



## A case of pulmonary sclerosing pneumocytoma diagnosed preoperatively using transbronchial cryobiopsy

Yutaka Muto<sup>a</sup>, Naoyuki Kuse<sup>a</sup>, Minoru Inomata<sup>a</sup>, Nobuyasu Awano<sup>a</sup>, Mari Tone<sup>a</sup>,  
Jonsu Minami<sup>a</sup>, Kohei Takada<sup>a</sup>, Kazushi Fujimoto<sup>a</sup>, Ami Wada<sup>b</sup>, Keita Nakao<sup>b</sup>,  
Yoshiaki Furuhashi<sup>b</sup>, Chisa Hori<sup>c</sup>, Yuan Bae<sup>c</sup>, Toshio Kumasaka<sup>c</sup>, Takehiro Izumo<sup>a,\*</sup>

<sup>a</sup> Department of Respiratory Medicine, Japanese Red Cross Medical Center, 4-1-22 Hiroo, Shibuya-ku, Tokyo, 150-8953, Japan

<sup>b</sup> Department of Thoracic Surgery, Japanese Red Cross Medical Center, 4-1-22 Hiroo, Shibuya-ku, Tokyo, 150-8953, Japan

<sup>c</sup> Department of Pathology, Japanese Red Cross Medical Center, 4-1-22 Hiroo, Shibuya-ku, Tokyo, 150-8953, Japan

### ARTICLE INFO

#### Keywords:

Pulmonary sclerosing pneumocytoma  
Cryobiopsy

### ABSTRACT

**Background:** The preoperative diagnosis of pulmonary sclerosing pneumocytoma (PSP) is complicated since PSP has several histological structural patterns in the same neoplasm; hence, it is sometimes pathologically misdiagnosed as adenocarcinoma or carcinoid. In recent years, with the prevalence of transbronchial cryobiopsy (TBLC), we are able to obtain larger specimens than previously. However, to date, there have been no reports describing PSP diagnosed using TBLC.

**Case reports:** A 43-year-old man was referred to our hospital for an abnormal lesion in the left lung discovered on routine health examination. A computed tomography scan of the chest revealed a 14-mm heterogeneous round nodule with surrounding ground-glass opacity in the left lower lobe. The tumor size increased to 18 mm in three weeks, and he developed bloody sputum. TBLC was performed using radial endobronchial ultrasonography and fluoroscopy. An occlusion balloon and prophylactic epinephrine were used to prevent severe bleeding. Histologically, epithelioid cells with solid proliferation, various papillary lesions, and hemosiderin-laden histiocytes were observed. Immunohistochemical staining revealed the histiocytes positive for thyroid transcription factor-1 and vimentin, and the type II pneumocyte-like-cells positive for cytokeratin 7. The tumor was preoperatively diagnosed as a PSP; the patient underwent left basal segmentectomy and consequently, a final diagnosis of PSP was formulated.

**Conclusion:** We report the first case of PSP preoperatively diagnosed using TBLC. Therefore, cryobiopsy could be beneficial in the preoperative diagnosis of PSP.

### 1. Introduction

Pulmonary sclerosing pneumocytoma (PSP) is a relatively rare lung tumor and is mainly seen in women in the age group of 40–70 years [1, 2]. It is typically a benign tumor; however, lymph node recurrence, pleural and bone metastases and malignant transformation can occur [3–8]. This tumor is also known for its difficult preoperative diagnosis since it possesses four typical histological structural patterns in the same neoplasm: papillary, sclerotic, solid, and hemorrhagic [9]. Because of the histological complication, PSP is often misdiagnosed as adenocarcinoma or carcinoid [10–12]. In recent years, with the prevalence of transbronchial cryobiopsy (TBLC), we are able to obtain larger specimens than previously. To the best of our knowledge, there have been no

reports describing the diagnosis of PSP using TBLC.

### 2. Case report

A 43-year-old man was referred to our hospital for an abnormal chest shadow observed during a routine checkup. He had a history of smoking 10 cigarettes per day for seven years. He was asymptomatic, and no abnormal findings were observed on physical examination and laboratory investigations. Chest radiography revealed a nodule in the left lower lung field (Fig. 1A), while computed tomography (CT) scan of the chest revealed a 14-mm heterogeneous round nodule with surrounding ground-glass opacity in the left lower lobe. (Fig. 1B and C). After three-week follow-up, the patient developed bloody sputum, and the size of

\* Corresponding author.

