PAPER

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Radiologic Evaluation of Alternative Sites for Needle Decompression of Tension Pneumothorax

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Objective: To compare the distance to be traversed during needle thoracostomy decompression performed at the second intercostal space (ICS) in the midclavicular line (MCL) with the fifth ICS in the anterior axillary line (AAL).

Design: Patients were separated into body mass index (BMI) quartiles, with BMI calculated as weight in kilograms divided by height in meters squared. From each BMI quartile, 30 patients were randomly chosen for inclusion in the study on the basis of a priori power analysis (n = 120). Chest wall thickness on computed tomography at the second ICS in the MCL was compared with the fifth ICS in the AAL on both the right and left sides through all BMI quartiles.

Setting: Level I trauma center.

Patients: Injured patients aged 16 years or older evaluated from January 1, 2009, to January 1, 2010, undergoing computed tomography of the chest.

Results: A total of 680 patients met the study inclusion criteria (81.5% were male and mean age was 41 years [range, 16-97 years]). Of the injuries sustained, 13.2% were penetrating, mean (SD) Injury Severity Score was 15.5 (10.3), and mean BMI was 27.9 (5.9) (range, 15.4-60.7). The mean difference in chest wall thickness between the second ICS at the MCL and the fifth ICS at the AAL was 12.9 mm (95% CI, 11.0-14.8; $P < .001$) on the right and 13.4 mm (95% CI, 11.4-15.3; $P < .001$) on the left. There was a stepwise increase in chest wall thickness across all BMI quartiles at each location of measurement. There was a significant difference in chest wall thickness between the second ICS at the MCL and the fifth ICS at the AAL in all quartiles on both the right and the left. The percentage of patients with chest wall thickness greater than the standard 5-cm decompression needle was 42.5% at the second ICS in the MCL and only 16.7% at the fifth ICS in the AAL.

Conclusions: In this computed tomography–based analysis of chest wall thickness, needle thoracostomy decompression would be expected to fail in 42.5% of cases at the second ICS in the MCL compared with 16.7% at the fifth ICS in the AAL. The chest wall thickness at the fifth ICS AAL was 1.3 cm thinner on average and may be a preferred location for needle thoracostomy decompression.

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TENSION PNEUMOTHORAX IS A potentially life-threatening condition that requires urgent decompression. Because of the time constraints associated with formal tube thoracostomy, the initial treatment sequence often involves percutaneous decompression

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with a catheter. Catheter-based needle thoracostomy, as outlined by the eighth edition of the American College of Surgeons Committee on Trauma's Advanced Trauma Life Support program,[1] recommends that decompression be performed using a 5-cm catheter inserted into the second intercostal space (ICS) in the midclavicular line (MCL). A validated set of clinical indications for needle placement does not exist. Consequently, the reported incidence of needle thoracostomy varies widely,

from 0.2% in a series of mixed advanced life support calls[2] to up to 1.7% in a highly selected series of patients with predominantly penetrating trauma seen in an urban setting.[3] With a clear lack of consensus on the true indications for needle thoracostomy decompression and the inability to obtain a definitive diagnosis of tension pneumothorax before decompression because of the urgency of the procedure, it is not sur-

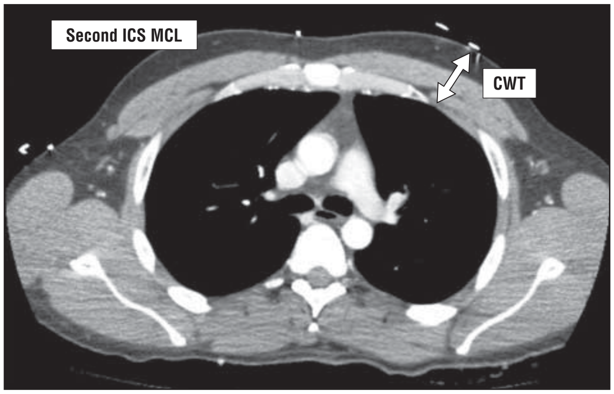

Figure 1. Transverse image showing the location of measurement for the second intercostal space (ICS) in the midclavicular line (MCL). CWT indicates chest wall thickness.

