

ความหนาของผนังทรวงอกในบริเวณที่ใช้ในการใส่สายระบายทรวงอก

ผาติ อังคสิทธิ์, ภาณุ วีระตกุลพิศาล*, ไชยยุทธ ธนไพศาล, ณรงค์ชัย ว่องกมลกิจศิลป์

ภาควิชาศัลยศาสตร์ คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่น

Chest Wall Thickness at a Proper Area for Insertion of Intercostal Chest Drainage

Phati Angkasith, Panu Teeratakulpisarn*, Chaiyut Thanapaisal, Narongchai Wongkonkitsin

Department of Surgery, Faculty of Medicine, Khon Kaen University, Thailand

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หลักการและวัตถุประสงค์: การใส่สายระบายช่องอกในปัจจุบันกระทำในตำแหน่งที่เรียกว่า “Safe triangle” (ซึ่งประกอบด้วยขอบด้านหน้าของกล้ามเนื้อ latissimus dorsi, ขอบหลังของกล้ามเนื้อ pectoralis major, และระดับของหัวนม) ผนังทรวงอกที่หนาขึ้นจะส่งผลต่อความยากของการทำหัตถการ การศึกษาครั้งนี้จึงกระทำเพื่อให้ทราบถึงตำแหน่งที่ปลอดภัยสำหรับการใส่สายระบายช่องอก

วิธีการศึกษา: การศึกษาโดยร่างอาจารย์ใหญ่ ซึ่งใช้วิธีวัดความหนาของผนังช่องอกเพื่อให้ทราบถึงตำแหน่งที่บางที่สุด โดยกระทำการวัดในหน่วยมิลลิเมตรและวัดระดับดัชนีมวลกายร่วมด้วย

ผลการศึกษา: ทำการศึกษาร่างอาจารย์ใหญ่ 20 ร่าง ค่าเฉลี่ยความหนาของผนังทรวงอกในตำแหน่ง safe triangle อยู่ที่ 14.4 – 23.9 มิลลิเมตร ส่วนบริเวณที่มีความหนามากกว่า 50 มิลลิเมตรนั้นอยู่ที่ขอบหน้า axillary line (54 และ 56 มิลลิเมตร) ตัดกับช่องซี่โครงช่องที่ 3 ในขณะที่บริเวณที่บางที่สุด (14.4 มิลลิเมตร) อยู่บริเวณซี่โครงช่องที่ 7 และเพศหญิงมักมีผนังทรวงอกที่หนากว่าเพศชาย

สรุป: ผนังทรวงอกบางพื้นที่ภายใน safe triangle นั้นมีความหนามากกว่า 50 มิลลิเมตร การใส่สายระบายช่องอกจึงควรกระทำด้วยความระมัดระวังโดยเฉพาะในผู้ป่วยเพศหญิง และควรหลีกเลี่ยงการทำหัตถการในระดับที่ต่ำกว่าซี่โครงช่องที่ 6 เนื่องจากอาจใส่สายระบายเข้าไปในช่องท้องได้

คำสำคัญ: การบาดเจ็บที่หน้าอก; ท่อระบายน้ำระหว่างซี่โครง

Background and objectives: Nowadays, the areas for insertion of tube thoracostomy are mostly applied in the safety triangle area (lateral border of pectoralis major muscle, anterior border of latissimus dorsi muscle and the nipple line). The thicker chest wall may contribute to difficult tube thoracostomy insertion. So, cadaveric chest walls are measured for thickness to confirm appropriateness of safety triangle.

Methods: The fresh cadaveric chest wall was measured by the needle tapping the chest wall within the safety triangle combined with sternotomy to determine the thinnest area of the chest wall. The measured values are recorded in millimeters (mm.). The mean thickness of the chest wall, standard deviation (SD), BMI of the cadaver before preparation were studied

Results: The 20 fresh cadaveric chest walls were measured for thickness. The mean chest wall thickness within the safety triangle varies between 14.4 mm. to 23.9 mm. The areas with more than 50 mm thickness were mostly found in the mid-axillary line and two cases (54 and 56 mm.) in the 3rd intercostal space crossing with anterior axillary line. While the thinnest areas (14.4 mm.) are found within 7th intercostal space. Most female cadavers have thicker chest wall than male.

Conclusion: Some areas in the safety triangle for tube thoracostomy insertion are more than 50 mm. in thickness. The area for insertion of the tube thoracostomy should be carefully selected,

*Corresponding author : Panu Teeratakulpisarn, Department of Surgery, Faculty of Medicine, Khon Kaen University, Thailand. E-mail: panute@kku.ac.th

especially in woman and the obese patients. Moreover, insertion below 6th intercostal space should be avoided due to risk of peritoneal penetration.

