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Computed tomography-guided coil localization for scapula-blocked pulmonary nodules

A trans-scapular approach

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Abstract

To evaluate the clinical efficiency, feasibility, and safety of computed tomography (CT)-guided trans-scapular coil localization (TSCL) approach to treating scapula-blocked pulmonary nodules (SBPNs).

In total, 105 patients with pulmonary nodules underwent CT-guided CL and subsequent video-assisted thoracoscopic surgery (VATS)-guided wedge resection (WR) between January 2016 and July 2020. Six of these patients (5.7%) had SBPNs that led them to undergo CT-guided TSCL. Rates of technical success and localization-related complications were then recorded and analyzed.

CT-guided TSCL was associated with a 100% technical success rate, with one coil being placed per patient. The median CT-guided TSCL duration was 15 min. No patients experienced any complications associated with this procedure, and subsequent VATS-guided WR of SBPNs was 100% technically successful. In two patients with invasive adenocarcinoma, additional lobectomy was performed. Median VATS duration and intraoperative blood loss were 120 min and 150 mL, respectively.

In summary, these results indicate that CT-guided TSCL could be easily and safely implemented to achieve high success rate when performing the VATS-guided WR of SBPNs.

Abbreviations: CL = coil localization, CT = computed tomography, PN = pulmonary nodule, SBPN = scapular-blocked PN, TSCL = trans-scapular CL, VATS = video-assisted thoracoscopic surgery, WR = wedge resection.

Keywords: coil, localization, pulmonary nodule, scapular

1. Introduction

Computed tomography (CT)-guided localization has been frequently conducted prior to performing video-assisted thoracoscopic surgery (VATS)-guided wedge resection (WR) for pulmonary nodules (PNs), enabling successful localization in 89.6% to 100% of cases and facilitating successful WR in 97% to 100% of cases with relatively low rates of complications (8.8–12.6%).[1–4] Localization has previously been conducted using coils, methylene blue, hook-wire, or radio-labeling agents.[4] Coil localization (CL) is associated with lower complication rates than these other approaches.[4]

Owing to the advantages associated with this approach, CL is widely used in patients with sub-centimeter PNs, multiple PNs, and sub-fissural PNs.[5–7] While CT-guided lung interventions typically seek to avoid all bony structures, a subset of patients exhibit scapula-blocked PNs (SBPNs).[8–10] In these patients, the scapula must be penetrated when conducting these interventions in order to effectively evaluate and treat SBPNs.[8–10]

Herein, we explore the clinical efficiency, feasibility, and safety of a CT-guided trans-scapular CL (TSCL) approach for SBPNs.

2. Materials and methods

2.1. Study design

The Xuzhou Central Hospital ethics committee (members: Jing Yang, Pei-An Wang, Cong-Hui Han, Hai-Tao Yin, Xian-Chi Li, Bo Bi, Na Zhang, Li-Li Ma, Zhong-Mei Wu, and Xin-Xin Zhang) approved this retrospective study, which was consistent with the Declaration of Helsinki.

As this was a non-interventional retrospective study, the requirement for informed consent was waived. All data were anonymized after removing all personally identifiable data.

In total, 105 patients with PNs were treated via CT-guided CL followed by VATS-guided WR between January 2016 and July 2020, of whom 6 (5.7%) had SBPNs and underwent CT-guided TSCL (Table 1).

Inclusion criteria for this analysis were:

1. PNs $\leq$ 3 cm in diameter, including ground-glass PNs $\leq$ 3 cm and solid PNs $\leq$ 1.5 cm;
2. a PN-pleura distance $\leq$2 cm; and
3. SBPNs for which no needle pathway was available that would enable avoidance of the scapula.

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The datasets generated during and/or analyzed during the present study are available from the corresponding author on reasonable request.

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Table 1

Baseline data of the 6 patients.

	Age (y)/Gender	BMI (kg/m^2)	Co-morbid	Tumor history	Location	Nature	Diameter (mm)	Lesion-pleura distance (mm)
1	65/male	23.7	Mild cerebral infarction	No	Right upper	GGN	7	4
2	50/male	24.6	None	No	Right upper	Solid	8	8
3	66/female	23.1	None	No	Left upper	Mixed GGN	18	6
4	45/female	22.5	None	No	Right upper	GGN	5	0
5	70/female	20.8	Mild cerebral infarction	No	Left upper	Solid	8	11
6	45/female	25.2	None	No	Left upper	GGN	6	0

BMI = body mass index, GGN = ground glass nodule.

Exclusion criteria were:

1. PNs < 5 mm in diameter;
2. typical benign PNs, including calcifications and nodules that grew smaller upon follow-up; and
3. patients with active bleeding, infections, abnormal coagulatory activity, or reduced cardiopulmonary reserves.

