ORIGINAL PAPER Interventional radiology

Preoperative computed tomography–guided localization of pulmonary nodules: comparison between tailed coil and suture anchor localization

Juan Shan[1*], Xiao-Xuan Ma[1*], Wen-Tao Zhang[1], Cheng Han[1], Jun Liu[1], Cheng-Shuang Zhou[2]

1 Department of Radiology, First Hospital of Zhangjiakou City, Zhangjiakou, China
2 Department of Ultrasound, Children's Hospital of Nanjing Medical University, Nanjing, China

KEY WORDS

computed tomography, localization, pulmonary nodule, video-assisted thoracic surgery

ABSTRACT

INTRODUCTION Both tailed coils and suture anchors are purpose-designed materials used for preoperative localization of pulmonary nodules (PNs). Their comparative clinical performance and safety profiles, however, have not been clearly established.

AIM We aimed to assess the comparative efficacy and safety of computed tomography (CT)-guided tailed coil and suture anchor placement for preoperative PN localization.

MATERIALS AND METHODS Patients who had undergone CT-guided PN localization followed by video-assisted thoracic surgery (VATS) resection between January and December 2025 were consecutively included in this retrospective analysis. The participants were categorized into 2 groups: group 1 (tailed coil) and group 2 (suture anchor). Baseline characteristics along with localization- and VATS-associated outcomes were collected and analyzed.

RESULTS CT-guided localization was performed in 98 patients using tailed coils (n = 47) and suture anchors (n = 51), with 1 PN localized per patient. The technical success rate was 100% in both cohorts. Mean (SD) localization time was 20.1 (4.4) minutes in group 1 and 21.2 (3) minutes in group 2 ($P = 0.16$). Pneumothorax occurred in 21.3% of the cases in the tailed coil group and 23.5% in the suture anchor cohort ($P = 0.79$). Pulmonary hemorrhage rates were 21.3% and 11.8%, respectively ($P = 0.2$). All patients successfully underwent VATS sublobar resection. Additional lobectomy following sublobar resection was required in 5 cases (10.6%) in group 1 and 6 (11.8%) in group 2 ($P = 0.24$).

CONCLUSIONS CT-guided tailed coil and suture anchor localization techniques appear to offer comparable clinical efficacy and safety for preoperative PN localization.

Correspondence to:
Cheng-Shuang Zhou, MD, Department of Ultrasound, Children's Hospital of Nanjing Medical University, 72 Guangzhou Road, 210008 Nanjing, China, phone: +86 025 83117500, email: zhouchengshuang123@126.com

Received: January 14, 2026.
Revision accepted: January 26, 2026.
Published online: February 3, 2026.
Wideochir Inne Tech Maloinwazyjne. 2026; 21 (2): 184-190
doi:10.20452/wiitm.2026.18013

*JS and X-XM contributed equally to this work.

INTRODUCTION Preoperative localization of pulmonary nodules (PNs) under computed tomography (CT) guidance is widely adopted to improve the success rate of video-assisted thoracic surgery (VATS) wedge or segmental resections.[1-3] Historically, a variety of localization materials, including hook-wires, microcoils, and liquid agents, have been used for this purpose.[4] These materials, however, were not designed for the express purpose of PN localization, and each is associated with inherent limitations despite their clinical utility.

In recent years, several PN-specific localization devices have been developed to address the shortcomings of the previously used techniques.[5,6] The suture anchor system represents an evolution of the hook-wire design, and was specifically engineered for PN localization.[5] Although hook-wire placement is technically straightforward, its rigid metallic structure has been linked to a higher incidence of complications, such as pneumothorax and patient discomfort.[4] Suture anchor retains the anchoring mechanism of the hook-wire while replacing the rigid wire with a flexible suture,

