Preoperative Detection of Pleural Adhesions by Chest Ultrasonography

Masato Sasaki, MD, PhD, Masakazu Kawabe, MD, Seiya Hirai, MD, Narihisa Yamada, MD, Kouichi Morioka, MD, PhD, Akio Ihaya, MD, PhD, and Kuniyoshi Tanaka, MD, PhD

Department of Surgery (II), University of Fukui Faculty of Medical Sciences, Fukui, Japan

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 October 2001 and September 2002, 42 consecutive patients undergoing thoracotomies (including video-assisted thoracic surgery) were evaluated with chest ultrasonography. These patients underwent a preoperative ultrasonic examination of the chest wall using a 7-MHz linear ultrasound probe at 7 points along the chest wall. We measured the movement of the visceral pleural slide.**

Results. **When restricted viscera sliding was defined as less than 1 cm of excursion at the upper thoracic wall during exaggerated respirations, ultrasonography demonstrated a sensitivity of 63.6%, a specificity of 79.4%, a negative predictive value of 87.7%, a positive predictive value of 50.0%, and an overall accuracy of 75.6%. When restricted viscera sliding was defined as less than 2 cm of excursion at the lower thoracic wall during exaggerated respirations, ultrasonography demonstrated a sensitivity of 81.5%, a specificity of 81.0%, a negative predictive value of 96.0%, a positive predictive value of 44.0%, and an overall accuracy of 81.0%.**

Conclusions. **Chest ultrasonography is moderately accurate in detecting the presence and location of pleural adhesions. 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.**

(Ann Thorac Surg 2005;80:439–42)

Video-assisted thoracoscopic surgery (VATS) has become an important tool for the thoracic surgeon and has gained widespread acceptance. But pleural adhesions between the visceral and parietal pleura prevent the lung from collapsing at the start of thoracoscopy, increase the risk of lung injury from the video-telescope, and in severe cases prevent access to the pleural space, requiring conversion to an open thoracotomy. Therefore, if we can detect pleural adhesions during preoperative evaluation, thoracoscopic surgery is optimized. It is very difficult to evaluate adhesions between the visceral and parietal pleura, even based on pleural thickness on chest computed tomography (CT) [1]. For laparoscopic surgery, there are several reports describing the use of preoperative abdominal ultrasound for detecting peritoneal adhesions based on the excursion of visceral slide [2–5]. It has been determined that a visceral slide less than 2 cm is diagnostic for the presence of adhesion.

However, there are no reports of whether the excursion of the visceral slide can be used to detect pleural adhesions, although there is one report of the use of preoperative ultrasound for detecting pleural adhesions [6]. The purpose of this study was to evaluate the use of preoperative ultrasound mapping of pleural adhesions on the chest wall in order to provide safe initial thoracoscopic access and to guide the placement of subsequent trocars, facilitating VATS.

Patients and Methods

Patients

This study was designed as a prospective study. The ultrasound study was performed within 1 week prior to the scheduled surgery. Patients were selected on the basis of two indications. First, all patients were to have surgical procedures that would allow the examination of the pleural space to confirm the presence of pleural adhesions. Second, patients were excluded if they had a history of prior chest surgery. Between October 2001 and September 2002, 42 consecutive patients who were scheduled for a thoracotomy or VATS underwent a preoperative visceral slide ultrasound examination of the chest wall. The patient characteristics are summarized in Table 1. All patients were examined in the sitting position using a 7-MHz linear ultrasound probe at 7 points in intercostal spaces (ICS) during exaggerated respiration. We measured the movement of the visceral pleural slide. Three points were used in the upper thoracic wall. The second ICS in the midclavicular line, the third ICS in the midaxillary line, and the third ICS in the paravertebral

Accepted for publication March 4, 2005.

Addresss reprint requests to Dr Sasaki, Department of Surgery (II), University of Fukui, Faculty of Medical Sciences, 23-3 Shimoaizuki, Matsuoka Fukui, Japan 911-1104; e-mail:masato@fmsrsa.fukui-med.ac.jp.

