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ORIGINAL ARTICLE

Radiologic Evaluation of Alternative Sites for Successful Needle Decompression of Pneumothorax

ABSTRACT

Objectives: The aim of this study was to evaluate chest wall thickness (CWT) using computed tomography (CT) and to determine which anatomic region should be selected for a successful needle thoracostomy (NT) procedure site in patients with a pneumothorax (PTX).

Methods: The 147 patients who had thorax CT in the emergency department (ED) were included. The CWTs at the 2nd intercostal space (ICS) midclavicular line (MCL), at the 5th ICS midaxillary line (MAL), and the anterior axillary line (AAL) were measured on both sides.

Results: The median CWTs were 27.2 mm and 27.3 mm on the right and left sides of the 2nd ICS-MCL, respectively. The median CWTs were 43.5 mm on the right and 43.8 mm on the left side of the 5th ICS-MAL. The median CWTs were 32.2 mm on the right and 31.2 mm on the left 5th ICS-AAL. This study also showed that when a standard 50-mm catheter was used, NT failed in 12.9% of patients in the 2nd ICS-MCL, in 67.4% of patients in the 5th ICS-MAL, and in 27.2% of patients in the 5th ICS-AAL.

Conclusion: Our study confirmed that a 50-mm catheter, which is used classically in tension pneumothorax cases, has higher success rates than the 5th ICS when applied from the 2nd ICS. It should be noted that the thickness of the thorax wall increases in proportion to body mass index, which may lead to a failure of the procedure.

Keywords: Needle thoracostomy, tension pneumothorax, thoracic wall thickness

Thoracic trauma is an important cause of morbidity and mortality throughout the world (1). The mortality rate is variable, ranging from about 10% to 60%, and the incidence of chest trauma still accounts for 10% of trauma patients in many populations (2,3). The aim of early intervention is to prevent and correct hypoxia because it is the most serious problem due to chest damage. Tension pneumothorax is a life-threatening injury that stems from pulmonary damage, and decreasing the intrapleural pressure quickly is an important treatment method for this injury. The American College of Surgeons (Chicago, Illinois, USA) Advanced Trauma Life Support (ATLS) currently recommends needle thoracostomy (NT) as a treatment for presumed tension pneumothorax until a tube thoracostomy can be performed (4).

However, various studies in the literature have demonstrated that the reported success rate has a wide range varying from 5% to 96% (5,6). One of the main reasons for this failure is claimed to be that the catheters used are too short for the chest wall thickness (CWT) (7,8). Although there are various studies in the literature in which CWT is measured using computed tomography (CT) and ultrasonography (USG) to assess the success rates of NT procedures, the results are contradictory (9–11). Another factor that affects the success of NT is the anatomic region in which the procedure is performed. Some studies support the fact that NT is more successful in the 2nd intercostal space-midclavicular line (ICS-MCL), and these studies have supported that recommendation to be safe and effective (4,12). In fact, in the 9th edition of the ATLS guideline, the 2nd ICS-MCL was recommended for a successful NT (13), but in the 10th edition, the 5th ICS-MAL was recommended for a successful NT (4). In addition, different studies support that NT can be more successful when applied from different anatomic locations such as the 5th ICS-anterior axillary line (AAL) and the 5th ICS-midaxillary line (MAL) (10,14).

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The aim of this study was to measure the CWT at the 2nd ICS-MCL, the 5th ICS-AAL, and the 5th ICS-MAL using CT for patients who presented to the emergency department (ED), to assess the probable success rate of 50-mm catheters at these sites separately, and to analyze how the probable success rates of NT performed at these sites differed based on the demographic features of the patients.