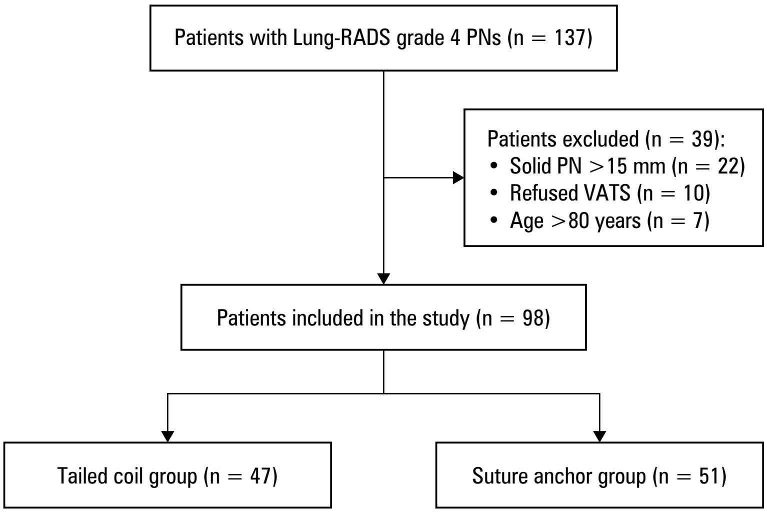

FIGURE 1 Flowchart of the study

Abbreviations: Lung-RADS, Lung Imaging Reporting and Data System; PN, pulmonary nodule; VATS, video-assisted thoracic surgery

thereby improving patient tolerance and potentially reducing procedure-related adverse events.[5]

Microcoils are another commonly used localization material with demonstrated lower complication rates than hook-wires.[7] Nevertheless, conventional microcoil localization has an important limitation: the entire coil may be deployed within the lung parenchyma, which can result in localization failure during surgery.[8] To mitigate this drawback, tailed coil was developed as a dedicated PN localization device, incorporating an external tail that remains visible on the pleural surface.[6] Despite the increasing availability of these PN-specific materials, direct comparative studies evaluating their clinical effectiveness and safety remain scarce.

AIM We analyzed the comparative efficacy and safety of CT-guided tailed coil and suture anchor placement as a means of preoperative PN localization.

MATERIALS AND METHODS **Study design** The study was approved by the Ethics Committee of the First Hospital of Zhangjiakou City (2025-LW-33), waiving the need for written informed consent due to the retrospective design. Consecutive patients who had undergone CT-guided PN localization before VATS resection between January and December 2025 were included. Tailed coils were used for localization prior to June 2025, after which suture anchors were adopted as the standard localization material. Inclusion criteria were as follows: 1) PNs classified as Lung Imaging Reporting and Data System category 4; 2) PN diameter between 8 and 30 mm; and 3) patients aged over 18 and below 80 years. The exclusion criteria comprised: 1) solid PNs above 15 mm in diameter; 2) hilar nodules; and 3) contraindications to VATS or patient refusal of surgical treatment. Baseline characteristics, localization-associated outcomes, and VATS-associated outcomes were collected and compared between the tailed coil and suture anchor groups.

Localization materials The tailed coil system (Cherish Medical, Changzhou, China) consists of a circular metallic coil attached to a 20–50-mm metal tail. The circular component enables localization close to the PN, while the tail remains exposed on the pleural surface to facilitate intraoperative identification. The device is preloaded into a dedicated 20-gauge introducer needle.

The suture anchor system (Senscure, Ningbo, China) comprises a 4-hook anchor connected to a 100–150-mm tricolored suture. The anchor secures the device within the lung parenchyma near the PN, and the suture extends externally to mark the pleural surface. This system is also delivered using a matched 20-gauge introducer needle.

Computed tomography–guided localization of pulmonary nodules All procedures were conducted under local anesthesia and CT guidance by an interventional radiologist with more than 10 years of experience. The patients were positioned according to the target PN location, and the puncture trajectory was planned accordingly.

In the tailed coil cohort (group 1), the introducer needle was entered into the lung parenchyma along the predetermined path. After positioning the tip of the needle approximately 10 mm from the target PN, the tailed coil was deployed using a pusher. The needle was then carefully withdrawn while ensuring that the coil tail was external to the pleura.

In the suture anchor group (group 2), the introducer needle was needle was advanced into the lung parenchyma in a manner similar to that adopted during tailed coil–based localization. After positioning the tip of the needle approximately 10 mm from the PN, the suture anchor was released. The needle was withdrawn smoothly, confirming that the tricolored suture extended beyond the pleural surface.

Video-assisted thoracic surgery procedures VATS was performed within 3 hours of localization. Guided by the localization marker, sublobar wedge resection or segmentectomy was initially attempted. Segmentectomy was performed when wedge resection did not achieve adequate surgical margins. The resected specimens were submitted for intraoperative pathological examination. Systematic lymph node dissection was undertaken when invasive lung cancer was identified. Additional lobectomy was performed for invasive tumors larger than 2 cm or those with a solid-to-ground-glass ratio above 50%.