Key words: chest trauma; intercostal chest drain; tension pneumothorax; chest injury

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Introduction

Accident patients who have suffered blunt chest trauma often experience pneumothorax or hemothorax. In which these conditions are mainly to be treated with intercostal chest drainage first, then initiated specific treatment depending the conditions¹. Inserting the intercostal chest drainage tube at an appropriate location will allow minor injuries to the tissue surrounding the area compared to inserting a tube in an inappropriate position². Inappropriate position of chest tube may cause soft tissue trauma such as pectoralis muscle, latissimus dorsi muscle, intercostal nerve or artery including breast tissue in female patient.

The proper placement of intercostal chest tube by considering the tissue surroundings is called a safe triangle, which the boundary is between the anterior axillary line to the mid axillary line and the 4th – 5th intercostal spaces³. However, studies on the measurement of thoracic wall thickness in this area have not been conducted throughout the area. The researcher then studies to find out where this suitable area, including the surrounding area, has the thinnest thoracic wall thickness for safety insertion of intercostal chest drain.

Methods

A cadaver based descriptive study was performed in Faculty of Medicine, Khon Kaen University, Thailand. Fresh cadaveric tissue dissection was conducted from February 2017 to December 2018. All fresh non-embalmed human bodies were kept in refrigerator at -20o C until 30 minutes before study, after that they were allowed to warm in room temperature. Age, sex, weight, height and BMI were collected for each cadaver. Any cadaver with chest wall abnormality was excluded.

From the Inaba et al⁴ study found that the mean thickness of chest wall at the intersection between 5th intercostal space and mid-axillary line in 20 cadavers is 3.5 cm. (SD 0.9 cm.) the SD 0.9 cm is used

for calculating. And the pilot study in the computer tomography, we found that the mean thickness of chest wall from the 20 samples is 2.8 cm. (SD 0.9 cm). It difference from the previous study. we determine the precision(d) = 0.3 cm. And when the numbers are calculated in the formula. Therefore, sample size in the study had at least 35 positions, or at least 18 cadavers.

Chest wall of the cadavers was drawn anterior axillary line; mid axillary line; and midpoint between these lines, called “anterior-mid axillary line” in this study, intersect with 3rd to 7th intercostal space (Figure 1). The thickness of chest wall is collected by sternotomy and enter to the pleural cavity, puncturing of 56 mm, 16G needle (Figure 2) and clamp while seeing tip of the needle then measure with standard ruler and collect data in data record form. The measured values are recorded in millimeters (mm.) and one decimal place.

All of the thickness of areas of chest wall were collected. Continuous data was presented in mean and standard deviation. Categorized data were presented in percentage.



Figure 1 The line over the cadaver’s chest wall



Figure 2 16G Punctured needle (56 mm. length)

The Ethic Committee of Khon Kaen University approved this study on October 19th, 2017 (reference HE601075)

Results

Twenty cadavers (40 chest wall sides) was used in this study. There were 14 male and 6 female cadavers. The mean age was 73.6 years old (range from 58-91). The average BMI was 23.7 (range from 18.0 to 32.9) kg/m².

The mean chest wall thickness within the safety triangle varies between 14 mm. and 25 mm. (Figure 3). The points on the anterior axillary line in each intercostal space were thinner than other locations. The thinnest point was the intersection of anterior axillary line the 7th intercostal space. the thickest points were on the mid-axillary line especially at 5th intercostal space.

There were three extreme cases found in this study, the thinnest chest wall, the thickest chest wall and the highest BMI.

The thinnest chest wall cadaver was the 82 years old male with 185 cm. tall and 82 kg. in weight, the BMI was 24 kg/m² (Figure 4). His chest wall was thinner than the others in all area and the thinnest area was 5mm. at the intersection of anterior axillary line with 7th intercostal space.

	Mid	Ant-Mid	Ant	Ant	Ant-Mid	Mid
3rd ICS			21	23		
4th ICS			20	21		
5th ICS	23	21	18	19	21	25
6th ICS	22	18	17	15	19	23
7th ICS	20	16	15	14	17	21

Figure 3 The mean chest wall thickness on safety triangle area

	Mid	Ant-Mid	Ant	Ant	Ant-Mid	Mid
3rd ICS			7	11		
4th ICS			10	7		
5th ICS	8	7	7	7	6	8
6th ICS	9	8	9	6	8	9
7th ICS	9	5	5	5	7	8

Figure 4 The thinnest chest wall cadaver, 82 years old man; body weight 82 kg, height 185 cm, BMI 24 kg/m²