E-mail address: [izumo\\_takehiro@med.jrc.or.jp](mailto:izumo_takehiro@med.jrc.or.jp) (T. Izumo).

<https://doi.org/10.1016/j.rmcr.2021.101494>

Received 27 February 2021; Received in revised form 5 May 2021; Accepted 10 August 2021

Available online 11 August 2021

2213-0071/© 2021 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

the tumor increased to 18 mm. Bronchoscopy was performed using a flexible bronchoscope under local anesthesia with 2% lidocaine as a bolus to the bronchi, following an intravenous injection of midazolam and pethidine hydrochloride. Bronchoscopic images revealed a blood clot found in the trachea (Fig. 1D). The lesion in the left lower lobe was approached with the aid of a radial endobronchial ultrasonography (R-EBUS) but the lesion was adjacent to the probe (Fig. 1E). Subsequent needle puncture was performed under fluoroscopic guidance in order to guide the R-EBUS probe to the target lesion and also so that we could check the bleeding tendency of the lesion. The probe was eccentrically oriented to the lesion (Fig. 1F) and there was minimal bleeding. We placed an occlusion balloon in the left B8 bronchus and administered prophylactic epinephrine before the biopsy to prevent severe bleeding. Then cryobiopsy was performed twice for 6 seconds each using the 1.9-mm-diameter cryoprobe under fluoroscopic guidance. Bleeding was well-managed and there were no complications. Histologically, epithelioid cells with solid proliferation and a low nuclear to cytoplasmic ratio, and various papillary lesions covered by type II pneumocyte-like-cells (Fig. 2A) were observed. Hemosiderin-laden histiocytes (Fig. 2B) were present in the superficial layer; immunohistochemical staining revealed the histiocytes positive for thyroid transcription factor-1 (TTF-1) (Fig. 2C) and vimentin, and the type II pneumocyte-like-cells positive for cytokeratin 7 (Fig. 2D). The Ki-67 labeling index was estimated to be approximately 5–10% in the hot spot. A diagnosis of PSP was formulated, and the patient was referred to the department of Respiratory Surgery. He underwent left basal segmentectomy of segments 8, 9, and 10, and the preoperative diagnosis was confirmed based on the surgical specimen.

### 3. Discussion

PSP is typically a benign tumor [1], which is derived from the primitive respiratory epithelium of the pulmonary alveolus, principally in type II alveolar cells [9]. Patients with PSP are usually asymptomatic and are detected incidentally during a routine checkup, while bloody sputum occurs in 8.6% of the cases [2]. PSP is known for its low preoperative diagnosis rate, and surgery is required for an accurate

diagnosis and treatment of PSP. Accurate preoperative diagnosis of PSP is critical because limited resection is indicated for patients with PSP [13,14].

PSP is radiologically often described as a single solitary nodule or mass with smooth margins and with obvious enhancement on the CT scan [2,9,15]. The lesion is usually smaller than 30 mm in diameter and is often peripherally located; 44.7% of the tumors are juxtaleural or juxtafissural [2,16]. It is sometimes misdiagnosed as lung cancer, pulmonary carcinoid, pulmonary hamartoma, tuberculoma, bronchial cyst, or inflammatory nodule [17–19]. 18F-fluorodeoxyglucose positron emission tomography (FDG-PET) is often useful in differentiating benign and malignant tumors; however, PSP shows various FDG accumulations [20]. It has been reported that the size of a round and oval PSP with well-defined borders was correlated with FDG accumulation [21]. In addition, symptomatic patients with PSP showed a higher maximum standardized uptake value than the asymptomatic group [21]. Actually, it is difficult to distinguish lung cancer from PSP using FDG-PET.