Definitions The technical success of PN localization was based on several criteria: 1) clear visualization of the localization material during VATS; 2) no dislodgement of the localization device; and 3) confirmation of the target PN in the resected

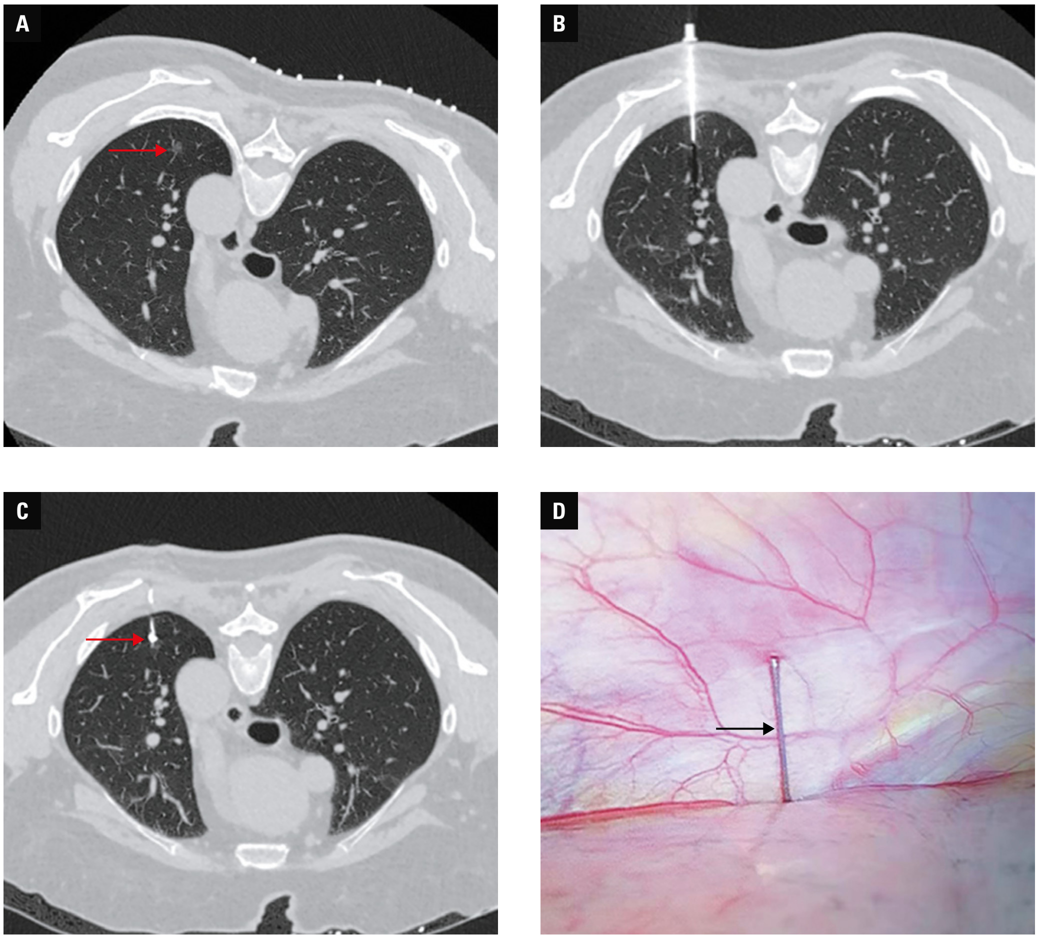

FIGURE 2 Preoperative computed tomography (CT)-guided tailed coil localization; **A** – thoracic CT showing a pure ground-glass nodule (arrow) in the left upper lobe; **B** – CT-guided needle puncture; **C** – tailed coil (arrow) placed for pulmonary nodule localization; **D** – tailed coil (arrow) visualized during video-assisted thoracic surgery

tissue. Localization time was defined as the time from the first to the final CT.

Statistical analysis The analyses were performed using SPSS Statistics software, version 16.0 (IBM Corp., Armonk, New York, United States). Continuous variables with normal and non-normal distributions are described as mean (SD) or median (interquartile range), respectively, and were compared using the *t* test and the Mann–Whitney test. Categorical variables are presented as numbers and percentages, with comparisons performed using the χ^2 test. Multivariable logistic regression was conducted to identify predictors of localization-related complications. The variables with a *P* value below 0.1 in the univariable analysis were incorporated in the multivariable model. A 2-sided *P* value below 0.05 was deemed significant.

RESULTS **Patients** The studyflow chart is provided in **FIGURE 1**. A total of 98 patients were enrolled, of whom 47 underwent CT-guided tailed coil localization (**FIGURE 2**) and 51 were subjected to CT-guided suture anchor localization (**FIGURE 3**) of PNs. Each patient had a single PN localized. Baseline demographic and nodule-related features were comparable between the 2 cohorts (**TABLE 1**).