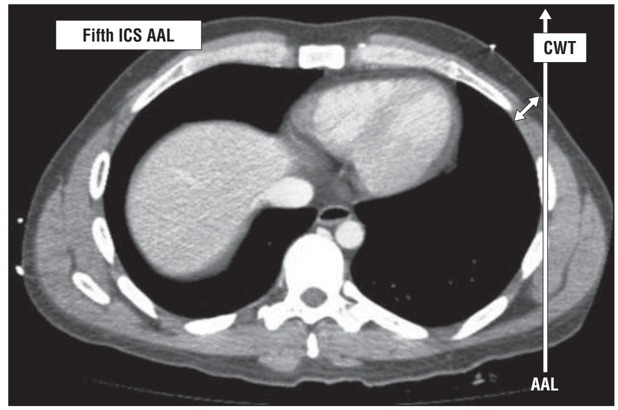

Figure 2. Transverse image showing the location of measurement for the fifth intercostal space (ICS) in the anterior axillary line (AAL). CWT indicates chest wall thickness.

prising that the utility or success rate of this procedure is unknown. While the success rates are poorly understood, it has been clearly demonstrated that needle thoracostomy decompression sometimes fails.

In a recently published study by Ball and colleagues[4] of patients with blunt trauma undergoing prehospital needle thoracostomy, the success rate for the procedure was examined for aircrews and ground-based emergency medical services crews with different-sized catheters. If a large residual pneumothorax detected at admission through either ultrasound or computed tomography (CT) is used as a surrogate marker of failure, 4% to 65% of patients had unsuccessful needle thoracostomy decompression. In their analysis, if all the patients who had immediate placement of a tube thoracostomy before imaging were also presumed to have had a residual pneumothorax, the failure rate would increase even higher, to 32% to 81%. The success rates were dependent primarily on catheter length, with the higher failure rate associated with 3.2-cm catheters compared with 4.5-cm catheters.

The thickness of the chest wall at the second ICS and its relationship to catheter length has been examined in several CT-based studies.[5-8] In one of these studies,[6] the catheters used could not traverse the chest wall in approximately half of the patients analyzed. This assumes that the catheter is placed perfectly through the chest wall, taking the most direct path into the pleural cavity. In reality, the success rate is likely to be even lower because perfectly perpendicular placement is unlikely to be the norm. In another study, Zengerink et al[7] found that female patients had an even higher chance of catheter failure because of increased chest wall thickness compared with males.

Whereas the Advanced Trauma Life Support[1] program recommends needle thoracostomy decompression in the second ICS at the MCL, it recommends that tube thoracostomy be performed in the fifth ICS anterior to the midaxillary line. This latter position is easily accessible in the supine patient and, if needle thoracostomy decompression were to be performed at this location, it would not impede emergency medical services transport. In addition, extensive experience is available with the placement of wire-guided thoracostomy tubes using the Seldinger technique in this location, a procedure that essentially begins with placement of a needle thoracostomy catheter. This formed the basis for considering the fifth ICS in the anterior axillary line (AAL) for needle thoracostomy decompression rather than the traditional second ICS in the MCL. This hypothesis was recently tested in a fresh cadaver-based study from our institution. After evaluation of 20 cadavers, needle thoracostomy was successfully placed in 100% of attempts at the fifth ICS but in only 58% at the traditional second ICS.[9]

The purpose of this study, therefore, was to compare the utility of needle thoracostomy decompression in these 2 positions: the second ICS at the MCL and the fifth ICS at the AAL. We also sought to assess the impact of progressively increasing body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared). Our hypothesis was that the chest wall thickness is increased at the second ICS compared with the fifth ICS and that this difference increases with increasing patient BMI.

METHODS

After institutional review board approval, all trauma patients 16 years or older admitted from January 1, 2009, to January 1, 2010, to the Los Angeles County University of Southern California (LAC+USC) Medical Center were retrospectively identified. Those who had a chest CT performed were eligible for inclusion in the analysis and, to assess the effect of BMI on chest wall thickness, were separated into BMI quartiles. From each BMI quartile, 30 patients were randomly chosen for inclusion in the study on the basis of results of a power analysis.

