Failure of First Attempt Needle Decompression in Tension Pneumothorax: Case Report

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ABSTRACT

Tension pneumothorax can occur as a potentially life threatening complication of chest trauma. Tension pneumothorax is commonly treated with needle decompression, both the 2nd intercostal space in the midclavicular line and the 4½/5th intercostal space in the anterior axillary. A 45 years old man came to our emergency department after blunt injury of the chest presenting tension pneumothorax with unstable hemodynamic treated with needle decompression using 14 gauge (4.5 cm) cannula at 2nd intercostal space mid clavicular line, patient successfully recover and became hemodynamic stable, after 30 minutes of successful needle decompression patient experienced with recurrent tension pneumothorax. Several studies show the failure of needle decompression it may due to several factor such as chest wall thickness, cannula length, and location of the needle decompression. In this case the cannula may has insufficient length (4.5 cm) to pass through the full thickness of the patient’s chest wall at 2nd intercostal space mid clavicular line (ICS 2) and makes air leaks from the lung faster than it can escape through the cannula.

1. Introduction

The term ‘pneumothorax’ was first mentioned by Itard and Laennec in 1803 and 1819, refers to air in the pleural cavity.¹ A pneumothorax occurs when the visceral or parietal pleura is breached and air enters the pleural space. This leads to loss of the negative intrapleural pressure and lung collapse. Pneumothorax may be classified into ‘simple’, ‘tension’ or ‘open’ according to the underlying pathophysiology². Based on the etiology there are primary and secondary. A primary spontaneous pneumothorax occurs automatically without a known eliciting event, while a secondary spontaneous pneumothorax occurs subsequent to an underlying pulmonary disease.¹

Tension pneumothorax is a life-threatening condition due to collapse of the lung and mediastinal shift away from affected side, resulting in hypoxemia and reduction of venous return. Tension pneumothorax can occur due to injury of the lung, bronchi or trachea that allows continuous leakage of air into pleural space and air cannot escape.³ Treatment tension pneumothorax is with high concentration oxygen and emergency needle decompression. Needle decompression is fast, simply applied, and used most commonly in the prehospital setting or during resuscitation. Current Advanced Trauma Life Support (ATLS) guidelines recommend initial treatment with needle thoracostomy decompression using a 5-cm angiocatheter at the second intercostal space on the midclavicular line.⁴ Evidence of successful penetration of the pleura by a 5 cm over-the-needle catheter is >50% of the time, whereas an 8 cm over the needle
catheter has success in >90% of the time.\textsuperscript{3,5}

However, there has been much debate over the preferred location for needle decompression. Whereas the ATLS recommendations have changed in 2018 from the 2nd intercostal space in the midclavicular line (ICS2-MCL) to the 4th/5th intercostal space just anterior to the mid axillary line other guidelines such as the ETC trauma guidelines and the guidelines from the Faculty of prehospital care of the Royal College of Surgeons of Edinburgh in the UK still adhere to placement in the ICS2-MCL. One of the considerations for choosing the location for Needle Decompression is the likelihood of penetration of the needle into the thoracic cavity\textsuperscript{5-10}. This likelihood depends on both patient (chest wall thickness) and equipment factors (needle length).\textsuperscript{6}

2. Case Presentation

We report 45 years old man came to our emergency department after blunt injury of the chest. He suffered from a vehicle accident after crashing his motorcycle to the tree 30 minute before came to our hospital. On arrival in our hospital, he was complaining shortness of breath and left sided chest pain. Primary survey revealed patent airway and cervical-spine. His respiratory rate was 35 times per minute and his oxygen saturation is 70% on room air. He presented a lagging left chest movement, resonant left hemithorax with absent of breath sounds and rising of jugular venous pressure. His blood pressure was 80/60 mm Hg and 140 times per minute heart rate. He was alert. Further examination revealed no external wound and no fracture of any bone.

A chest radiograph revealed left sided pneumothorax with collapse of the lung and mediastinal shift (Figure 1). We performed needle decompression using 14\textsuperscript{th} (4.5 cm) gauge cannula through second intercostal space at mid-clavicular line. After decompression, the symptoms and the vital sign of the patient stable instantly. Then we made a mini water seal drainage system using the infusion and connected it to cannula. 10 minutes after decompression we performed an evaluation chest radiograph and it showed improved resolution of pneumothorax (Figure 2).