2.2. CT-guided TSCL

All CT-guided interventions were performed with a 16-slice CT device by a skilled radiologist with 14 years of experience performing interventional chest radiology procedures. Patients in the lateral or prone positions were given local anesthesia and directed to remain still and breathe regularly for the course of the procedure.

Preoperative CT scanning was performed to evaluate the needle passage. Scapular puncture was conducted with a 17G needle (DuoSmart, Modena, Italy) using a drill while steadily applying pressure. An 18G needle (Precisa, Roma, Italy) was then advanced coaxially via the 17G needle and gently advanced to the lung parenchyma to within 1 cm of the PN. A coil (length: 5-cm; diameter: 0.038 inches) (Cook, IN) was then advanced until it was almost within the lung parenchyma, and the needle was then removed so that the coil tail was still localized above the visceral pleura (Fig. 1).

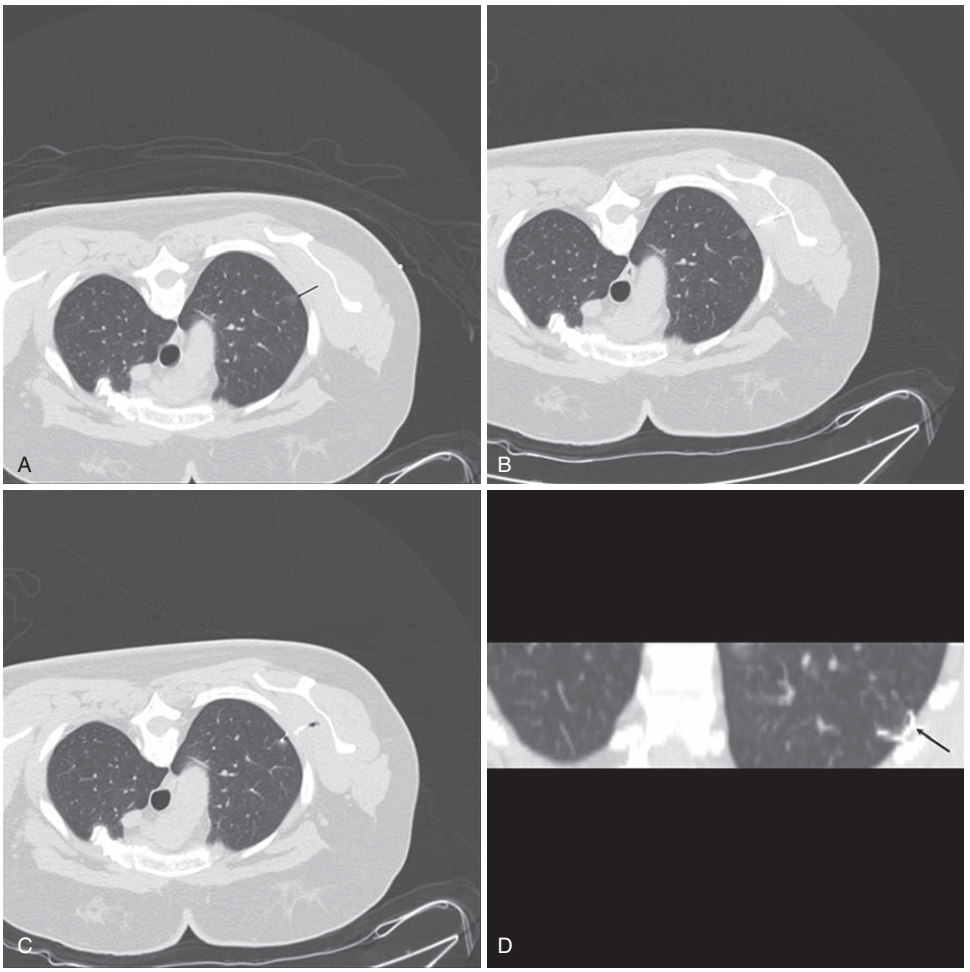

Figure 1. (A) A SBPN (ground glass nodule, arrow) was found in the left upper lobe. (B) The needle was punctured via the trans-scapula approach. (C) The coil was inserted for localization. (D) The coil tail (arrow) remained positioned above the visceral pleura.

Postoperative CT scanning was then conducted to assess patients for procedure-associated complications.

2.3. VATS-guided WR

VATS-guided WR was conducted within 24 h after TSCL, using the coil tail as a guide such that the edge of the resected area was ≥2 cm from the coil. When the coil tail was no longer visible, it was instead located via palpation. When coil tail localization was not possible, lobectomy was performed in lieu of the WR procedure.

High-speed pathological assessments of the resected lesion were performed in the Department of Pathology. In cases where LNs that experienced enhanced further than the mini-invasive adenocarcinoma level, excessive lymph and lobectomy dissection of node were executed.

2.4. Definitions

CT-guided TSCL was considered to be technically successful when the coil could be visualized upon VATS. WR was considered to be successful when the target nodule was located within the resected wedge of tissue.

