lateral chest wall placement to reduce the risk for injury to hilar structures,[6] but there are no data to support this theoretically appealing approach. Because air rises in the anterior chest of a supine patient, it is most accessible in this position.

Our standard practice is to place a tube thoracostomy in all patients who have undergone needle decompression in the field. Our rationale was based on concern that, after pleural space decompression, a patient would be at risk for developing a pneumothorax even if one was not present on admission chest radiography. Patients who undergo positive pressure ventilation, either in the operating room or in the intensive care unit, may be at greater risk. However, review of selected cases demonstrated that in some patients undergoing prehospital needle decompression, the catheter was placed tangentially in the soft tissue and did not even enter the chest.

The hypothesis of our study was that routine tube thoracostomy is unnecessary in patients undergoing prehospital needle decompression of the chest. It may be possible to spare some patients the associated discomfort and morbidity of the procedure.

Methods

This study was conducted over a 2-year period at an American College of Surgeons–verified level 1 trauma center. The data were collected prospectively, and informed consent was obtained from patients and/or their next of kin. Approval for this project was obtained from the hospital institutional review board. Patients aged $\geq$18 years with blunt or penetrating injuries to the chest who underwent prehospital needle decompression were included. Exclusion criteria were pregnancy, incarceration, and asystole on arrival. Demographic data were recorded. Results of chest radiography and thoracic computed tomography were compared. The clinical diagnostic testing statistics of sensitivity, specificity, and positive and negative predictive value were calculated.

Informed consent was obtained from the remaining 41 patients. Twelve sustained penetrating injuries (7 stab wounds and 5 gunshot wounds), and 29 sustained blunt injuries (15 motor vehicle and 5 motorcycle accidents, 2 motor vehicle–pedestrian injuries, and 7 due to other blunt mechanisms). In the study group, there were 8 women and 33 men. Ages ranged from 18 to 69 years (mean, 38 $\pm$ 14 years).

Initial chest radiography was performed; small hemopneumothoraces were observed. If tube thoracostomy was not initially indicated, thoracic computed tomography was performed. If tube thoracostomy was still not indicated, subsequent chest radiography was done at 2, 4, 6, and 12 hours per study protocol to evaluate for progression, and the patient was observed on the trauma unit.

Results

Over a 2-year period, 6,357 trauma patients were admitted to the trauma center. Fifty-one patients (1%) who underwent needle decompression of the chest by prehospital personnel were identified upon arrival in the trauma bay. Nine patients were dead on arrival, and 1 patient had a tube thoracostomy placed at an outside hospital. These 10 patients were excluded from further study.

Penetrating trauma

There were 15 decompressions in 12 patients: 3 right, 6 left, and 3 bilateral decompressions. One patient died in the operating room after a pneumonectomy. Tube thoracostomy was placed on the side of the penetrating injury in 2 patients for clinical indications (hypotension with decreased breath sounds). Four tube thoracostomies were placed for hemopneumothorax present on initial chest radiography and 4 more for a normal-appearing chest radiograph followed by identification of a significant hemopneumothorax on thoracic computed tomography shortly after arrival. One patient developed a progressive hemothorax on chest radiography 12 hours after admission and had a tube placed. However, the hemothorax was incompletely evacuated, and he required a video-assisted thoracoscopy at a later point in his course. Only 1 penetrating trauma patient, with a stab wound, who had needle decompression for hypotension, escaped tube thoracostomy.

Blunt trauma

Twenty-nine blunt trauma patients underwent 37 needle decompressions of the chest: 6 right, 15 left, and 8 bilateral. Eight patients died, 2 in the operating room and 2 later of death by neurologic criteria. Seven patients underwent tube thoracostomy for clinical indications, 3 for abnormal initial chest radiographic findings, 9 for findings on thoracic computed tomography, 3 delayed 2 hours, 2 delayed 4 hours, and another 1 at 12 hours; all these patients had normal-appearing initial chest radiographs and abnormal thoracic computed tomographic findings. Four blunt trauma patients did not require tube thoracostomy.

Data analysis

Data for penetrating and blunt trauma patients were combined because there were no significant differences between the 2 groups in the likelihood of positive radiographic findings or need for tube thoracostomy. Each individual hemithorax was treated as a separate data point; 52 needle-decompressed hemithoraces were evaluated. Five patients who did not undergo initial chest radiography were not studied further; this left 47 hemithoraces with adequate data for evaluation.