METHODS

Patients

This study was conducted prospectively at Yıldırım Beyazıt University Ankara Ataturk Research and Training Hospital between February 2017 and July 2017. One thousand six hundred forty-three patients who presented to the ED had thorax CT due to any illness, and their demographic data were recorded. Pediatric patients (aged under 18 years), patients with diseases that increase the chest diameter such as chronic obstructive pulmonary disease (COPD), patients with anatomic structural defects on the chest wall, and patients whose weight/height could not be measured due to physical disabilities were excluded from the study. After the exclusion criteria were applied, assessments were made based on the 147 patients (91 male, 56 female) who were willing to participate in the study. Informed consents were obtained from all patients. This study was approved by Yıldırım Beyazıt University Medical Ethics Committee (approval date: 2017, no: 26379996/25).

Measurements

The ages and sexes of the patients were obtained from the electronic recording system. Weight was measured using Omron HN-286 scales (Krell Precision, Yangzhou Co, Yangzhou, China), and height was measured with a Seca 213 stadiometer (Seca Trading, Hangzhou Co, Hangzhou, China). Measurements of unstable patients were performed when they were stable. Personal statements were recorded for those in whom measurements couldn't be obtained. Weight and height measurements were always made using the same devices. Body mass index (BMI) was calculated using the following formula: BMI = weight/(height)^2. According to the BMI classification of the World Health Organization (WHO), BMI between 0 and 18.4 kg/m^2 was classified as underweight, BMI between 18.5 and 24.9 kg/m^2 was classified as normal, BMI between 25 and 29.9 kg/m^2 was classified as overweight, BMI between 30 and 34.9 kg/m^2 was classified as obese, and BMI of ⩾35 kg/m^2 was classified as morbid obese. Participants were classified based on their BMIs using these criteria (15). In terms of age, patients aged ⩾65 years were classified as old, and patients under 65 years were classified as young (16).

Data on the CWT of the patients were collected by reviewing the thorax CT scans on the Picture Archive and Communication System (PACS) of Ankara Ataturk Research and Training Hospital. CT reviews were performed using a 16-detector Siemens Somatom Emotion Single Slice device (Siemens Healthineers, USA). In contrast examinations, the mAs value was 67, the kVP value was 130, section thickness was 0.6 mm, and the pitch value was 1.5. In non-contrast examinations, the mAs value was 20, the kVP value was 110, section thickness was 2 mm, and the pitch value was 0.9. All measurements were made by an expert radiologist. In all thorax CT examinations, the thicknesses of cutaneous-subcutaneous tissues and muscle planes were measured from skin to pleura at the 2nd ICS-MCL and the 5th ICS-AAL and 5th ICS-MAL.

The main criterion for the success of NT procedures with a 50-mm catheter was if the measured CWT was <50 mm. In the study, it was seen that breast tissue was a confounding factor for the measurement of the 5th ICS-AAL; therefore, CWT was assessed as ⩾50 mm for most patients. Considering that this assessment could cause statistical error, the morbidly obese group was not included in the comparisons of 5th ICS-AAL measurements. The remaining patients were divided into two groups as underweight-normal and overweight/obese, and assessments were made between these two groups.

Statistical Analysis

The dispersion of continuous measurements such as age, height, weight, and BMI was reviewed using the Shapiro-Wilk test and normality graphics. All continuous variables are indicated as median (min-max), and categorical variables such as sex are indicated as percentages (%).

Measurements were compared using the independent sample t-test or Mann-Whitney U test depending on their dispersion based on sex and age groups, and the balance of the groups. Through step-by-step paired comparisons, BMI sub-groups that were homogeneous in terms of measurements were determined. Right and left measurements were compared using the Wilcoxon test for underweight-normal and overweight-obese patients. The statistical significance level was taken as $p<0.05$.

For statistical analyses and calculations, IBM SPSS Statistics 21.0 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) software was used, and for graph drawing, Microsoft Office Excel 2013 was used.

RESULTS

The median age of the 147 patients who participated in the study was 57 (min-max: 18–95) years. Ninety-one (61.9%) patients (n=91) were male, and 56 (38.1%) were female. The mean BMI of the participants was 26.00±4.28 kg/m^2. The number of patients who were aged ⩾65 years was 56 (38.1%).