The trauma CT chest examinations were performed on a single-source 64-detector CT scanner (Aquilion CFX; Toshiba), using the following criteria: 120 kilovolt (peak), 200 to 500 mA seconds (using dose modulation depending on the size of the patient), gantry revolution speed of 0.5 to 1.0 seconds, beam pitch of 0.5 to 0.828, beam collimation of 64×1.0 mm, variable field of view (depending on the size of the patient), and standard body kernel. Through a line suitable for power contrast injection (14- to 20-gauge peripheral intravenous line in the antecubital fossa or a central venous catheter that has been approved by the manufacturer for power injection), 75 to 100 mL iodinated intravenous contrast material (Omnipaque 350; GE Healthcare) was injected at a rate of 3 mL/s followed by a 40-mL saline flush by a power injector (Medrad). Delay of contrast injection was 35 to 40 seconds before the beginning of the scan. Reconstruction section thickness of 3 mm in the axial, coronal, and sagittal planes was routinely performed.

Table 1. Chest Wall Thickness by Location

	Distance From Skin to Pleural Cavity, Mean (SD) [Range], mm			
	Right Second ICS at MCL	Left Second ICS at MCL	Right Fifth ICS at AAL	Left Fifth ICS at AAL
All patients (N = 120)	46.0 (13.9)	45.1 (14.7)	32.9 (17.1)	31.6 (14.7)
By BMI quartile				
1 (n = 30)	33.0 (6.3) [23.5-0.4]	33.1 (8.0) [19.0-53.8]	20.5 (7.2) [11.8-39.7]	20.1 (6.6) [11.9-35.5]
2 (n = 30)	40.8 (10.7) [22.5-66.2]	40.2 (9.3) [22.0-64.0]	26.5 (8.5) [14.5-52.3]	27.7 (10.4) [12.5-54.9]
3 (n = 30)	50.5 (8.8) [25.3-70.5]	49.0 (9.4) [30.4-71.5]	33.2 (10.5) [17.2-66.1]	32.9 (9.8) [17.4-65.3]
4 (n = 30)	59.6 (12.3) [35.2-93.4]	58.0 (17.1) [37.9-108.1]	51.6 (20.0) [24.7-103.3]	46.0 (16.6) [24.7-103.3]

Abbreviations: AAL, anterior axillary line; BMI, body mass index; ICS, intercostal space; MCL, midclavicular line.

Patient variables extracted from the electronic medical record system (Sunrise Critical Care version 1.4, Eclipsys, Inc [now Allscripts, Inc]) included age, sex, Injury Severity Score (ISS), mechanism of injury, height, and weight. In addition, chest wall thickness, defined as the distance between the skin and the pleural cavity perpendicular to the chest wall, was measured for each patient at 4 different locations: the second ICS in the MCL on the right and left and the fifth ICS in the AAL on the right and left. Measurements were obtained using the caliper function of image-viewing software (Synapse version 3.1.1, Fujifilm Medical Systems) on a standard workstation.

The technique used to measure the desired distances was standardized. For the second ICS in the MCL, using the scout and coronal images, the length of each clavicle was measured or was estimated when the entire clavicle was not imaged, and the MCL was identified. Using sagittal sections, the second and third ribs and the second ICS were identified on the transverse sections by using a linking function. A mark was made at the intersection between the determined MCL and the second ICS, on the transverse section. At this mark, chest wall thickness was then measured in a straight line perpendicular to the skin (**Figure 1**).

For the fifth ICS in the AAL, again using the sagittal section, the fifth and sixth ribs and the fifth ICS were identified. The fifth ICS was then identified on the transverse section by using a linking function, and the anterior portion of the fifth ICS was followed down to the penultimate slice on which the fifth rib remains visible. The AAL was defined as the posteriormost portion of the fifth rib visible on this penultimate slice. The chest wall thickness was measured in a straight line perpendicular to the skin at the AAL on the transverse section (**Figure 2**).