Bronchoscopic diagnosis is sometimes difficult when the lesion is small and is located in peripheral lesion, such as in the present case. The American College of Chest Physicians guidelines report that the sensitivity of bronchoscopy for diagnosing for peripheral lung lesions <2cm was 34% in 2013 [22]. In these cases, the lesion is endoscopically invisible and localizes with respiratory movement. We used an intravenous injection of midazolam and pethidine hydrochloride to reduce the respiratory movement as much as possible. To further improve the diagnostic yield, we used R-EBUS and virtual bronchoscopy navigation (VBN) software, SYNAPSE VINCENT® (Fujifilm, Tokyo, Japan). A meta-analysis reported that the diagnostic yield for 1067 peripheral pulmonary lesions ≤ 2 cm was 60.5% when R-EBUS was used [23]. A review showed that the diagnostic yield for lung lesions ≤ 2 cm was 67.4% using VBN [24]. Even if a sample is collected, pathological diagnosis of PSP is often challenging if an inadequate amount of tissue is obtained. PSP is composed of four major histologic patterns: papillary, sclerotic, solid, and hemorrhagic [9]. When the papillary component is predominant, it is often pathologically misdiagnosed as adenocarcinoma [10]. When the solid component is predominant, it could be misdiagnosed as carcinoid [11]. These reports indicate that obtaining larger

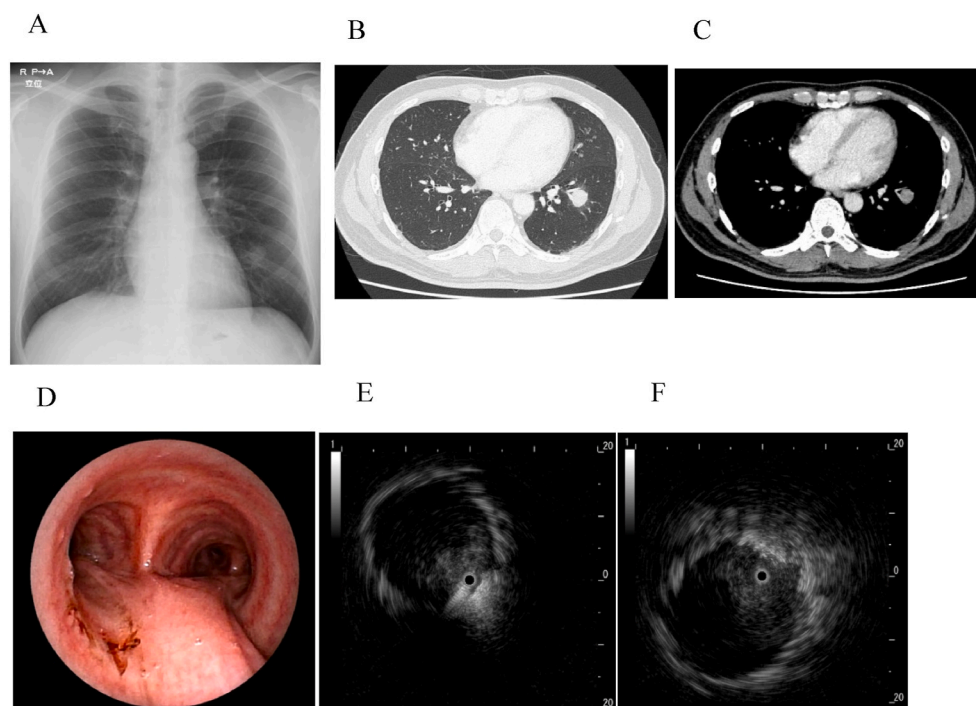


Fig. 1. Imaging and bronchoscopic findings of the patient.