After 30 minutes, the patient suddenly felt shortness of breath again. His vital sign instantly to deteriorate. We found, His left hemithorax resonant and absent of his breath sound. His jugular venous pressure is rising again. No bubble and no undulation found in mini WSD system. Chest radiograph revealed pneumothorax at his left lung (Figure 3). After that, we performed an immediately needle decompression using 14\textsuperscript{th} (4.5 cm) gauge cannula through 5\textsuperscript{th} intercostal space anterior axillary line and then we performed tube thoracostomy at his 5\textsuperscript{th} intercostal space using 28 French gauge chest tube and connected to underwater seal. Chest radiograph and showed recovery of the lung (Figure 4).

![Figure 1. Chest radiograph when a patient first came to hospital](image)
Figure 2. Chest radiograph evaluation after first needle decompression

Figure 3. Chest radiograph when patient deteriorate

Figure 4. Chest radiograph after placement of tube thoracostomy
3. Discussion

In this patient we performed needle decompression using 14th gauge (4.5cm) cannula through 2nd intercostal space mid clavicular line in our first attempt. The patient symptoms relived instantly and chest x-ray showed improved resolution but after 30 minutes the patient became unstable and chest x-ray showed recurrent tension pneumothorax at ipsilateral side.

This case shows the potential for failure of needle decompression in the management of a tension pneumothorax. Failure of the procedure may be attributable to a number of factors. Chad et al study showed needle decompression using a 3.2 cm catheter was unsuccessful in up to 65% of cases. When a larger 4.5 cm catheter was used, fewer procedures failed (4%). Previous studies describing chest wall thickness at the mid clavicular line (second intercostal space) via CT scan (3.1 cm in 100 heterogeneous adults, 3.41 cm in men, 3.92 cm in women, 4.24 cm in 111 resuscitated patients and 5.36 cm in military personnel or US 14 (57% thicker than 3 cm) support the observed 65% failure rate using a 3.2-cm sheath. Evidence successful penetration of the pleura by a 5 cm cannula is > 50% of the time, whereas 8 cm cannula has success in 90% of the time. Although some authors have called for 7 to 8 cm needles to ensure that all pneumothorax are decompressed, it appears that even catheters as short as 4.5 cm can puncture the heart at standard insertion locations in 2.5% of trauma patients. Other complications include chest wall hematoma, hematothorax. empyema and dislodgement in up to 8% of patients. They analyzed safety with 8 cm needles at both 2nd intercostal space mid clavicular line (ICS 2-MCL) and fifth intercostal space anterior axillary line (ICS 5th AAL). They found an injury rate as high as 9% with optimal placement of the 8-cm needle and a 32% rate of injury to an underlying structure with placement at a shallow angle at ICS 5-AAL. The use of longer needles has also been proposed. This was not without risk, however, as it significantly increased the ability to reach underlying vital structures (especially the left ventricle from a left lateral approach). These latter findings bring into question the safety of using longer catheters at alternative sites.

We used needle decompression in the 2nd intercostal space (ICS) mid clavicular line (MCL) because it is traditional site for needle decompression and is easy to access and entails penetration of pectoral muscles and a variable quantity of subcutaneous tissue with or without oedema and subcutaneous emphysema. Leigh smith study showed a standard 14 gauge (4.5 cm) cannula may not be long enough to penetrate parietal pleura with up to one third of trauma patients having a chest wall thickness greater than 5 cm in the 2nd ICS MCL. The use of the 4th or 5th ICS in the mid axillary line may be safer and has been recommended by ATLS as it contains less fat and avoids large muscles. Unfortunately this site may have an increased risk of lung damage in the supine patient, as gas collects at the highest point and adhesions are most likely in more dependent parts of the lung. Some studies showed the average chest wall thickness on the 2nd ICS mid clavicular line is 38 mm for men and 52 mm for women. The chest wall in the 5th ICS anterior axillary line was 13 mm thinner on average compared to the 2nd ICS mid clavicular line A subcutaneous emphysema and multiple rib fractures may even increase chest wall thickness in trauma patients. Obesity increases chest wall thickness requiring at least a needle of 64 mm in length to be successful in 79%.

4. Conclusion

In this case the cannula may have insufficient length (4.5 cm) to pass through the full thickness of the patient’s chest wall at 2nd intercostal space mid clavicular line (ICS 2) and makes air leaks from the lung faster than it can escape through the cannula.

5. Reference


4. American College of Surgeons, Committee on Trauma. ATLS Advanced Trauma Life Support. 10th ed. Chicago: American College of Surgeons; 2018; 62–78