STATISTICAL ANALYSIS

A power analysis was performed using 20 consecutive CT scans of the chest read twice in random order by an independent reader (K.M.) who was blinded to the previous reading. When we used the calculated intrareader variability as standard error, an estimated observed difference in chest wall thickness of 1 cm from cadaver-based measurements from our institution, and a β value of 0.20, the sample size needed to achieve statistical significance at the 5% level was 30 patients per group. The same reader performed the power analysis and final study readings. The normality of the data was evaluated using the histogram plot, kurtosis, and skewness; *P* values for normality were obtained using the 1-sample Kolmogorov-Smirnov test. Mean, standard deviation, range, and percentage were used to describe variables. Two-tailed paired *t* test or Wilcoxon signed rank test was used to compare means. Analysis was performed using commercial software (SPSS for Windows, version 12.0; SPSS, Inc).

RESULTS

During the 1-year study, a total of 5124 trauma patients aged 16 years or older were admitted to the LAC+USC Medical Center. Of those, 680 patients (13.3%) underwent CT of the chest. The patient population was 81.5% male (n=554), the mean age was 41 years (range, 16-97 years), and 13.2% had sustained penetrating trauma (n=90). Mean (SD) ISS was 15.5 (10.3) and mean BMI was 27.9 (5.9) (range, 15.4-60.7). Quartile 1 had a mean BMI of 21.4 (1.7) (range, 15.4-23.7), quartile 2 had a mean of 25.7 (1.1) (range, 23.8-27.4), quartile 3 had a mean of 29.1 (0.94) (range, 27.5-30.8), and quartile 4 had a mean of 35.5 (5.3) (range, 30.9-60.7). There were no statistically significant differences between the total population and the subgroup randomly selected for inclusion in the study (n=120): the subgroup was 82.5% male, the mean age was 39.2 years (range, 16-88 years), 13.3% sustained penetrating trauma, the mean ISS was 15.4 (9.8), and the mean BMI was 27.6 (6.7).

The mean chest wall thickness on the right second ICS at the MCL was 46.0 (13.9) mm. The mean chest wall thickness at the same position on the left was 45.1 (14.7) mm. The mean difference between those measurements was 0.8 mm (95% CI, −0.7 to 2.4; $P=.13$). The mean chest wall thickness at the right fifth ICS at the AAL was 32.9 (17.1) mm. The chest wall thickness at the same position on the left was 31.6 (14.7) mm. The mean difference between those measurements was 1.3 mm (95% CI, −0.1 to 2.7; $P=.04$). The difference in chest wall thickness between the second ICS at the MCL and the fifth ICS at the AAL was significant on both the right and the left; the mean difference was 12.9 mm (95% CI, 11.0-14.8; $P<.001$) on the right and 13.4 mm (95% CI, 11.4-15.3; $P<.001$) on the left. After patients were separated into BMI quartiles, the chest wall thickness increased stepwise across the quartiles at each location of measurement (**Table 1**). The difference in chest wall thickness between the second ICS at the MCL and the fifth ICS at the AAL remained significant in all quartiles on both the right and the left (**Table 2**). The difference in chest wall thickness between the right and left at the fifth ICS in AAL was significant only in the highest BMI quartile.

The percentage of patients with a chest wall thickness greater than 5 cm was 42.5% at the second ICS in the MCL and 16.7% at the fifth ICS in the AAL (**Figure 3**). This difference was most pronounced in the