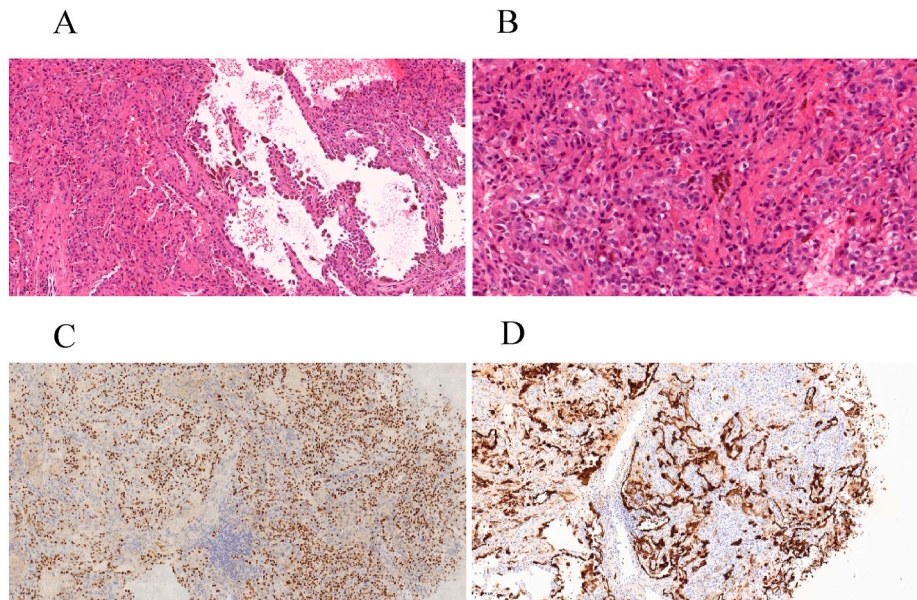


Fig. 2. Pathological findings of specimens from transbronchial cryobiopsy.

specimens are crucial; therefore, diagnosis using traditional methods such as percutaneous needle biopsy, transbronchial forceps biopsy, or transbronchial aspiration biopsy is difficult [25,26].

To ensure an accurate diagnosis, obtaining large samples is essential. However, transbronchial approach is often difficult since PSP is derived from the pulmonary epithelium cells and less likely exposed to the bronchial lumen. Cryobiopsy allows obtaining larger specimens with less disturbance compared to forceps biopsy [27]. Unlike forceps biopsy, cryobiopsy enables tissues to be obtained by the probe in a 360° manner. However, the diagnostic yield of TBLC varies depending on the location of the lesion and the R-EBUS probe. A previous study reported that when the lesion was adjacently, eccentrically, and concentrically oriented, the diagnostic yields of TBLC were 66.7%, 80.0%, and 85.7%, respectively [28]. In our case, the probe was initially adjacent to the lesion. Then the affected bronchial wall was punctured with a needle under fluoroscopic guidance in order to place the guide sheath and the R-EBUS probe inside the tumor. A previous study of transbronchial needle aspiration through a guide sheath with endobronchial ultrasonography showed that this procedure can be performed without an excessive risk of pneumothorax or bleeding [29]. Finally, the R-EBUS probe was eccentrically oriented to the lesion. Cryoprobes are stiff and often stick to cartilage. Using fluoroscopy, we adjusted the position of the cryoprobe to match the position of the ultrasonic probe. The sizes of our two samples were 3.5 mm × 4.5 mm and 3.5 mm × 3.5 mm, respectively. The specimens were of adequate size and of quality for making an accurate diagnosis even if the lesion was adjacent to the bronchial wall. Immunohistochemical staining is useful; however, no specific immunohistochemical markers have been identified thus far. PSP is often positive for TTF-1, epithelial membrane antigen, and cytokeratin 7 [30]. The mean Ki-67 labeling index of PSP is reportedly lower than that of adenocarcinoma [27]. Intraoperative frozen sections are also beneficial; however, the rate of accurate diagnosis is relatively low (44.1%) [31,32]. To maximize the diagnostic yield, it is important to collect a sample of sufficient size for immunochemical staining, so TBLC is a useful method.

In our case, there were no bleeding complications. Histologically, PSP has some hemorrhagic features, but life-threatening bleeding is rarely reported with transbronchial lung biopsy or transbronchial needle aspiration. There is a report of a transbronchial biopsy that failed due to bleeding; however the PSP was large (13.5 cm in diameter) in that case [33]. In addition, in our case, the amount of bloody sputum was scant, and the patient did not take any antiplatelets or anticoagulants. Thus,

we did not consider our patient to be at particularly high risk of bleeding on bronchoscopic procedures [34]. However, the risk of moderate-to-severe bleeding is higher in TBLC than in transbronchial lung biopsy [35]. An occlusion balloon and prophylactic epinephrine were used to prevent severe bleeding [34]. A retrospective multicenter study showed that the frequency of moderate-to-severe bleeding reduced by using an occlusion balloon with TBLC (1.8% vs 35.7%; adjusted odds ratio, 0.02) [36]. Furthermore, we confirmed that the lesion did not have an excessive bleeding tendency when needle puncture was performed prior to the TBLC. Using these techniques, the TBLC was safely conducted.