Localization-related outcomes Both localization techniques achieved a technical success rate of 100% (**TABLE 2**). Mean (SD) localization time was 20.1 (4.4) minutes in group 1 and 21.2 (3) minutes in group 2 (*P* = 0.16). Pneumothorax occurred in 21.3% of the tailed coil cohort and 23.5% in the suture anchor cohort patients (*P* = 0.79). Pulmonary hemorrhage was observed in 21.3% and 11.8% of the cases in groups 1 and 2, respectively (*P* = 0.2). Importantly, none of these complications interfered with or delayed the subsequent VATS procedures.

Predictors of complications Univariable and multivariable logistic regression demonstrated that localization of PNs in the upper lobe was independently predictive of pneumothorax (*P* = 0.03; **TABLE 3**). Additionally, lower PN diameter (*P* = 0.04) and more extensive lesion depth (*P* = 0.02) were independently linked with an increased risk of pulmonary hemorrhage (**TABLE 4**).

Video-assisted thoracic surgery–related outcomes All patients successfully underwent VATS sublobar resection. Details of the surgical procedures are provided in **TABLE 5**. The sublobar resection types were comparable between the 2 cohorts (*P* = 0.05). Following intraoperative pathological assessment, additional lobectomy was required in 5 cases (10.6%) in the tailed coil cohort and 6 cases (11.8%) in the suture anchor group (*P* = 0.24). Final pathological diagnoses were also similar in both groups (*P* = 0.24).

DISCUSSION An ideal PN localization device should achieve a secure anchor within the lung

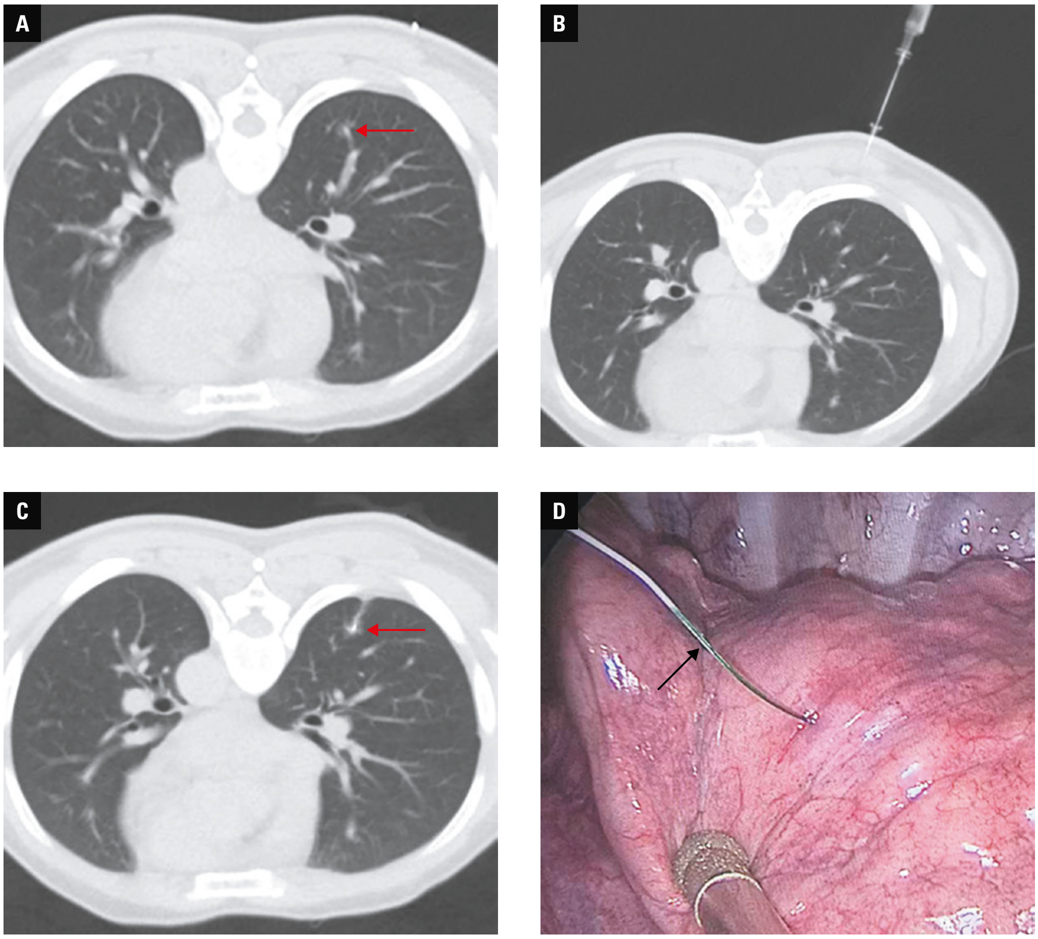

FIGURE 3 Preoperative computed tomography (CT)-guided suture anchor localization; **A** – thoracic CT showing a mixed ground-glass nodule (arrow) in the right lower lobe; **B** – CT-guided needle puncture; **C** – suture anchor (arrow) placed for pulmonary nodule localization; **D** – suture anchor (arrow) visualized during video-assisted thoracic surgery