	Mid	Ant-Mid	Ant	Ant	Ant-Mid	Mid
3rd ICS			56	54		
4th ICS			44	40		
5th ICS	38	50	44	40	44	50
6th ICS	44	36	50	30	44	32
7th ICS	28	28	42	36	38	27

Figure 5 The thickest chest wall cadaver, 76 years old woman; body weight 60 kg, height 150 cm, BMI 26.7 kg/m²

	Mid	Ant-Mid	Ant	Ant	Ant-Mid	Mid
3rd ICS			17	18		
4th ICS			17	17		
5th ICS	17	17	19	19	18	22
6th ICS	16	19	12	18	15	20
7th ICS	16	13	14	15	15	16

Figure 6 The highest BMI cadaver, 65 years old man; body weight 95 kg, height 170 cm, BMI 32.9 kg/m²

The second case was 76 years old female cadaver with 150 cm. tall and 60 kg in weight, the BMI was 26.7 kg/m² (Figure 5). She had the thickest chest wall in this study. The area thicker than 50 mm. was located on the intersection of anterior axillary line with 3rd intercostal space. The points on the anterior axillary line were thicker than other points in each intercostal level.

The last case, 65 years old male cadaver who had the highest BMI in this study. He was 170 cm. in height and 95 kg. in weight, the BMI was 32.9 kg/m² (Figure 6). Although he had a high BMI, he has chest wall close to average chest wall thickness in this study. His chest wall thickness was between 13 mm. to 22 mm.

The areas with more than 50 mm. thickness were mostly found in the mid-axillary line and two cadavers (54 and 56 mm.) in the 3rd intercostal space crossing with anterior axillary line.

From observation, we found that the intersection of anterior axillary line with imaginary nipple line be almost on the 5th intercostal space, in male cadaver. The intersection of mid-axillary line with imaginary nipple line be almost on the 6th intercostal space.

Discussion

In this study, the average thickness of the chest wall at the intersection of 5th intercostal space with anterior axillary line (18-19 mm.) was less than other studies (31.6-39.9 mm.)⁴⁻⁷.

Kenji Inaba, et al.⁴ mentioned about cadaveric study, by requiring pre-hospital medical personnel performed needle thoracocentesis. Then measure the chest wall thickness and success rate of procedure at 2nd intercostal space – midclavicular line compared with 5th intercostal space – anterior axillary line. There was statistical significant different in chest wall thickness of both locations, the 5th intercostal space was 1.2(1.5) cm., and the 2nd intercostal space was 3.1(1.7) cm. (p<0.001). The success rate of the procedure in 5th intercostal space – anterior axillary line was 82.0% and in 2nd intercostal space – midclavicular line was 22.0%.

Daniel V. Laan, et al⁷, performed a meta-analysis of 15 studies comparison of chest wall thickness in 3 locations, 2nd intercostal space – midclavicular line, 4th-5th intercostal space – anterior axillary line and 4th-5th intercostal space – midaxillary line. The mean thickness of the chest wall were 42.79 (38.78-46.81) cm., 34.33 (28.20-40.47) cm., and (28.70-51.00) cm. respectively.

Laws, et al³, study the proper location to insert the intercostal drain called “Safe triangle”, which has boundaries are the anterior edge of latissimus dorsi muscle, lateral edge of pectoralis major muscle, superior to nipple level and below axilla level.

The recommended area for insertion the tube thoracostomy in male patient is intersection of anterior axillary line with imaginary nipple line (5th intercostal space).

The thinnest areas are on the 7th intercostal space, anterior axillary line but insertion tube thoracostomy below the 6th intercostal space should be dangerous because when fully exhale the highest diaphragm level could reach to 6th intercostal space. In this study, we found that the intersection of mid-axillary line with imaginary nipple line is 6th intercostal space. Thus, insertion tube thoracostomy below the nipple line must be careful.

The chest wall thickness is related to BMI^{5,6} but in this study found some of cadavers do not meet expectations. We found that not only the BMI can affect the thickness of the chest wall.

The limitation in this study was studying in the elderly cadavers. It cannot be represented the

younger population. In the female cadaver, we did not retract the breast while measuring. It may explain that why some female has thicker chest wall on the anterior axillary line.

Conclusion

The chest wall thickness in this study is thinner than others. The area for insertion of the tube thoracostomy should be carefully selected, especially in woman and the obese patients. Insertion below 6th intercostal space should be avoided due to risk of peritoneal penetration.

Some areas in the safety triangle for tube thoracostomy insertion are more than 50 mm. in thickness. The area for insertion of the tube thoracostomy should be carefully selected, especially in woman and the obese patients.

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