CASE REPORT

Massive hemothorax after computed tomography-guided lung tumor biopsy: An unusual but disastrous complication

Wei-Ming Huang1,2,3, Hui-Chen Lin1,2,3, Chia-Hung Chen1,2,3, Chien-Wen Chen1,2,3, Chih-Hsin Wang1,2,3, Chung-Yao Huang1,2,3, Ching-Che Wang1,2,3 & Chun-Chao Huang1,2,3

1 Department of Radiology, MacKay Memorial Hospital, Taipei, Taiwan
2 Department of Medicine, MacKay Medical College, Taipei, Taiwan
3 Mackay Junior College of Medicine, Nursing, and Management, Taipei, Taiwan

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Correspondence
Chun-Chao Huang, Department of Medicine, MacKay Medical College, No. 46, Sec. 3, Zhongzheng Road, Sanchi District, New Taipei City, 252 Taiwan.
Tel: +886 2 2636 0303
Fax: +886 2 2636 1295
Email: efen1982@gmail.com

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Abstract
Intercostal artery injury during transthoracic puncture is rare but is accompanied by high rates of morbidity and mortality. We report a case with metachronous double primary esophageal cancers and development of multiple lung nodules. Tissue proof for the lung nodules is required to guide the following treatment protocol. Our patient died soon after computed tomography-guided lung tumor biopsy was performed, as a result of procedure-related massive and uncontrolled hemothorax. The cause is likely intercostal artery injury related to the transthoracic puncture. After review of our case and the wide variation in intercostal artery courses, we identify several considerations that should be included in procedural planning to further decrease the risk of intercostal artery injury during transthoracic puncture, including avoiding choosing target lesions at the posterior lung, keeping the puncture needle as close to the superior rib margin as possible, and checking the density of new pleural fluid. In addition, it is important to inform clinical doctors when the risk of periprocedural vascular injury is high.

Introduction
Computed tomography (CT)-guided percutaneous needle biopsy has been commonly performed for many years because of the high diagnostic accuracy and low complication rate. The most common complications are pneumothorax and pulmonary hemorrhage. Other less common complications include air embolism and pleural or chest wall tumor seeding. Postprocedural pulmonary hemorrhaging is reported at a rate of 4–27% based on different definitions, from hemoptysis to postprocedural perilesional opacity. Severe pulmonary hemorrhage, hemoptysis, or hemothorax occur in < 0.1% of cases. The identified potential risk factors of postprocedural pulmonary hemorrhage include subsolid lesion patterns, small lesion size, greater lesion depth or long biopsy path, emphysema, and pulmonary arterial hypertension. The use of anticoagulant medication or a bleeding diathesis is contraindicated for this procedure. Injury to systemic arteries or central vessels should be avoided. Attention should be paid to the subclavian, axillary, internal mammary, and intercostal arteries during the biopsy procedure. On CT images, the first three kinds of artery are relatively easily identified. However, CT angiography is required to assess injury to intercostal arteries. In daily practice, avoiding intercostal artery injury during biopsy is chiefly based on anatomical knowledge. The intercostal artery is usually located in the subcostal groove, but with variation. Previous studies have shown that this artery might be exposed below the subcostal groove in the first 6 cm from the spine and varies more widely in older patients and cephalad rib spaces. Therefore, intercostal artery injury is still possible during the transthoracic puncture, even with a gap from the inferior rib margin. Herein, we demonstrate a case in which a disastrous complication of CT-guided lung tumor biopsy occurred. The patient expired as a result of massive hemothorax, which is considered a result of intercostal artery injury.
Case report

A 51-year-old man was diagnosed with underlying esophageal squamous cell carcinoma with multiple metastatic lymphadenopathy at the right neck, right axillary region, and bilateral supraclavicular fossa 17 months ago. He had received a complete course of concurrent chemoradiotherapy and all lesions disappeared. Recently, he complained of general weakness and dyspnea and was sent to our emergency department. Laboratory data showed severe anemia (hemoglobin level 6.8 g/dL) and leukopenia (2900 10^3/μL), but no fever or other signs of infection were identified. Panendoscopy was arranged to evaluate the anemia and revealed an 8 mm irregular ulceration with pigmentation at the distal esophagus (Fig 1). A biopsy was performed and the pathological report suggested melanoma. Chest CT was arranged for tumor staging and revealed a 4 cm distal esophageal mass and multiple pulmonary nodular lesions (Fig 2). Considering the underlying esophageal squamous cell carcinoma and newly diagnosed esophageal melanoma, this patient was referred to the Department of Radiology for CT-guided lung tumor biopsy in order to confirm which was the advanced malignancy and to decide the treatment protocol.