Cryobiopsy is considered beneficial in the preoperative diagnosis of PSP. Nonetheless, caution should be exercised in the interpretation of our report. In our case, the location of the PSP lesion adjacent to the bronchus and using needle puncture may have facilitated its diagnosis using TBLC. This implies that TBLC may be useful in cases where the target lesion is in close proximity to the bronchus. Therefore, further multicenter prospective studies are warranted to evaluate the usefulness of preoperative TBLC in diagnosing PSP.

#### 4. Conclusions

We report the first case of PSP diagnosed preoperatively using TBLC. Cryobiopsy is considered beneficial in the preoperative diagnosis of PSP.

#### Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

#### Ethics approval and consent to participate

Not applicable.

#### Declaration of competing interest

None.

#### Acknowledgments

We would like to thank Editage ([www.editage.com](http://www.editage.com)) for English

language editing.

## References

- [1] Y. Otani, I. Yoshida, O. Kawashima, et al., Benign tumors of the lung: a 20-year surgical experience, *Surg. Today* 27 (1997) 310–312, <https://doi.org/10.1007/BF00941804>.
- [2] J. Zhu, Analysis of the clinical differentiation of pulmonary sclerosing pneumocytoma and lung cancer, *J. Thorac. Dis.* 9 (9) (2017) 2974–2981, <https://doi.org/10.21037/jtd.2017.08.07>.
- [3] S. Wei, J. Tian, X. Song, Y. Chen, Recurrence of pulmonary sclerosing hemangioma, *Thorac. Cardiovasc. Surg.* 56 (2008) 120–122, <https://doi.org/10.1055/s-2007-989280>.
- [4] Y. Adachi, K. Tsuta, R. Hirano, et al., Pulmonary sclerosing hemangioma with lymph node metastasis: a case report and literature review, *Oncol. Lett.* 7 (4) (2014) 997–1000, <https://doi.org/10.3892/ol.2014.1831>.
- [5] S. Pokharel, S.S. Dhillon, L. Ylagan, S. George, S. Yendamuri, Sclerosing pneumocytoma with lymph node metastasis, *J. Thorac. Oncol.* 11 (10) (2016) 1802–1804, <https://doi.org/10.1016/j.jtho.2016.06.005>.
- [6] M.K. Kim, S.J. Jang, Y.H. Kim, S.W. Kim, Bone metastasis in pulmonary sclerosing hemangioma, *Korean J. Intern. Med.* 30 (6) (2015) 928–930, <https://doi.org/10.3904/kjim.2015.30.6.928>.
- [7] H. Suzuki, Y. Saitoh, E. Koh, et al., Pulmonary sclerosing hemangioma with pleural dissemination: report of a case, *Surg. Today* 41 (2011) 258–261, <https://doi.org/10.1007/s00595-009-4220-5>.
- [8] X. Teng, X. Teng, First report of pulmonary sclerosing pneumocytoma with malignant transformation in both cuboidal surface cells and stromal round cells: a case report, *BMC Canc.* 19 (1) (2019) 1154, <https://doi.org/10.1186/s12885-019-6356-z>.
- [9] A.L. Katzenstein, J.T. Gmelich, C.B. Carrington, Sclerosing hemangioma of the lung: a clinicopathologic study of 51 cases, *Am. J. Surg. Pathol.* 4 (4) (1980) 343–356, <https://doi.org/10.1097/0000478-198008000-00003>.
- [10] B. Yalcin, T.T. Bekci, S. Kozacioglu, O. Bolukbas, Pulmonary sclerosing pneumocytoma, a rare tumor of the lung, *Respir. Med. Case Rep.* 26 (2019) 285–287, <https://doi.org/10.1016/j.rmcr.2019.02.002>.
