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

Christianto Wisman[1]*, Boby Yaputra[2]

[1]General Practicioner of Johannes Leimena Hospital, Ambon, Indonesia

[2]Intern Doctor of Johannes Leimena Hospital, Ambon, Indonesia

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***Corresponding author:**
Christianto Wisman

E-mail address:
Christwisman7@gmail.com

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A B S T R A C T

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 4th/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 14th (5 cm) gauge cannula at 2nd intercostal space midclavicular line, the patient felt comfortable and became hemodynamic stable, but chest radiograph evaluation showed no improvement tension pneumothorax. Several studies show the failure of needle decompression may be due to several factors such as chest wall thickness, cannula length, occlusion of the catheter, and location of the needle decompression. In this case, failure of needle decompression may be because of the occlusion due to catheter kinking so that the air cannot escape through the cannula and may also be caused by the insufficient length of the cannula to pass through the full thickness of the patient's chest wall.

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 negative intrapleural pressure and lung collapse. Pneumothorax' may be classified into 'simple,' 'tension,' or 'open' according to the underlying pathophysiology.[2] 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 the collapse of the lung and mediastinal shift away from the 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

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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 angio-catheter 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.[3,5]

However, there has been much debate over the preferred location for needle decompression. Whereas the ATLS recommendations changed in 2018 from the 2nd intercostal space in the midclavicular line (2nd ICS 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 2nd ICS MCL. One of the considerations for choosing the location for Needle Decompression is the likelihood of penetration of the needle into the thoracic cavity.[5–10] This likelihood depends on both patient (chest wall thickness) and equipment factors (needle length).[6]

2. Case Presentation

A 45 years old man came to our emergency department after a blunt injury to the chest. He suffered from a vehicle accident after crashing his motorcycle into a tree 30 minutes before he came to our hospital. On arrival at our hospital, he was complaining of shortness of breath and left-sided chest pain. The primary survey revealed a patent airway and cervical- spine. His respiratory rate was 35 times per minute, and his oxygen saturation was 70% on room air. He presented a lagging left chest movement, resonant left hemithorax with the absence of breath sounds, and rising 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.

The needle decompression was performed using the 14th (5 cm) gauge cannula through the second intercostal space at the midclavicular line (2nd ICS MCL). After decompression, the symptoms and the vital sign of the patient are stable instantly. Then, a mini water seal drainage system was made using the infusion and connected to the cannula. The mini-WSD system showed bubbles and undulation.

After that, we performed a chest radiograph for evaluation, but the chest radiograph still revealed tension pneumothorax in his left lung (figure 1). We performed an immediate needle decompression using a 14th gauge cannula through the second intercostal space at the midclavicular line (2nd ICS MCL), and then we performed tube thoracostomy at his 5th intercostal space (5th ICS AAL) using 24th gauge chest tube and connected to underwater seal. Chest radiograph showed recovery of the lung (Figure 2).

Figure 1. Chest radiograph evaluation after first needle decompression.

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Figure 2. Chest radiograph after placement of tube thoracostomy.

3. Discussion

In this patient, needle decompression was performed using the 14th (5 cm) gauge cannula through the 2nd intercostal space midclavicular line (2nd ICS MCL) in our first attempt. The patient's symptoms were relieved instantly, but the chest x-ray evaluation showed no improvement in tension pneumothorax at the 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 were unsuccessful in up to 65% of cases. When a larger 4.5 cm catheter was used, fewer procedures failed (reduced up to 4%). Previous studies described chest wall thickness at the midclavicular line (second intercostal space) via CT scan (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.[1-3] Evidence of 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.[4] Leigh smith's study showed a standard 14th (5 cm) gauge cannula might 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.[5-7]

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. They analysed safety with 8 cm needles at both the 2nd intercostal space midclavicular line (2nd ICS MCL) and the fifth intercostal space anterior axillary line (5th ICS AAL). They found an injury rate as high as 32% to an underlying structure. These findings bring into question the safety of using longer catheters at alternative sites.[8-9]

Cullinane et al. questioned the effectiveness of Needle Decompression. Failure can occur in 50% of patients despite adequate catheter length. Failure to evacuate can be caused by occlusion secondary due to blood, compression or kinking of the catheter, or tissue entrapment of the catheter that makes air leaks greater than escape through the catheter.[10-11] Conces et al. published a series of 79 patients treated with needle decompression for pneumothorax. Of the 11 that failed, two were due to device kinking in the pleural space and an additional two failed due to occlusion with pleural debris. Martin et al. studied the

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effectiveness of needle decompression in a swine model. In the first arm of the study, 19 events failed due to kinking.[11]

The needle decompression was used in the 2nd intercostal space midclavicular line (ICS MCL) because it is a traditional site for needle decompression and is easy to access, and entails the penetration of pectoral muscles and a variable quantity of subcutaneous tissue with or without oedema and subcutaneous emphysema.[1] The use of the 5th intercostal space in the anterior axillary line (5th ICS AAL) may be safer and has been recommended by ATLS as it contains less fat and avoids large muscles.[4] 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[8]. Some studies showed the average chest wall thickness on the 2nd intercostal space in the midclavicular line is 38 mm for men and 52 mm for women. The chest wall in the 5th ICS AAL was 13 mm thinner on average compared to the 2nd ICS MCL. 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%.[7-8]

4. Conclusion

In this case, failure of needle decompression may be because of the occlusion due to catheter kinking so that the air cannot escape through the cannula and may also be caused by the insufficient length of the cannula to pass through the full thickness of the patient's chest wall.

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