Table 2. Mean Differences in Chest Wall Thickness Between Locations

Location 1	Location 2	Mean Difference, mm (95% CI)	*P* Value
Results for All Patients (N = 120)			
Right second ICS at MCL	Left second ICS at MCL	0.8 (−0.7 to 2.4)	.13
Right fifth ICS at AAL	Left fifth ICS at AAL	1.3 (−0.1 to 2.7)	.04
Right second ICS at MCL	Right fifth ICS at AAL	12.9 (11.0 to 14.8)	<.001
Left second ICS at MCL	Left fifth ICS at AAL	13.4 (11.4 to 15.3)	<.001
Results by BMI Quartile			
Quartile 1: BMI, 20.4 (2.6) (n = 30)			
Right second ICS at MCL	Left second ICS at MCL	−0.1 (−2.0 to 1.9)	.62
Right fifth ICS at AAL	Left fifth ICS at AAL	0.4 (−0.8 to 1.6)	.63
Right second ICS at MCL	Right fifth ICS at AAL	12.5 (9.8 to 15.3)	<.001
Left second ICS at MCL	Left fifth ICS at AAL	13.0 (9.8 to 16.1)	<.001
Quartile 2: BMI, 24.9 (1.2) (n = 30)			
Right second ICS at MCL	Left second ICS at MCL	0.5 (−3.2 to 4.3)	.79
Right fifth ICS at AAL	Left fifth ICS at AAL	−1.2 (−4.5 to 2.1)	.86
Right second ICS at MCL	Right fifth ICS at AAL	14.4 (10.9 to 17.9)	<.001
Left second ICS at MCL	Left fifth ICS at AAL	12.6 (8.3 to 16.8)	<.001
Quartile 3: BMI, 28.7 (1.0) (n = 30)			
Right second ICS at MCL	Left second ICS at MCL	1.6 (−1.3 to 4.4)	.17
Right fifth ICS at AAL	Left fifth ICS at AAL	0.3 (−1.7 to 2.3)	.66
Right second ICS at MCL	Right fifth ICS at AAL	17.4 (14.5 to 20.3)	<.001
Left second ICS at MCL	Left fifth ICS at AAL	16.1 (12.8 to 19.4)	<.001
Quartile 4: BMI, 36.2 (6.3) (n = 30)			
Right second ICS at MCL	Left second ICS at MCL	1.5 (−2.3 to 5.4)	.178
Right fifth ICS at AAL	Left fifth ICS at AAL	5.6 (2.2 to 9.1)	.006
Right second ICS at MCL	Right fifth ICS at AAL	8.0 (2.5 to 13.4)	.006
Left second ICS at MCL	Left fifth ICS at AAL	12.1 (7.0 to 17.1)	<.001

Abbreviations: AAL, anterior axillary line; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); ICS, intercostal space; MCL, midclavicular line.

higher BMI quartiles. The difference in the proportion of patients with chest wall thickness greater than 5 cm at the 2 locations was not as pronounced in female patients but remained statistically significant (41.0% vs 36.4%; *P* = .003).

COMMENT

Traditionally, needle thoracostomy is performed in the second ICS at the MCL. This has also been the standard recommendation by the Advanced Trauma Life Support program for emergent chest decompression. Review of the published clinical series[2,3,10-12] describing this procedure demonstrates that the true indications, technique for placement, and reported success rates are poorly understood. Examining the second ICS as an insertion site, Ball and colleagues[4] found a high rate of residual pneumothorax, despite an attempt at needle decompression, on the initial admission ultrasonogram, serving as a clear demonstration that needle thoracostomy decompression often fails. In their series of patients with blunt trauma, decompression had failed in 4% to 65% of patients, increasing even more to 32% to 81% if all patients undergoing immediate tube thoracostomy were assumed to have had unsuccessful decompression.

The actual process of decompression through a catheter is likely effective and may not be the primary reason for failure. Holcomb and colleagues[13] used a 14-gauge catheter in a swine model of tension hemopneumothorax created by instilling blood into the pleural space followed by needle insufflation. The tension was equally well relieved by needle thoracostomy or 32F tube thoracostomy, with 100% survival compared with no survivors in the control group. In clinical practice, however, the chest wall thickness relative to the catheter length is likely the limiting factor determining success.