The median right 2nd ICS-MCL of the patients was 27.2 mm (min-max: 3.5–70.3 mm), and the median left 2nd ICS-MCL was 27.3 mm (min-max: 3.5–73.1 mm). The median right 5th ICS-MAL of the patients was 43.5 mm (min-max: 14.2–86.8 mm), and the median left ICS-MAL was 43.8 mm (min-max: 14.5–87.0 mm). The median right 5th ICS-AAL was 31.2 mm (min-max: 6.6–72.1 mm), and the median left 5th ICS-AAL was 32.2 mm (min-max: 6.9–76.5 mm).

When the patients whose 2nd and 5th ICS measurements were ⩾50 mm were assessed, it was detected that the number of patients whose right 2nd ICS-MCL measurement was ⩾50 mm was 9 (6.1%), and the number of patients whose left 2nd ICS-MCL measurement was ⩾50 mm was 10 (6.8%). The percentage of patients whose measurements were ⩾50 mm was mostly for the measurements of the right and left 5th ICS-MAL. The number of patients whose right 5th ICS-MAL measurement was ⩾50 mm was 46 (31.3%), whereas 53 patients' (36.1%) left 5th ICS-MAL was measured as ⩾50 mm. The number of patients whose right 5th ICS-AAL was measured as ⩾50 mm was 20 (13.6%), and there were 20 patients (13.6%) whose left 5th ICS-AAL was measured as ⩾50 mm. The right and left 2nd ICS-MCL measurements of the patients, and the dispersion of these measurements according to sex and BMI, are shown in Table 1. It was determined that the right and left

MCL distances of female patients were thicker than those of male patients (Z=2.936, p=0.003; Z=2.920, p=0.004, respectively). When the right and left MCL measurements were analyzed according to BMI groups, it was seen that as BMI increased, both distances also increased (Z=6.090, p<0.001; Z=5.763, p<0.001, respectively). It was detected that the underweight and normal group were similar in terms of right and left MCL distances and had the thinnest thickness, while the obese and morbidly obese group were similar and had the thickest distance.

The grouping of the right and left 2nd ICS-MCL measurements of the participants as <50 mm and ⩾50 mm, and the dispersion of these values according to age, sex, and BMI, are presented in Table 2. In the group whose right and left 2nd ICS-MCL measurements were ⩾50 mm, the percentage of women was higher (p<0.001) than the percentage of patients whose measurements were below 50 mm. The distribution of BMI groups according to MCL distance classification is also given in Table 2. No statistical inference could be made due to the insufficient number of people in the groups.

Table 1. The comparison of right and left 2nd intercostal space-midclavicular line measurements

	Right 2nd ICS-MCL [mm]		Left 2nd ICS-MCL [mm]	
Groups	**Median (min-max)**	**Mean±sd**	**Median (min-max)**	**Mean±sd**
Gender				
Male	25.60 (6.5-48.8)	26.16±8.53	25.10 (5.8-50.4)	26.22±8.42
Female	31.25 (3.5-70.3)	33.17±14.87	31.55 (3.5-73.1)	33.05±14.89
Z; p	2.936; **0.003**		2.920; **0.004**	
BMI				
Underweight	14.5 (9.5-19.5)[a]	14.50±7.07	15.1 (8.5-21.7)[a]	15.10±9.33
Normal	24.1 (3.5-57.4)[a]	24.28±10.30	24.5 (3.5-50.8)[a]	24.34±9.59
Overweight	28.6 (8.6-60.5)[b]	29.77±10.79	27.5 (8.8-60.6)[b]	29.54±11.02
Obese	35.6 (24.6-57.4)[c]	38.19±9.13	35.3 (25.8-59.4)[c]	37.93±9.20
Morbid obese	39.35 (31.7-70.3)[c]	45.18±17.57	43.5 (32.3-73.1)[c]	48.10±18.37
Z; p	6.090; **<0.001**		5.763; **<0.001**	

Same letters show similar groups. ICS: Intercostal Space; MCL: Midclavicular Line; min: minimum; max: maximum; sd:standart deviation; BMI: Body Mass Index; mm: millimeter.

