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Ultrasonography in the diagnosis of lung adhesion before surgery

Abstract: Background: The presence of pleural adhesions may render video-assisted thoracoscopic surgery difficult or impossible. The aim of this study was to assess the value of chest ultrasonography in the detection of pleural adhesions prior to thoracotomy.

Methods: Between 2013 and 2014, 42 consecutive patients undergoing thoracotomies (including video-assisted thoracicsurgery) were evaluated with chest ultrasonography. These patients underwent a preoperative ultrasonic examination of the chestwall using a 7.5-10-MHz linear ultrasound probe at 7 points along the chest wall. We measured the movement of the visceral pleuralslide.

Results: In the upper thoracic wall,ultrasonography demonstrated a sensitivity of 63.0%, a specificity of 66%, a negative predictive value of 77%, a positive predictive evalue of 50.0%, and an overall accuracy of 65.0%. And for the lower thoracic wall, ultrasonography demonstrated a sensitivity of 81.0%, a specificity of 59.0%,a negative predictive value of 89.0%, a positive predictivevalue of 44.0%, and an overall accuracy of 65.0%.

Conclusion: Chest ultrasonography is moderately accurate in detecting the presence and location of pleural adhesions. The use of preoperative chest sonographic findings to plan trocar placement and to determine the need for an open approach is valuable in helping prevent visceral injury and facilitating video-assisted thoracoscopic surgery.

Keywords: Pleural Adhesion; Ultrasonography; Chest,

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Introduction

For thoracic surgeons, Video-Assisted Thoracoscopic surgery (VATS) is an important diagnostic tool that is widely used in the diagnosis and treatment of pulmonary pathologies and pleural adhesions [1, 2]. In the adhesions between the visceral and pleural walls for prevent lungs collapse at the onset of thoracoscopy, open thoracotomy can prevent the increased risk of lung damaged by the video-telescope in severe adhesions [3, 4]. Investigating the adhesions between the visceral wall and the pleural effusion is even more difficult by the CT scan, even based on the thickness of the lung [5]. In other studies, it has been reported that abdominal ultrasonography is performed prior to laparoscopic surgery and determination of peritoneal adhesions is based on visceral slides. If visceral slides show a distance of less than 2 centimeters, it is helpful in detecting adhesion [6-10]. Today ultrasonography is a modern, easy and accessible method. About 30 years ago, the first ultrasonography units were designed for medical examination. Some types of ultrasonography were controlled on the basis of Defectoscopy and some were based on Doppler. In recent years, ultrasonography devices with two-dimensional and dynamic B-mode images, usually Doppler-type, are most commonly used. Three-dimensional and four-dimensional ultrasonography devices are also available [11]. A study reported that the CT scan had a moderate sensitivity and specificity in the preoperative examination of patients to show pleural lesions as compared to VATS [5]. Another study reported that ultrasonography is the most useful technique for conducting and operating Trocar in laparoscopic surgery. Today, ultrasonography is the gold standard for diagnosing some diseases. In recent years, ultrasonography has been used in all surgical fields, including thoracic surgery [12].

Two studies conducted so far have shown that ultrasonography can be used to determine pre-surgical pleural adhesions [10-13]. Considering the limited studies in this field, preventing unnecessary thoracotomy, performing thoracoscopy, pleural adhesion in preventing open surgery, use of ultrasonography, reducing the

physical and psychological effects on patients are the importance actions that needs to attention. The aim of this study was to determine the sensitivity, specificity and usefulness of ultrasonography in the diagnosis of preoperative lung adhesion in patients referred to Shahid Beheshti Hospital in the years 2009-2013, and thus determine the false positive and false positive rates.

Methods

This study was performed on the basis of process evaluations among patients undergoing thoracotomy and thoracoscopy surgery, of both genders and aged between 20 and 70 years, who were referred to the Thoracic Surgery, Department of Shahid Beheshti Hospital from October 2009 to May 2010. All subjects were selected to complete the required sample size of admission criteria. Among the inclusion criteria for the project, the consent to participate in the research project, the patients undergoing thoracotomy and thoracoscopy surgery, lack of heart disease such as Dilated Cardiomyopathy which affects the building, a BMI less than 35, lack of Gynecomastia, and lack of mastectomy in the past can be mentioned.In this preoperative study, a single radiologist unit was performed by an ultrasonography device manufactured by Voluson, a US-based company with 7-10-5 MHz probe for 7 points of intercostal ultrasonography, for all patients. Meanwhile, during the ultrasonography, the patient were asked to breathe deeply. The rate of lung movement and slider viscosity of the lung was measured. Ultrasonography was performed in the upper thoracic wall at three points. These points include the second point of the intercostal space in the midclavicular, the third point in the midaxillary and the third point in the paravertebral, defined by the upper thoracic wall. Four points in the lower thoracic wall were include and took place at the seventh point of intercostal space in the midaxillary, the fifth point in the scapula, the ninth point in the scapula, and the seventh point in the midclavicular, defined as the lower thoracic wall (Fig. 1).