Published by Elsevier Inc

0003-4975/05/$30.00
doi:10.1016/j.athoracsur.2005.03.021

Table 1. Patient Profiles

Gender	
26 men, 17 women	
Lesion location	
right 24; left 16; bilateral 3	
Underlining diagnosis	
Primary lung cancer	23
Metastatic lung cancer	6
Benign lung disease	7
Pericarditis	2
Infectious disease	1
Hemangiosarcoma	1
Interstitial pneumonia	1
Angina pectoris	2

line were defined as the upper thoracic wall. Four points were used in the lower thoracic wall. The seventh ICS in the midaxillary line, the fifth ICS in the scapular line, the ninth ICS in the scapular line and the seventh ICS in the midclavicular line were defined as lower thoracic wall (Fig. 1). The ultrasound system used for the viscera slide studies was a LOGIQ500 MR3plus (GE Yokogawa Medical Systems, Tokyo, Japan) 7-MHz array B-mode scanner. A linear-array type of transducer was used to scan the intercostal spaces at a 45 degree angle relative to the longitudinal direction. A distinct focal point in the image of the viscera, usually several hyperechoic points, was observed as the visceral pleura moved during respiration (Fig 2). The distance of the longitudinal excursion of the selected point was measured in relation to the chest wall. An electronic scale on the ultrasound screen was used to measure the exact distance transversed by the focal point. Preoperative scans were interpreted by the consensus read of two thoracic specialists. When we began this study, chest ultrasonography was interpreted by the consensus read of one thoracic surgeon and one radiologist at three patients. Afterwards, this examination was performed by two thoracic surgeons for the remaining 39 patients.

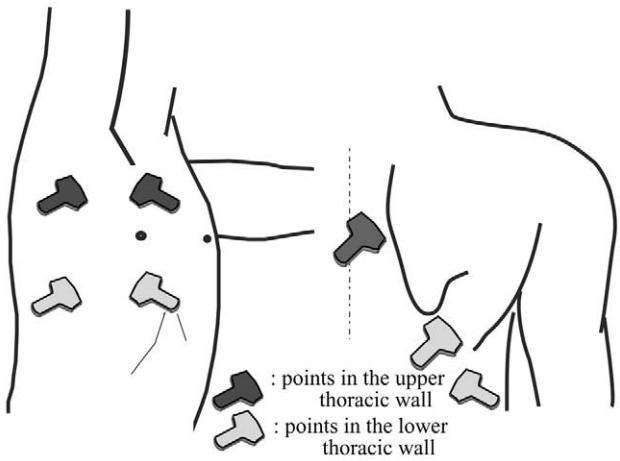

Fig 1. Schematic diagram showing the measurement locations of the 7 points for chest ultrasonography.

Statistical Analysis

The ultrasonographic-predicted and VATS-detected adhesions were used to determine the sensitivity and specificity of ultrasonography for detecting adhesions, using lesion-by-lesion analysis. In lesion-by-lesion analysis, the simple presence or absence of adhesions for each lesion was used to categorize true positive and true negative findings. If adhesions were falsely suggested by sonography, the lesion was categorized as a false positive in the lesion-by-lesion analysis. A false negative finding occurred if one or more adhesions were found during VATS and the sonography revealed no lesions. A true positive finding was recorded if both sonography and VATS demonstrated pleural adhesions. All data are expressed as the mean ± standard deviation. Excursion values were analyzed using the unpaired Student's t test and a p value less than 0.05 was considered significant.

Results

In the first consecutive 32 patients (220 lesions) we compared the excursion of the visceral slide with the findings from operation for every lesion. In the upper thoracic wall, the mean excursion where there was an adhesion was 0.70 ± 0.82 cm (n = 24), and the excursion where there was no adhesion was 1.52 ± 1.00 cm (n = 74, vs 0.70 ± 0.82 cm, $p = 0.0006$). Restricted visceral sliding in the upper thoracic wall was defined as less than 1 cm of excursion during exaggerated respiration. In the lower thoracic wall, the mean excursion where there was an adhesion was 1.13 ± 0.97 cm (n = 20), and the excursion where there was no adhesion was 2.38 ± 0.90 cm (n = 102, vs 1.13 ± 0.97 cm, $p < 0.001$). Restricted visceral sliding in the lower thoracic wall was defined as less than 2 cm of excursion during exaggerated respiration. We analyzed the accuracy of visceral sliding in the detection of chest wall adhesions in 43 consecutive patients (322 lesions) based on these results (Table 2). Nine locations could not be assessed due to disagreement between the two thoracic specialists or inability to image the area because of upper extremity immobility. Therefore, 313 lesions were evaluated in this study. In the upper thoracic wall, a total of 33 adhesions were found at VATS in the 15 patients. The detection of adhesions by visceral slide sonography revealed 21 true positive, 12 false negative, 21 false positive, and 81 true negative findings (sensitivity, 63.6%; specificity, 79.4%; accuracy, 75.6%). In the lower thoracic wall, 27 adhesions were found at VATS in 10 patients. The detection of adhesions by visceral slide sonography revealed 22 true positive, 5 false negative, 28 false positive, and 119 true negative findings (sensitivity, 81.5%; specificity, 81.0%; accuracy, 81.0%). The negative predictive value was 87.0% for the upper thoracic wall and 96.0% for the lower thoracic wall.