Table 2. The sociodemeographic features of the participants grouping of the right and left 2nd intercostal space-midclavicular line measurements as <50 mm and ⩾50 mm

	Right 2nd ICS MCL		Left 2nd ICS MCL	
	<50mm	**⩾50mm**	**<50mm**	**⩾50mm**
Groups	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Age Group				
Young	84 (60.9)	7 (77.8)	83 (60.6)	8 (80.0)
Old	54 (39.1)	2 (22.2)	54 (39.4)	2 (20.0)
χ2; p	–; 0.483		–; 0.319	
Gender				
Male	91 (65.9)	0 (0.0)	90 (65.7)	1 (10.0)
Female	47 (34.1)	9 (100.0)	47 (34.3)	9 (90.0)
χ2; p	–; **<0.001**		–; **0.001**	
BMI				
Underweight	2 (1.4)	0 (0.0)	2 (1.5)	0 (0.0)
Normal	61 (44.2)	2 (22.2)	62 (45.3)	1 (10.0)
Overweight	54 (39.1)	3 (33.3)	53 (38.7)	4 (40.0)
Obese	18 (13.0)	3 (33.3)	18 (13.0)	3 (30.0)
Morbid obese	3 (2.2)	1 (11.1)	2 (1.5)	2 (20.0)
χ2; p	–		–	

ICS: Intercostal Space; MCL: Midclavicular Line; BMI: Body Mass Index; mm: millimeter

Table 3. 5th intercostal space distance measurements based on age, gender and BMI groups

	Right 5th ICS MAL [mm]		Left 5th ICS MAL [mm]		Right 5th ICS AAL [mm]		Left 5th ICS AAL [mm]	
Groups	**Median (min-max)**	**Mean±sd**	**Median (min-max)**	**Mean±sd**	**Median (min-max)**	**Mean±sd**	**Median (min-max)**	**Mean±sd**
Age Group								
Young	43.2 (19.6-72.1)	44.96±11.84	43.8 (20.2-76.8)	44.76±11.53	31.2 (9.4-65.2)	33.11±11.34	32.2 (9.8-63.2)	33.26±11.00
Old	43.8 (14.2-86.8)	44.66±18.05	43.8 (14.5-87.0)	45.29±18.31	31.8 (6.6-72.1)	33.92±16.16	32.2 (6.9-73.5)	31.22±16.12
Z; p	0.217; 0.828		0.028; 0.978		0.042; 0.967		0.030; 0.976	
Gender								
Male	42.1 (14.5-67.5)	41.75±12.55	42.6 (14.8-66.7)	41.66±12.23	29.8 (6.6-58.2)	29.28±9.97	30.1 (6.9-57.8)	29.72±10.13
Female	48.7 (14.2-86.8)	49.88±16.00	49.7 (14.5-87.0)	50.31±16.17	40.6 (9.2-72.1)	40.14±15.33	40.3 (10.4-73.5)	39.97±14.98
Z; p	2.890; **0.004**		3.073; **0.002**		4.214; **<0.001**		4.055; **<0.001**	
BMI								
Underweight	25.6 (19.6-31.6)[a]	25.60±8.49	26.7 (20.2-33.2)[a]	26.70±9.19	14.6 (13.0-16.1)[a]	14.55±2.19	14.8 (13.2-16.3)[a]	14.75±2.19
Normal	36.1 (14.2-77.3)[a]	36.83±12.45	36.1 (14.5-80.2)[a]	36.65±12.89	25.4 (9.2-68.6)[a]	26.94±11.16	24.8 (9.8-69.1)[a]	27.23±11.46
Overweigh	48.5 (14.5-72.1)[b]	47.73±10.93	49.3 (14.8-71.2)[b]	48.29±10.19	33.4 (6.6-65.2)[b]	35.30±12.09	33.5 (6.9-59.0)[b]	35.36±11.13
Obese	60.1 (38.2-86.8)[c]	58.06±11.00	56.2 (41.5-87.0)[c]	57.94±10.76	44.7 (33.7-72.1)[c]	46.02±9.29	45.8 (33.8-73.5)[c]	46.54±9.48
Morbid obese	71.7 (58.3-79.4)[c]	70.25±9.26	70.7 (56.1-79.8)[c]	69.33±10.75	53.0 (45.2-56.2)[c]	51.83±4.87	51.2 (44.5-58.2)[c]	51.30±6.16
Z; p	8.140; **<0.001**		8.343; **<0.001**		7.430; **<0.001**		7.612; **<0.001**	