The distance between the thoracic wall and the pulmonary movement was measured. The amount of lung movement during operation was also recorded. It should be noted that in order to reduce the experimental error, the surgeon was unaware of the ultrasonography results of the patient. The obtained information was coded and the findings were considered as the gold standard and ultrasonography results were considered. All information was provided by the statistical program V. 12 SPSS were coded and then sensitivity, specificity, positive predictive
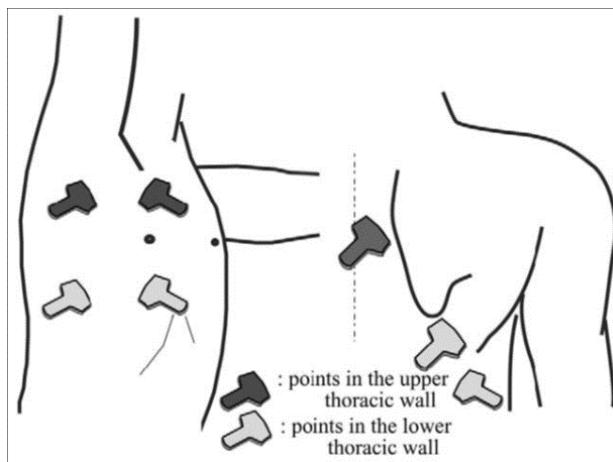

Figure 1: 7-point schematic diagram for chest ultrasonography.

value, negative predictive value and diagnostic accuracy were calculated.

Ethical approval: The research related to human use has been complied with all the relevant national regulations, institutional policies and in accordance the tenets of the Helsinki Declaration, and has been approved by the Ethics Committee of Qom University of Medical Sciences, Qom, Iran (Ethics Code: IR.MUQ.REC.1393.100).

Informed consent: Informed consent has been obtained from all individuals included in this study.

Results

The mean age of the subjects was 45.4 ± 13.8 years (23 up 63). In this study, 82 (85.4%) were male and 14 (14.6%) were female.In the upper thoracic wall, the mean pleural motion on the adhesion site was 0.78 ± 0.8 cm and in the place where the adhesion was not 1.55 cm / 1 cm.The difference in motion, was statistically significant (P <0.05).In the lower thoracic wall, the mean pleural motion in the adhesion site was 1.5 ± 0.19 cm and in the site with no adhesion, it was 2.4 ± 0.89 cm. This difference was also statistically significant (p <0.001).

Comparison of pleural motion between two groups with adhesion and non-adhesion is presented in figure 2.

There was no relationship between gender and pleural motion in the upper thoracic wall (P = 0.13), as well as between gender and pleural motion in the lower thoracic wall (P = 0/14).

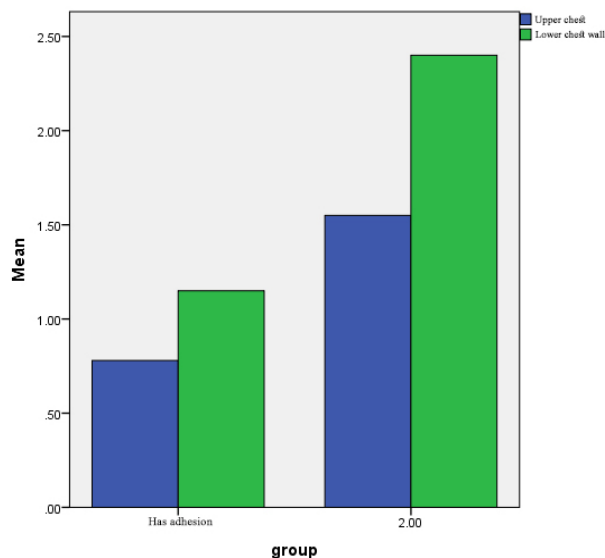There was no relationship between age and pleural motion in the upper thoracic wall (P = 0.07), and between

Figure 2: Comparison of pleural motion based on adhesion.

age and pleural upper thoracic wall in the loerthoracic wall (P = 0.09).