2.5. Statistical analysis

SPSS v16.0 (SPSS, Inc, IL) was employed for all statistical testing. Quantitative data are given as medians, while categorical data are percentages (number/total).

3. Results

3.1. Baseline data

This study included 6 patients (4 female, 2 male) with a median age of 57.5 years who were treated via this approach (Table 1). Each patient had a single SBPN located behind the central portion of the scapula. These lesions had a median diameter of 7.5 mm and a median lesion-pleura distance of 5 mm. None of these patients had any history of cancer, while two had experienced mild cerebral infarction.

3.2. Localization procedures

CT-guided TSCL was technically successful in 100% of patients. The median duration of CT-guided TSCL was 15 min. A single coil was placed in all patients, and no procedure-related complications were reported (Table 2).

3.3. VATS procedures

The VATS-guided WR of SBPNs was technically successful in 100% of patients (Table 3). Subsequent lobectomy was conducted in two of these patients owing to the diagnosis of invasive adenocarcinoma. The median VATS duration and intraoperative blood loss were 120 min and 150 mL, respectively. Resected SBPNs were diagnosed as adenocarcinoma (T1N0M0, n = 2) and adenocarcinoma in situ (n = 4).

Table 2

Details of CT-guided coil localization.

	Technical success	Patients' position	Duration (min)	Complication
1	Yes	Prone	12	None
2	Yes	Prone	20	None
3	Yes	Prone	14	None
4	Yes	Prone	13	None
5	Yes	Prone	16	None
6	Yes	Prone	18	None

CT = computed tomography.

Table 3

Details of VATS.

	Successful wedge resection	Additional lobectomy	Duration (min)	Blood loss (mL)	Diagnosis
1	Yes	No	60	25	AIS
2	Yes	Yes	270	200	Adenocarcinoma
3	Yes	Yes	220	200	Adenocarcinoma
4	Yes	No	120	200	AIS
5	Yes	No	60	50	AIS
6	Yes	No	120	100	AIS

AIS = adenocarcinoma in situ, VATS = video-assisted thoracoscopic surgery.

4. Discussion

Herein, we detailed our clinical experience performing CT-guided TSCL for SBPNs. When conducting CT-guided lung interventional procedures, bony structures have the potential to obstruct the needle pathway.[8–10] Typically, avoiding these bones is considered to be the optimal approach. However, when a viable pathway is not available, it is instead considered acceptable to conduct a trans-bone approach. Herein, we achieved a 100% rate of technical success when performing CT-guided TSCL for SBPNs, in line with similarly high rates that have previously been reported in other studies about CT-guided trans-bone lung interventional procedures (91–100%).[8–10]

When performing CT-guided lung biopsy, a number of potentially acceptable alternative needle pathways need to be evaluated when the most direct pathway is occluded by bone, even though these pathways are likely to increase the pleura–lesion distance. In contrast to biopsy approaches, however, the CL of PNs is intended to facilitate high technical success rates when conducting VATS-guided WR.[1] It is thus important that the coil body by localized proximal to the PN, while the coil tail remains above the pleural surface as near the lesion as possible. Minimizing the pleura-lesion distance is therefore essential to facilitate effective CT-guided CL. As such, a trans-scapular approach was selected in the present study for cases wherein the optimal needle pathway was blocked by the scapula.

No patients exhibited any TSCL-related complications. However, this finding may be attributable to our small study size, given that in prior studies the rates of complications associated with CT-guided localization ranged from 9% to 12.3%,[1–3] and prior studies of the CT-guided trans-scapular biopsy approach reported complication rates of 18.2% to 25%.[8,10]

VATS-guided WR was performed successfully for all patients in this study. In line with results pertaining to most other preoperative CT-guided localization strategies,[1–3] preoperative CT-guided TSCL is capable of achieving high rates of WR success when evaluating SBPNs without compromising pulmonary function.

This study has multiple limitations. For one, it was a single-center retrospective study and thus potentially susceptible to selection bias. Our sample size was also very small, so additional

work will be required to validate our conclusions. Furthermore, we did not include a control group in this study. Even so, as this is a specialized technique which is only used when treating a very limited number of specific patients, we believe these data support it being a safe and feasible approach. Lastly, this technique only applies to the sub-pleural PNs. Thus, it cannot be used for the deeper PNs.

In summary, CT-guided TSCL can be conducted to easily and safely achieve high success rates when performing the VATS-guided WR of SBPNs. However, this technique is not suit for the deeper SBPNs.

Author contributions

Data curation: Xia Liu, Wei Cao.
Funding acquisition: Qing-Song Xu.
Methodology: Wei Cao.
Supervision: Qing-Song Xu.
Writing – original draft: Xia Liu.
Writing – review & editing: Qing-Song Xu.

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