Same letters show similar groups. ICS: Intercostal Space, MAL: Midaxillary Line, AAL: Anterior Axillary Line, min: minimum, max: maximum, sd: standart deviation, BMI: Body Mass Index, mm: millimeter

The right and left 5th ICS-MAL and 5th ICS-AAL measurements of the participants are shown in Table 3. When the distance measurements of the 5th ICS were analyzed according to sex, it was determined that MAL and AAL distances were greater for female patients than for male patients ($p<0.05$). It was detected that as BMI level increased, the MAL and AAL distances increased for both sides ($p<0.001$). In all measurements, it was seen that the underweight and normal-weighted patient groups were similar and had the lowest 5th ICS MAL and AAL distances, while the obese and morbidly obese groups were similar and had the highest 5th ICS MAL and AAL distances ($p<0.05$).

The percentage of participants whose MCL, MAL, and AAL distances were measured as ≥50 mm for both sides is shown in Figure 1. According to this, it was seen that 50-mm catheters, which are classically used for tension pneumothorax, cannot access the pleural area when the procedure is performed at the 2nd ICS-MCL for 12.9% of patients included in the study. This percentage was found to be 67.4% for the 5th ICS-MAL, and 27.2% for the 5th ICS-AAL.

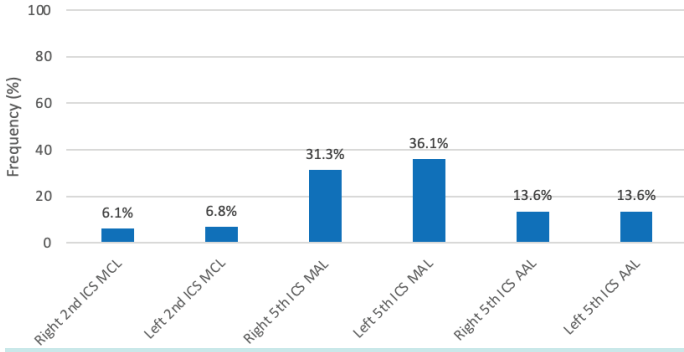

Figure 1. The dispersion of the patients whose measurement is 50 mm and above for computed tomography

ICS: Intercostal Space; MCL: Midclavicular Line; MAL: Mid Axillary Line; AAL: Anterior Axillary Line.

DISCUSSION

This research demonstrated that a high BMI independently predicts NT failure. Additionally, it was observed that CWT increases in correlation with BMI across all three regions, with CWT measurements being larger in female patients compared to male patients. Moreover, it was found that CWT is thinner at the 2nd ICS-MCL than at the 5th ICS-MAL and 5th ICS-AAL.

NT is a simple but crucial procedure that can be performed on patients with tension pneumothorax. Determining the appropriate catheter size and procedure site prior to the procedure increases the success rate of this critical intervention. Although there are current guidelines that explain how NT should be performed, the number of studies regarding the impacts of differences in BMI, sex, catheter size, and application areas on the success rate of the treatment is increasing (17,18).