The findings showed that in the ultrasonography of the upper thoracic wall produced were 21 cases of true positives, 42 true negative cases, 21 cases of false positive and 12 cases of false negative. Thus, the technique had a sensitivity of 63%, a specificity of 66%, a positive predictive value of 50%, a negative predictive value of 77%, and a diagnostic accuracy of 65%. In the examination of ultrasonography in the lower thoracic wall, 22 positive cases were true, 41 cases were true negative, false positives in 28, and false negative in 5 cases. Thus, sensitivity there was a sentivitiy of81%, a specificity of 59%, a positive predictive value of 44%, a negative predictive value of 89%, and a diagnostic accuracy of 65%.

Discussion and conclusion

Thoracoscopy in thoracic surgery leads to a reduction in pain and suffering associated with surgery and a reduction in recovery time. Plan trocar placementin pleural adhesion leads to visceral injuries.Therefore, the determination of pre-operative pleural adhesion reduces the risk of incident events during thoracoscopy.Several studies have been perfomed exploring the benefits of using ultrasonography to evaluate the peritoneal adhesion before laparoscopic surgery [14-17]. In the study, the benefits of ultrasound in determining the site of abdominal wall adhesion were reported before

laparoscopy or laparotomy [14]. Ultrasonography of the upper thoracic wall demonstrated 21 true positive cases, 42 true negative cases, 21 false positive cases, and 12 false negative cases. Therefore, a sensitivity of 63%, a specificity of 66%, apositive predictive value of 50%, a negative predictive value of 77% and an accuracy of 65% were recorded. In a study by Sasaki et al., the sensitivity was close to the same value, but the specificity of using ultrasound in its study was estimated to be around 80%. This difference may be due to the smaller size of sample or the technique and skill of the radiologist. The positive and negative predictive value of the study by Sasaki, as well as its diagnostic accuracy regarding the use of ultrasound to find adhesion in the upper thoracic wall, was also close to those of our study [13].

Ultrasonography of the lower thoracic wall demonstrated 22 true positive cases, 41 true negative cases, 28 false positive cases, and 5 false negative cases. Therefore, a sensitivity of 81%, a specificity of 59%, a positive predictive value of 44%, a negative predictive value of 89% and an accuracy of 65% was reported.In this case, just like in the upper thoracic wall, the only difference with their study was a greater specificity of their research, which can be caused by the reasons given [13].

In a study by Kolecki et al., sensitivity and specificity of ultrasound were found to be 90% and 92%, respectively [15]. This difference could be due to the fact that they included people with a history of abdominal surgery and peritonitis.These interventions can lead to more obvious diagnostic differences whose finding using ultrasound is more feasible.

Tateishi and Mason in the two separate studies in this case, found a sensitivity of 75% and 72%, and a specificity of 93% and 71% respectively [18, 19]. The sensitivity obtained in their studies was close to that of our study, but the estimated specificity was higher. These differences can be due to the sample size or the difference in the diagnostic power of specialists.

It is worth noting that in very limited studies, the ultrasonography diagnostic power in pleural adhesions has been investigated.In one study, ultrasonography of the upper thoracic wall demonstrated, a sensitivity of 63.6%, a specificity of 79.4%, a negative predictive value of 87.7%, a positive predictive value of 50% and a diagnostic accuracy of 75.6% and ultrasonography of the lower thoracic wall demonstrated a sensitivity of 81.5%, a specificity of 81.0%, a negative predictive value of 96%, a positive predictive value of 44% and a diagnostic accuracy of 81.0% [13]. In a study, the sensitivity and specificity of ultrasonography in indicating visceral motion in patients with a history of peritonitis and abdominal surgery were 90% and 92%

[15]. In another study, which evaluated pleural adhesion by sonography, the sensitivity of sonography was 75% and its specificity was 93% [18].

Another study to demonstrate pleural adhesion with CT scan, sensitivity was 72% and specificity was 71% [19]. In this study, ultrasonography had a moderate positive sensitivity, diagnostic accuracy, and prognostic value, which may be due to a misinterpretation of ultrasonography for the presence of adhesions and inadequate radiologist skills and the presence of such symptoms as emphysema in the patient. Therefore, the proficiency and skill of the radiologist and the high accuracy of the diagnosis of ultrasound are important in determining the pleural adhesions.

Conclusion

Chest ultrasonography is moderately accurate in detecting the presence and location of pleural adhesions. The use of preoperative chest sonographic findings to plan trocar placement and to determine the need for an open approach is valuable in helping prevent visceral injury and facilitating video-assisted thoracoscopic surgery. In addition, it is recommeded to use two or more radiologists to examine the diagnostic power of ultrasound, so that individual diagnostic differences have less effect on the study outcome.

Conflict of interest: Authors state no conflict of interest

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