- [11] K. Kataoka, T. Fujiwara, Y. Iwamoto, H. Sumiyoshi, M. Matsuura, N. Seno, A case of pulmonary sclerosing hemangioma appearing as primary carcinoid on intraoperative frozen section examination, *JJLC* 48 (7) (2008) 850–855, <https://doi.org/10.2482/haigan.48.850>. [https://www.jstage.jst.go.jp/article/haigan/48/7/48\\_7\\_850/pdf/-char/ja](https://www.jstage.jst.go.jp/article/haigan/48/7/48_7_850/pdf/-char/ja).
- [12] W.D. Travis, E. Brambilla, A.G. Nicholson, Y. Yatabe, J.H.M. Austin, M.B. Beasley, et al., The 2015 world health organization classification of lung tumors: impact of genetic, clinical and radiologic advances since the 2004 classification, *J. Thorac. Oncol.* 10 (2015) 1243–1260, <https://doi.org/10.1097/JTO.0000000000000630>.
- [13] J.S. Park, K. Kim, S. Shin, H. Shim, H.K. Kim, Surgery for pulmonary sclerosing hemangioma: lobectomy versus limited resection, *Korean J. Thorac. Cardiovasc. Surg.* 44 (1) (2011) 39–43, <https://doi.org/10.5090/kjtc.2011.44.1.39>.
- [14] K. Sugio, H. Yokoyama, S. Kaneko, T. Ishida, K. Sugimachi, Sclerosing hemangioma of the lung: radiographic and pathological study, *Ann. Thorac. Surg.* 53 (2) (1992) 295–300, [https://doi.org/10.1016/0003-4975\(92\)91336-8](https://doi.org/10.1016/0003-4975(92)91336-8).
- [15] M.J. Chung, K.S. Lee, J. Han, Y.M. Sung, S. Chong, O.J. Kwon, Pulmonary sclerosing hemangioma presenting as solitary pulmonary nodule: dynamic CT findings and histopathologic comparisons, *AJR Am. J. Roentgenol.* 187 (2) (2006) 430–437, <https://doi.org/10.2214/AJR.05.0460>.
- [16] S.Y. Shin, M.Y. Kim, S.Y. Oh, et al., Pulmonary sclerosing pneumocytoma of the lung: CT characteristics in a large series of a tertiary referral center, *Med. (United States)* 94 (4) (2015) 1–10, <https://doi.org/10.1097/MD.0000000000000498>.
- [17] A.M. Hu, D. Zhao, H. Zheng, et al., Preoperative diagnosis in 46 cases of pulmonary sclerosing hemangioma, *Chin. Med.* 129 (11) (2016) 1377–1378, <https://doi.org/10.4103/0366-6999.182839>.
- [18] Y. An, C. Li, W. Zhao, Y. Ao, L. Chen, Imaging features, diagnosis and treatment of pulmonary sclerosing pneumocytoma complicated with lung cancer, *Int. J. Clin. Exp. Med.* 10 (7) (2017) 10905–10911.
- [19] A. Khanna, K. Alshabani, S. Mukhopadhyay, L. Lam, S. Ghosh, Sclerosing pneumocytoma, *Med. (Baltim.)* 98 (15) (2019) 1–4, <https://doi.org/10.1097/MD.00000000000015038>.
- [20] L. Jiang, Y. Huang, Q. Tang, et al., 18 F-FDG PET/CT characteristics of pulmonary sclerosing hemangioma vs. pulmonary hamartoma, *Oncol. Lett.* 16 (1) (2018) 660–665, <https://doi.org/10.3892/ol.2018.8660>.
- [21] J. Xu, Y. Dong, G. Yin, et al., 18F-FDG PET/CT imaging: a supplementary understanding of pulmonary sclerosing pneumocytoma, *Thorac. Cancer.* 10 (7) (2019) 1552–1560, <https://doi.org/10.1111/1759-7714.13100>.
- [22] M.P. Rivera, A.C. Mehta, M.M. Wahidi, Establishing the diagnosis of lung cancer: diagnosis and management of lung cancer, 3rd ed: American college of chest physicians evidence-based clinical practice guidelines, *Chest* 143 (2013) e142S–e165S, <https://doi.org/10.1378/chest.12-2353>, 5 SUPPL.
- [23] M.S. Ali, W. Trick, B.I. Mba, D. Mohanane, J. Sethi, A.I. Musani, Radial endobronchial ultrasound for the diagnosis of peripheral pulmonary lesions: a systematic review and meta-analysis, *Respirology* 22 (3) (2017) 443–453, <https://doi.org/10.1111/resp.12980>.