After reviewing the chest CT images, two small 1.2 cm nodules close to each other in the left basal lung were targeted for the biopsy. The patient was placed in the prone position. After CT localization and local anesthesia, a 17 gauge localization needle was inserted via the intercostal space in the left of the back until the tip of the localization needle reached the posterior superior margin of the nodules (Fig 3a,b). Biopsy was performed six times using an 18-gauge biopsy needle. Post-biopsy CT revealed regional pulmonary hemorrhage and mild pneumothorax (Fig 3c). The patient complained of severe pain at the biopsy wound but no hemoptysis or dyspnea was found. The patient was sent back to the general ward with a routine order of close monitoring of vital signs every two hours.

The patient complained of chest pain at the biopsy site for two hours. Although his blood pressure and heart rate were stable, he felt some dyspnea. Emergency chest plain film was arranged and showed diffuse haziness in the left lung (Fig 4). The patient soon developed tachycardia, shock status, loss of consciousness, and then pulseless electrical activity. Under the suspicion of massive hemothorax, cardiopulmonary resuscitation, fluid resuscitation, blood transfusion, vasopressors, endotracheal tube insertion, and left chest tube insertion were all attempted. Massive blood was drained from the chest tube. Eventually the patient expired as a result of uncontrolled bleeding in the left pleural cavity. The final pathological report of the lung nodules was metastatic squamous cell carcinoma.

After multidisciplinary discussion and review of the CT images, the cause of hemothorax was concluded as a complication of the lung tumor biopsy and likely intercostal artery injury during needle insertion because the images showed the needle insertion course was close to the infra-costal location, with bleeding into the pleural cavity.

Discussion

Although minor complications commonly occur during CT-guided percutaneous needle biopsy, the major complication rate is as low as 5%, composed of pneumothorax requiring intervention, hemothorax, air embolism, needle tract seeding, and death.10 The rate of hemothorax is only < 0.1% and is partly the result of intercostal artery injury, which is accompanied by high rates of morbidity and mortality.3,8 However, this complication might be further avoided with some additional consideration.

Herein, we report a case with metachronous double primary esophageal cancers and the development of multiple lung nodules. Tissue proof for the lung nodules is required to guide treatment protocol. CT-guided lung tumor biopsy was performed and showed metastasis from the initial squamous cell carcinoma. Nonetheless, the patient died as a result of major procedure-related complications. The most reasonable explanation is massive and uncontrolled hemothorax after intercostal artery injury related to transthoracic puncture. The vascular structures with the potential to be injured during transthoracic biopsy mainly include the central large vessels and some systemic arteries: subclavian, axillary, internal mammary, and intercostal.2 Among these, the intercostal artery requires CT angiography to better demonstrate injury.8 Traditionally, when
Interventionalists try to avoid intercostal artery injury during transthoracic puncture, it is based on anatomical knowledge. The supracostal course is the most well known and safest puncture tract, but this approach cannot always be taken because of the dynamic position of the target lesion during respiration and the limited intercostal window for the procedure. After review of our case and wide variations in the intercostal artery course, we identify several considerations that should be included in procedural planning.

Our case was a 51-year-old man, considered middle aged. The biopsy was taken from the left lower back, 11 cm from the spine; however, the intercostal artery at the puncture region in this case was still injured, even with a 2 mm gap below the inferior rib margin, suggesting that the intercostal artery at this region in this case was not located in the subcostal groove. The intercostal artery might be exposed within the intercostal space in the first 6 cm from the spine, with even wider variation in older patients and in cephalad rib spaces.8,9 Considering the possible wide variation in the intercostal artery course, we propose two key points for procedural planning: (i) if possible, choose a target lesion in the anterior rather than the posterior lung because anterior chest wall puncture is safer as the intercostal artery might travel a long course in the back below the subcostal groove; and (ii) if posterior puncture is

Figure 2. Chest computed tomography demonstrated (a) a 4 cm distal esophageal mass (arrow) and (b, c) multiple pulmonary nodular lesions.

Figure 3. (a, b) A 17 gauge localization needle was inserted via the intercostal space in the left of the back until the tip of the localization needle reached the posterior superior margin of the nodules. (b) The needle course is close to the subcostal groove with a 2 mm gap. (c) Post-biopsy computed tomography revealed regional pulmonary hemorrhage and mild pneumothorax.
required, plan a puncture course as close to the superior margin of the ribs as possible, which may require three-dimensional imaging reconstruction to view a different direction, such as the sagittal view.