In our study, whereas there were no clinically significant differences between the right and left chest walls, the second ICS had a significantly thicker distance for a needle to traverse, with a mean difference of 12.9 mm on the right and 13.4 mm on the left. Even assuming a perfect straight-line trajectory into the pleural cavity, 42.5% of catheters would not have entered the chest in the second ICS compared with 16.7% at the fifth space. The impact of BMI was also clear. As BMI increased, there was a stepwise increase in the chest wall thickness for both insertion sites. On both the right and the left in each of the BMI quartiles, the distance that the needle would have to traverse to penetrate the pleural cavity was significantly shorter at the fifth ICS compared with the second. When we used the average chest wall thickness, patients in the second BMI quartile would have a high likelihood of decompression failing with any eccentric needle placement if an attempt was made in the second ICS. For the third and fourth quartiles, even with perfect straight-line placement, decompression would have failed. For the fifth ICS, however, on average, needle thoracostomy decompression would be possible up to and including the third BMI quartile, with the average chest wall thickness remaining less than 3.5 cm. For patients

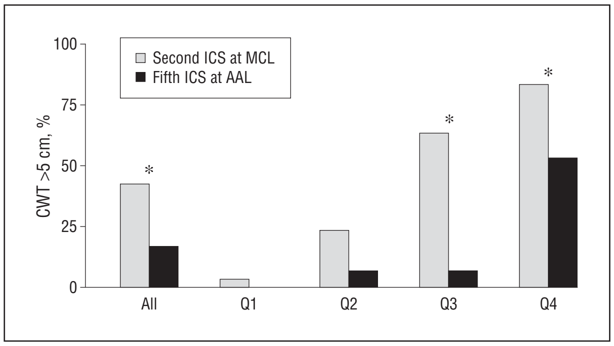

Figure 3. Percentage of patients with chest wall thickness (CWT) greater than 5 cm. AAL indicates anterior axillary line; ICS, intercostal space; MCL, midclavicular line; and Q, body mass index quartile (n=30 in each). *$P < .05$.

in the fourth quartile, needle decompression would have failed in the fifth ICS as well as the second.

In a previous model from our institution,[9] 20 randomly selected unpreserved adult cadavers were evaluated. Overall, 100% (40 of 40) of needles placed in the fifth ICS and 57.5% (23 of 40) of the needles placed in the second ICS entered the chest cavity ($P < .001$). When the thickness of the chest wall was evaluated in both locations, the chest wall thickness in the fifth ICS was 1 cm thinner ($P < .05$). In a case series outlining the complications associated with needle thoracostomy decompression in the second intercostal space, Rawlins et al[14] suggested that the fifth ICS at the AAL be considered for needle thoracostomy decompression. Wax and Leibowitz[15] analyzed a series of preoperative chest CT scans in patients who had undergone video-assisted thoracoscopy. They concluded that decompression should be performed using a 7-cm needle, also in an alternative position, which they described as the midline of the hemithorax, at the level of the sternal angle. This is a position lying medial to the MCL using surface anatomy cues for landmarking. The rationale behind their recommendation stems from a study[16] performed in Ireland in which emergency medicine physicians demonstrated significant difficulty in marking the position for needle decompression in a human volunteer despite the fact that the majority could correctly name where the decompression should occur. They compared this position with 2 other landmarks, which they defined as the midaxillary line at the level of the xiphoid process and the AAL at the same level. Despite their conclusions, the authors found that the AAL had the shortest distance between the skin and pleura at 2.6 cm (range, 1.0-7.7 cm) compared with the midaxillary line at 3.5 cm (range, 1.7-9.3 cm) and their hemithorax midline position at the level of the sternal angle, which measured 3.1 cm (range, 1.4-6.9 cm). In other studies using CT to measure chest wall thickness at the second ICS,[5-8] a similar range of chest wall thicknesses was found. The lack of BMI stratification makes direct comparison difficult; however, all uniformly report the inadequacy of catheter decompression at the second ICS, even if a perfect entry into the pleural cavity is assumed. In the study by Givens et al,[5] the mean chest wall thickness was 4.24 cm, with approximately a quarter (22.5%) having a chest wall thickness in excess of 5 cm. A similar finding of 4.5 cm on the right and 4.1 cm on the left was found in the study by Stevens et al[6] and by Harcke and colleagues[8] in a cohort of male military personnel who had undergone a virtual autopsy, with the mean thickness 5.36 cm. In the study by Givens et al,[5] as well as that by Zengerink et al,[7] female patients were found to have increased chest wall thickness. A similar finding was seen in our study. Because these data are translated into clinical practice, female patients, in particular, may benefit from a change in needle length or in the position of needle placement.