- [24] F. Asano, R. Eberhardt, F.J.F. Herth, Virtual bronchoscopic navigation for peripheral pulmonary lesions, *Respiration* 88 (5) (2014) 430–440, <https://doi.org/10.1159/000367900> (p. 19, line 9–11). doi: 10.1136/thx.2010.145490.
- [25] H. Agatsuma, M. Miyazawa, N. Kobayashi, Pulmonary sclerosing hemangioma diagnosed before surgery: report of a young male case, *J. Jpn. Assoc. Chest Surg.* 24 (6) (2010) 6–10, [https://www.jstage.jst.go.jp/article/jacsurg/24/6/24\\_6\\_896/pdf/-char/ja](https://www.jstage.jst.go.jp/article/jacsurg/24/6/24_6_896/pdf/-char/ja).
- [26] A. Iyoda, K. Hiroshima, M. Shiba, et al., Clinicopathological analysis of pulmonary sclerosing hemangioma, *Ann. Thorac. Surg.* 78 (6) (2004) 1928–1931, <https://doi.org/10.1016/j.athoracsur.2004.05.069>.
- [27] Z. Aktas, E. Gunay, N.T. Hoca, et al., Endobronchial cryobiopsy or forceps biopsy for lung cancer diagnosis, *Ann. Thorac. Med.* 5 (4) (2010) 242–246, <https://doi.org/10.4103/1817-1737.69117>.
- [28] S. S. Kho, S.K. Chan, M.C. Yong, S.T. Tie, Performance of transbronchial cryobiopsy in eccentrically and adjacently orientated radial endobronchial ultrasound lesions, *ERJ Open Res* 5 (4) (2019) 135–2019, <https://doi.org/10.1183/23120541.00135-2019>.
- [29] M. Takai, T. Izumo, C. Chavez, T. Tsuchida, S. Sasada, Transbronchial needle aspiration through a guide sheath with endobronchial ultrasonography (GS-TBNA) for peripheral pulmonary lesions, *Ann. Thorac. Cardiovasc. Surg.* 20 (1) (2014) 19–25, <https://doi.org/10.5761/atcs.0a.13-00261>.
- [30] B. Aramini, V. Masciale, B. Manfredini, et al., Expression of ALDH and SOX-2 in pulmonary sclerosing Pneumocytoma (PSP) of the lung: is there a meaning behind? *Front. Med.* 7 (2020) 497, <https://doi.org/10.3389/fmed.2020.00497>.
- [31] C.H. Yang, L.Y. Lee, Pulmonary sclerosing pneumocytoma remains a diagnostic challenge using frozen sections: a clinicopathological analysis of 59 cases, *Histopathology* 72 (2018) 500–508, <https://doi.org/10.1111/his.13391>.
- [32] A.C. Chan, J.K. Chan, Can pulmonary sclerosing haemangioma be accurately diagnosed by intra-operative frozen section? *Histopathology* 41 (2002) 392–403, <https://doi.org/10.1046/j.1365-2559.2002.01461.x>.
- [33] S.K. Boham, K.A. Kesler, M.E. Geib, X. Wang, A massive 13.5 cm sclerosing pneumocytoma in a 61-year-old female, *Hum Pathol Case Reports* 24 (2021) 200490, <https://doi.org/10.1016/j.ehpc.2021.200490>.
- [34] I.A. Du Rand, J. Blaikley, R. Booton, et al., British Thoracic Society guideline for diagnostic flexible bronchoscopy in adults, *Thorax* 68 (SUPPL. 1) (2013) i1–i44, <https://doi.org/10.1136/thoraxjnl-2013-203618>.
- [35] J. Hetzel, R. Eberhardt, C. Petermann, et al., Bleeding risk of transbronchial cryobiopsy compared to transbronchial forceps biopsy in interstitial lung disease - a prospective, randomized, multicentre cross-over trial, *Respir. Res.* 20 (1) (2019) 140, <https://doi.org/10.1186/s12931-019-1091-1>.
- [36] S. Dhooria, R.M. Mehta, A. Srinivasan, et al., The safety and efficacy of different methods for obtaining transbronchial lung cryobiopsy in diffuse lung diseases, *Clin. Res. J* 12 (4) (2018) 1711–1720, <https://doi.org/10.1111/crj.12734>.