The studies in the literature that assess CWT measurements differ in terms of results. In our study, the mean CWT of the patients was found to be 34.2 mm, and CWT was >50 mm for 158 (17.9%) of the total of 882 distances measured. In a study conducted in Japan, the mean CWT of patients was found to be 30.6 mm, and the thickness measured in a total of 483 areas (94.3%) was found to be less than 50 mm (10). Another study determined that the mean chest wall thickness for the anterior approach was 4.04 cm on the left and 3.92 cm on the right (18). On the other hand, in a study on patients

with trauma, the mean CWT was found to be 42 mm, and it was stated that NT could be successfully performed with a 50-mm catheter on only 75% of the patients (19). Based on these results, it can be concluded that CWT can vary between societies and that the percentage of individuals with a CWT of ⩾50 mm is higher for the Turkish society than the average in the literature. Another reason could be that as the number of female patients included in the study increases, the measurements also increase in all areas. The percentage of female patients included in our study (38.1%) was higher than the percentage of female patients in other studies in the literature (22%) (20). This could explain why CWT was found to be higher when compared with other studies.

Various recent studies in different countries yielded results supporting that procedures performed at different anatomic localizations could achieve more success. In a study by Rawlins et al., lateral needle aspiration performed at the 5th ICS-AAL line was found to be technically easier and potentially safer when compared with the 2nd ICS-MAL (21). In a cadaver-based study, NT was successfully placed in 100% of attempts at the 5th ICS-MAL but in only 58% at the 2nd intercostal position (22). In a different study, the 2nd ICS-MCL and the 5th ICS-MAL were compared, and it was shown through tomography measurements that the 5th ICS-MAL was thinner than the 2nd ICS-MCL measurements. Therefore, it was concluded that the 5th ICS-MAL could yield a higher success rate for NT (14). By contrast, our study showed that the ICS-MCL thicknesses of the patients were thinner when compared with other measured areas (5th ICS-MAL, 5th ICS-AAL).

According to the 9th edition of the ATLS guideline, NT should be performed at the 2nd ICS in the MCL using a catheter more than 5 cm in length (13). However, the 10th edition of this guideline suggested that the latest evidence supported the 5th ICS-MAL for a successful NT (4). Our study may reflect differences in the Turkish population, as previous studies showed that CWT might vary between different populations. There are few studies that evaluated the most convenient anatomic region for a successful NT in Turkey (17,23). However, these studies are insufficient to generalize these results for the Turkish population. Moreover, in the recent versions of the ATLS guideline (9th and 10th editions), there is no reference to any Turkish study or population for this procedure. Therefore, the practical use of this guideline in the Turkish population may be limited.

Additionally, according to some studies, it is not recommended to use a catheter longer than 50 mm for NT due to the risks of subclavian or pulmonary artery injury and cardiac tamponade (23,24). Our studies showed that the 2nd ICS measurements were mostly under 50 mm (87.1%) and thinner than the measurements of the other two areas, and that the 50-mm catheter, which is usually recommended, is therefore more suitable.

The 5th ICS-MAL is also recommended for chest decompression procedures (24–26). In a study where 160 patients with trauma from Turkey were included, the 2nd ICS-MCL and 5th ICS-MAL measurements were compared, and it was concluded that needle thoracostomy performed at the 5th ICS-MAL yielded better results (23). The risk of damaging veins and the heart is lower in this area because there is less fatty and muscle tissue. However, the risk of pleural adhesion is higher, and the risk of pulmonary damage can increase when a large pneumothorax is not present (27). Our study showed that the 2nd ICS-MCL thickness was thinner than the 5th ICS-MAL thickness, and therefore, the use of the 5th ICS-MAL for NT procedures is not supported by our study, in contrast to other studies.

In our study, the measurements made in the areas of both the 2nd ICS-MCL and the 5th ICS-MAL and 5th ICS-AAL were higher for female patients than for male patients. Except for the study by Britten et al. (28), all studies, along with our study, emphasize that CWT varies between the sexes (18,29,30). When the impact of BMI on CWT was analyzed, it was seen that CWT increased in both the right and left thoraxes in all three areas. In a previous study, it was also revealed that CWT increased in proportion to BMI (14). Based on these results, it can be suggested that NT procedures could yield lower success rates for female patients and individuals with obesity.

