Editorial

One size does not fit all: prediction of presence of pleural adhesions

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Most surgeons would agree that the presence of pleural adhesion negatively impacts on lung surgery intraoperatively and postoperatively. This is especially critical in minimal invasive surgery, either single or multiport video-assisted thoracoscopic surgery (VATS), or robot-assisted thoracoscopic surgery (RATS), in which access to the pleural cavity is limited and lung injury is concerned, particularly during the first port placement. Further, additional ports or incisions or conversion to open surgery may be considered in cases with extensive pleural adhesions. Studies revealed a significant increase in operative time, intraoperative blood loss, and durations of air leak and chest drainage in cases with severe adhesion compared to cases with no or mild adhesions (1,2).

To assist preoperative and intraoperative decision-making, efforts have been made to predict pleural adhesions by preoperative image analysis. Traditionally, pleural adhesion has been suspected with findings in conventional computed tomography (CT), such as pleural thickness and emphysema (3). Despite its affinity with daily clinical practice because most patients go through a preoperative CT scan, its sensitivity and specificity are not ideal, and the localization of adhesions is challenging from this analysis using static images.

Other modalities, such as four-dimensional (4D) (4,5) or respiratory dynamic CT (6,7) and ultrasonography (8-10), have been utilized to analyze dynamic images of lungs' physiological motion, resulting in higher sensitivity and/or specificity compared conventional CT. However, these modalities come with their limitations, such as additional radiation exposure (4-7), limited scanning area (4,5), resource intensity (4-10), and the need for highly skilled examiners (8-10).

A recent study by Watanabe *et al.* investigated the utility of dynamic chest radiography (DCR) in detecting pleural adhesions (11). DCR is a relatively new X-ray imaging modality for analyzing and diagnosing chronic obstructive pulmonary disease, cystic fibrosis, and pulmonary hypertension. The authors analyzed each series of images of DCR lasting for approximately 20 seconds using software that can visualize the area where lung motion during deep breathing is little [low-motion area (LMA)]. In addition to the visual data, the authors suggested the LMA ratio, which can be calculated by the software, may be an objective supplemental parameter to predict the presence of pleural adhesion. Along with its ease of application in clinical practice and lower cost than CT, high specificity (91.0%) and negative prediction rate (84.9%) are shown. However, issues of low sensitivity, exposure to radiation, and the availability of the software to analyze the LMA ratio remain limitations of this study.

To enhance its value in clinical practice, preoperative detection of pleural adhesion should be evaluated multidimensionally on a patient-by-patient and lesion-

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by-lesion basis (3,12). The patient-by-patient analysis focuses on the presence or absence of adhesions in each case, expressed as "yes" or "no". This analysis may help estimate operative time and intraoperative blood loss, leading to more efficient scheduling of surgical cases. Generally, conventional CT, 4D or dynamic CT are useful for this analysis providing the overall lung motion. The lesion-by-lesion analysis is aimed at detecting adhesions at specific areas, such as sites of port placement, for which focused evaluation by ultrasonography is most likely to be appropriate (8-10). In cases with peripheral lung cancer, analysis by 4D or respiratory dynamic CT may be applicable for the evaluation of pleural invasion as well as ultrasonography in cases with peripheral lung cancer (6,7). Watanabe and colleagues examined DCR mainly from the perspectives of the patient-by-patient analysis aiming to estimate operative time and bleeding volume (11). Regarding the lesion-by-lesion analysis, although LMA may suggest approximate adhesion sites (e.g., apex, lower lung field), the localization of adhesion only with frontal chest radiography seems to be challenging. In the era of minimally invasive surgery, adhesion analysis at port sites is crucial, particularly at institutions where single-port VATS is performed like the authors' institution.

Further, analysis of the degree and extent of pleural adhesion is difficult since the image analyses do not precisely differentiate the tightness or density of focal adhesion from the surface area covered by the adhesions. Various classifications have been used in literature based on the presentation of the pleural adhesions (e.g., density, coverage) (1) and the degree of surgical disturbance (6). In the work of Watanabe and colleagues, the presence of pleural adhesion was confirmed with intraoperative findings: the coverage of more than 20% of the thoracic cavity and/or dissection time of more than 5 minutes (11). The criteria include the aspects of the presentation and surgical disturbance, elaboration of the determination of the cut-off value is expected for future reference. Separate evaluations of global and local analyses would be valuable to standardize the adhesion evaluation.

DCR may be useful for excluding the existence of pleural adhesions, given its ease of implementation and high negative predictive rate. Complementary use of other modalities may address DCR gaps, low sensitivity, and difficulty in localization. Currently, there is no single comprehensive method to predict and localize pleural adhesions. A combination and selection of imaging analysis should be considered based on patient factors, logistics, and modality availability for effective and efficient surgical planning and risk management. In addition, future studies should focus on the impact of the predictions on surgical approach decisions and perioperative outcomes.

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