In addition, the post-biopsy CT images show abnormal fluid accumulation at a density of 20–30 HU in the dependent portion of the left pleural cavity (Fig 5). Pleural effusion can develop after artificial pneumothorax in 5–70% cases, probably resulting from trauma to the pleura or infection. Acute post-biopsy pleural effusion might be attributed to a similar mechanism as trauma to the pleura. Although there is a small overlap, pleural fluid of a density > 15.6 HU is likely a result of hemothorax rather than simple effusion. The post-biopsy pleural fluid density in our case was higher than this threshold and hemothorax should have been suspected. Early intervention to achieve hemostasis, such as surgical intervention or transarterial embolization, might be possible to avoid morbidity or mortality. As such, it is vital to scrutinize post-biopsy CT images to detect not only the presence of pneumothorax and pulmonary parenchymal hemorrhage but also new pleural fluid accumulation and its density. If there is any suspicion of intercostal artery injury, such as the biopsy tract was too close to the inferior rib margin, especially at the back, or new abnormally high density pleural fluid, clinical doctors should be informed of this risk in order to prepare emergency treatment for possible massive hemothorax. Moreover, short-term and repeated chest plain films might be helpful for the early detection of this severe complication.

**Conclusion**

Several points should be considered during procedural planning to further decrease the risk of intercostal artery injury during transthoracic puncture, including avoiding choosing target lesions at the posterior lung, keeping the puncture needle as close to the superior rib margin as possible, and checking the density of new pleural fluid. In addition, it is important to inform clinical doctors when the risk of periprocedural vascular injury is high.

**Disclosure**

No authors report any conflict of interest.
References

1 Chen CH, Huang WM, Liang SH et al. Does biopsy needle traversing through central portion of lesion increase the risk of hemoptysis during percutaneous transthoracic needle biopsy? Jpn J Radiol 2018; 36: 231–7.
2 Wu CC, Maher MM, Shepard JA. Complications of CT-guided percutaneous needle biopsy of the chest: Prevention and management. AJR Am J Roentgenol 2011; 196: W678–82.
3 Tomiyama N, Yasuhara Y, Nakajima Y et al. CT-guided needle biopsy of lung lesions: A survey of severe complication based on 9783 biopsies in Japan. Eur J Radiol 2006; 59: 60–4.
4 Yeow KM, Su IH, Pan KT et al. Risk factors of pneumothorax and bleeding: Multivariate analysis of 660 CT-guided coaxial cutting needle lung biopsies. Chest 2004; 126: 748–54.
5 Khan MF, Straub R, Moghaddam SR et al. Variables affecting the risk of pneumothorax and intrapulmonary hemorrhage in CT-guided transthoracic biopsy. Eur Radiol 2008; 18: 1356–63.
6 Heyer CM, Reichelt S, Peters SA, Walther JW, Müller KM, Nicolas V. Computed tomography-navigated transthoracic core biopsy of pulmonary lesions Which factors affect diagnostic yield and complication rates? Acad Radiol 2008; 15: 1017–26.
7 Pearce JG, Patt NL. Fatal pulmonary hemorrhage after percutaneous aspiration lung biopsy. Am Rev Respir Dis 1974; 110: 346–9.
8 Dewhurst C, O’Neill S, O’Regan K, Maher M. Demonstration of the course of the posterior intercostal artery on CT angiography: Relevance to interventional radiology procedures in the chest. Diagn Interv Radiol 2012; 18: 221–4.
9 Helm EJ, Rahman NM, Talakoub O, Fox DL, Gleeson FV. Course and variation of the intercostal artery by CT scan. Chest 2013; 143: 634–9.
10 Heerink WJ, de Bock GH, de Jonge GJ, Groen HJ, Vliegenthart R, Oudkerk M. Complication rates of CT-guided transthoracic lung biopsy: Meta-analysis. Eur Radiol 2017; 27: 138–48.
11 Rosenthal DB. The incidence of pleural effusion in artificial pneumothorax: With special reference to medical treatment. Br Med J 1936; 1: 95–9.
12 Liu F, Huang YC, Ng YB, Liang JH. Differentiate pleural effusion from hemothorax after blunt chest trauma; comparison of computed tomography attenuation values. J Acute Med 2016; 6: 1–6.