Our study had some limitations. Primarily, our study was conducted with a limited number of patients at a single center. Furthermore, irrespective of BMI, the fact that some patients have subcutaneous thickness increases or asymmetric muscle tissue for right and left chest walls, or large breast tissues, could have had an impact on the measurements.

CONCLUSION

As a result, this study showed that high BMI is an independent indicator of NT failure. It was also illustrated that CWT increases in proportion to BMI in all three areas, and that CWT measurements are greater for female patients than for male patients. Furthermore, it is presented that CWT is thinner at the 2nd ICS-MCL than at the 5th ICS-MAL and 5th ICS-AAL; hence, using a 50-mm catheter, which is used as the standard for NT, at the 2nd ICS-MCL could yield a higher success rate. It should therefore be considered that preferring the 2nd ICS-MCL for the NT procedure can result in a higher success rate.

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Ethics Committee Approval: This study was conducted with the permission of the Yıldırım Beyazıt University Medical Local Ethics Committee (decision no: 26379996/259, date: 18.01.2017).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

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REFERENCES

1. Seamon M, Haut E, Van Arendonk K, Barbosa R, Chiu W, Dente C, et al. An evidence-based approach to patient selection for emergency department thoracotomy: A practice management guideline from the Eastern Association for the Surgery of Trauma. J Trauma Acute Care Surg 2015;79(1):159-173. [CrossRef]
2. Veysi V, Nikolaou VS, Paliobeis C, Efstathopoulos N, Giannoudis PV. Prevalence of chest trauma, associated injuries and mortality: A level I trauma centre experience. Int Orthop 2009;33(5):1425-33. [CrossRef]
3. Lema M, Chalya P, Mabula J, Mahalu W. Pattern and outcome of chest injuries at Bugando Medical Centre in Northwestern Tanzania. J Cardiothorac Surg 2011;6(1):7. [CrossRef]