This study quantified the chest wall thickness at both the second ICS in the MCL line as well as at the fifth ICS in the AAL and factored in the impact of BMI, increasingly a problem with our injured patient population. These measurements were performed on a workstation where perfect needle trajectory could be plotted. Consequently, the real-life clinical translation of these data must take into consideration the less-than-optimal environment, which would favor imperfect, eccentric needle placement. It is likely, however, that this limitation serves to accentuate the magnitude of our findings. In addition, because the purpose of this study was to analyze the technical aspects of needle thoracostomy decompression, the results do not allow validation of the indications for needle placement, an issue that warrants further clarification to place this work in context. Finally, simply entering the chest does not ensure that the tension pneumothorax will be adequately treated. Even under optimal conditions, needle decompression may only relieve the tension physiology; definitive treatment with chest tube insertion, regardless of where the decompression was performed, may still be required. Despite these limitations, this CT-based study demonstrated that, for all but the lowest BMI quartile, successful needle placement in the second ICS in the MCL would be challenging. For many patients in the upper 2 BMI quartiles, it would likely be impossible. Contrary to this, for most patients, needle placement in the fifth ICS in the AAL is feasible on both the left and the right sides of the chest.

We conclude from this CT-based analysis of chest wall thickness that needle thoracostomy would be expected to fail in 42.5% of cases at the second ICS compared with 16.7% at the fifth ICS. On average, the chest wall thickness was 1.3 cm less in the fifth ICS, which may facilitate successful needle placement. As BMI increases, there is a stepwise increase in chest wall thickness, further compounding the difficulty of needle placement in all but the lowest BMI quartile for the second ICS. Validation in trauma patients of use of a longer needle or alternate insertion site, such as the fifth ICS in the midaxillary line, is warranted.

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INVITED CRITIQUE

ONLINE FIRST

The Death of Another Sacred Cow

Generations of advanced trauma life support students have been taught that placing a 5-cm needle in the fifth ICS at the MCL is one of the fastest and easiest ways to save the life of a patient with a tension pneumothorax. This article[1] is another in a series of assaults by Dr Inaba and his colleagues on this very basic concept. In their previous work,[2] Dr Inaba placed 5-cm needles in cadavers and then performed thoracotomies to see whether the needles entered the chest. They found that 100% of needles placed in the fifth ICS at the AAL entered the chest, while only 58% of needles placed in the second ICS at the MCL did so.

In this manuscript, Dr Inaba studied patients admitted to LAC+USC Medical Center, and he analyzed their chest wall thickness using CT. There were 4 important findings:

1. The chest wall thickness was greater at the MCL site compared with the AAL line.
2. Chest wall thickness increased with increasing BMI.
3. Standard 5-cm needles are not long enough to reach the chest cavity in more than 42% of patients at the MCL site vs in almost 17% of patients at the AAL site.
4. Chest wall thickness is greater in females than in males.

This study is very well done; however, I question the need to perform it in light of their previous data, and there are several critical issues that could have been addressed in the article but were not:

1. None of the patients in this study underwent needle thoracostomy. It would have been interesting to provide clinical correlations in patients who did and assess the success of the procedure relative to chest wall thickness seen on CT.
2. The authors have repeatedly shown that use of a 5-cm needle in the second ICS at the MCL is inadequate in a significant portion of the population, but they have not advocated for a solution or a course of action to correct this problem. They also have not addressed the potential complications of using a longer needle or the devastating complication of cardiac injury if the fifth ICS at the AAL is used.
3. In addition to the problem of length, angiocatheters kink easily in transport and they can be displaced. These issues were not addressed.

Although the studies that Inaba and colleagues are performing are straightforward, they have major implications for the way treatment of trauma is practiced. These types of studies make one ask, How could we have done it so wrong for so long?

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