4. Galvagno S, Nahmias J, Young D. Advanced trauma life support Update 2019: Management and applications for adults and special populations. Anesthesiol Clin 2019;37(1):13-32. [CrossRef]
5. Aho J, Thiels C, El Khatib M, Ubl D, Laan D, Berns K, et al. Needle thoracostomy: Clinical effectiveness is improved using a longer angiocatheter. J Trauma Acute Care Surg 2016;80(2):272. [CrossRef]
6. Ball C, Wyrzykowski A, Kirkpatrick A, Dente C, Nicholas J, Salomone J, et al. Thoracic needle decompression for tension pneumothorax: Clinical correlation with catheter length. Can J Surg 2010;53(3):184.
7. Laan D, Vu T, Thiels C, Pandian T, Schiller H, Murad M, et al. Chest wall thickness and decompression failure: A systematic review and meta-analysis comparing anatomic locations in needle thoracostomy. Injury 2016;47(4):797-804. [CrossRef]
8. Sanchez L, Straszewski S, Saghir A, Khan A, Horn E, Fischer C, et al. Anterior versus lateral needle decompression of tension pneumothorax: Comparison by computed tomography chest wall measurement. Acad Emerg Med 2011;18(10):1022-6. [CrossRef]
9. Mandt M, Hayes K, Severyn F, Adelgais K. Appropriate needle length for emergent pediatric needle Thoracostomy utilizing computed tomography. Prehospital Emerg Care 2019;23(5):663-71. [CrossRef]
10. Yamagiwa T, Morita S, Yamamoto R, Seki T, Sugimoto K, Inokuchi S. Determination of the appropriate catheter length for needle thoracostomy by using computed tomography scans of trauma patients in Japan. Injury 2012;43(1):42-5. [CrossRef]
11. McLean A, Richards M, Crandall C, Marinaro J. Ultrasound determination of chest wall thickness: Implications for needle thoracostomy. Am J Emerg Med 2011;29(9):1173-7. [CrossRef]
12. Weichenthal L, Crane D, Rond L. Needle thoracostomy in the prehospital setting: A retrospective observational study. Prehospital Emerg Care 2016;20(3):399-403. [CrossRef]
13. Brasel KJ. Advanced trauma life support (ATLS): The ninth edition. J Trauma Acute Care Surg 2013;74(5):1363-6. [CrossRef]
14. Inaba K, Ives C, McClure K, Branco B, Eckstein M, Shatz D, et al. Radiologic evaluation of alternative sites for needle decompression of tension pneumothorax. Arch Surg 2012;147(9):813-8. [CrossRef]
15. World Health Organization. World Health Organization obesity and overweight fact sheet. Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. Accessed Sep 6, 2024.
16. World Health Organization Definition of an older or elderly person. Available at: http://www.who.int/healthinfo/survey/ageingdefnolder/en/index.html. Accessed May 22, 2023.
17. Ozen C, Akoglu H, Ozdemirel R, Omeroglu E, Ozpolat C, Onur O, et al. Determination of the chest wall thicknesses and needle thoracostomy success rates at second and fifth intercostal spaces: A cadaver-based study. Am J Emerg Med 2016;34(12):2310-4. [CrossRef]
18. Goh S, Xu W, Teo L. Decompression of tension pneumothoraces in Asian trauma patients: Greater success with lateral approach and longer catheter lengths based on computed tomography chest wall measurements. Eur J Trauma Emerg Surg 2017;44(5):767-71. [CrossRef]
19. Givens M, Ayotte K, Manifold C. Needle thoracostomy: Implications of computed tomography chest wall thickness. Acad Emerg Med 2004;11(2):211-3. [CrossRef]
20. Zengerink I, Brink P, Laupland K, Raber E, Zygun D, Kortbeek J. Needle thoracostomy in the treatment of a tension pneumothorax in trauma patients: What size needle? J Trauma Acute Care Surg 2008;64(1):111-4. [CrossRef]
21. Rawlins R, Brown K, Carr C, Cameron C. Life threatening haemorrhage after anterior needle aspiration of pneumothoraces. A role for lateral needle aspiration in emergency decompression of spontaneous pneumothorax. Emerg Med J 2003;20(4):383-4. [CrossRef]
22. Inaba K, Branco B, Eckstein M, Shatz D, Martin M, Green D. Optimal positioning for emergent needle thoracostomy: A cadaver-based study. J Trauma Acute Care Surg 2011;71(5):1099-103. [CrossRef]
23. Akoglu H, Akoglu EU, Evman S, Akoglu T, Altinok A, Guneysel O, et al. Determination of the appropriate catheter length and place for needle thoracostomy by using computed tomography scans of pneumothorax patients. Injury 2013;44(9):1177-82. [CrossRef]
24. Jenkins C, Sudheer P. Needle thoracocentesis fails to diagnose a large pneumothorax. Anaesthesia 2000;55(9):925-6. [CrossRef]
25. Leight-Smith S, Haris T. Tension pneumothorax: Time for a re-think? Emerg Med J 2005;22(1):8-16. [CrossRef]
26. Maybauer M, Geisser W, Wolff H, Maybauer D. Incidence and outcome of tube thoracostomy positioning in trauma patients. Prehospital Emerg Care 2012;16(2):237-41. [CrossRef]
27. Wernick B, Hon H, Mubang R, Cipriano A, Hughes R, Rankin D, et al. Complications of needle thoracostomy: A comprehensive clinical review. Int J Crit Illn Inj Sci 2015;5(3):160. [CrossRef]
28. Britten S, Palmer S, Snow T. Needle thoracocentesis in tension pneumothorax: Insufficient cannula length and potential failure. Injury 1996;27(5):321-2. [CrossRef]
29. Schroeder E, Valdez C, Krauthamer A, Khati N, Rasmus J, Amdur R, et al. Average chest wall thickness at two anatomic locations in trauma patients. Injury 2013;44(9):1183-5. [CrossRef]
30. Rottenstreich M, Fay S, Gendler S, Klein Y, Arkovitz M, Rottenstreich A. Needle thoracotomy in trauma. Mil Med 2015;180(12):1211-3. [CrossRef]