TABLE 1 Baseline characteristics of the patients

Variable		Tailed coil group (n = 47)	Suture anchor group (n = 51)	*P* value
Age, y		61.3 (10.2)	59.2 (10.4)	0.32
Sex	Men	15 (31.9)	20 (29.2)	0.45
	Women	32 (68.1)	31 (60.8)	
Smoking history		12 (25.5)	11 (21.6)	0.64
Malignancy history		2 (4.3)	5 (9.8)	0.44
PN diameter, mm		9.5 (3.6)	8.6 (3.5)	0.19
Nature of PN	Solid	8 (17)	5 (9.8)	0.37
	Mixed GGN	21 (44.7)	20 (39.2)	
	Pure GGN	18 (38.3)	26 (51.)	
Lung side	Left	22 (46.8)	25 (49)	0.83
	Right	25 (53.2)	26 (51)	
Lobe	Nonupper	20 (42.6)	27 (52.9)	0.3
	Upper	27 (57.4)	24 (47.1)	
PN depth, mm, median (IQR)		9.8 (6.5–15.2)	9.2 (2.4–16.3)	0.57

Data are presented as number (percentage) or mean (SD) unless indicated otherwise.

Abbreviations: GGN, ground-glass nodule; IQR, interquartile range; others, see FIGURE 1

parenchyma near the target lesion and reliable intraoperative visualization during VATS. In recent years, localization devices specifically designed to satisfy these criteria, such as suture anchors and tailed coils, have been introduced into clinical practice.[6,9] Prior evidence has shown that CT-guided suture anchor localization achieves higher success rates and fewer complications than traditional hook-wire techniques.[10] Similarly, Shan et al[6] reported that tailed coil localization markedly improved technical success, as compared with conventional microcoil placement (100% vs 87.8%; $P = 0.03$).

We compared the efficacy and safety of CT-guided tailed coil and suture anchor localization. Both techniques demonstrated excellent performance, achieving a 100% technical success rate. These rates were comparable to those reported in previous studies (99.1%–100%).[6,9,11] The 4-pronged anchoring tip of the suture anchor provides stable fixation within the lung parenchyma. Zhou et al[9] found that suture anchor had a considerably lower dislodgement rate than hook-wire (0% vs 4.8%; $P = 0.03$). Similarly, the structure of the tailed coil offers similar anchoring capability. In addition, the tail-like external components of both devices extend beyond the pleural surface, facilitating easy intraoperative identification. These shared structural advantages likely account for the uniformly high localization success observed in both groups.

Localization time did not differ significantly between the 2 techniques, suggesting that procedural complexity and operator effort are comparable. Previous studies have indicated that both tailed coil and suture anchor localization require less time than conventional microcoil technique.[6,11] Traditional microcoils may be inadvertently deployed entirely within the lung parenchyma, increasing the risk of technical failure and necessitating additional manipulations, which prolongs procedure

TABLE 2 Localization-related outcomes

Variable		Tailed coil group (n = 47)	Suture anchor group (n = 51)	*P* value
Success rate of PN localization, %		100	100	Not applicable
Localization time, min		20.1 (4.4)	21.2 (3)	0.16
Complications	Pneumothorax	10 (21.3)	12 (23.5)	0.79
	Pulmonary hemorrhage	10 (21.3)	6 (11.8)	0.2

Data are presented as number (percentage) or mean (SD).

Abbreviations: see **FIGURE 1**

TABLE 3 Logistic regression analysis of pneumothorax predictors

Variable		Univariable analysis		
		Odds ratio	95% CI	*P* value
Age		1.001	0.956–1.049	0.96
Sex	Men	1	–	–
	Women	0.964	0.359–2.589	0.94
Smoking history		0.667	0.201–2.217	0.51
Malignancy history		0.556	0.063–4.878	0.6
PN diameter		1.092	0.963–1.239	0.17
Nature of PN	Solid	1	–	–
	Mixed GGN	3.375	0.385–29.556	0.27
	Pure GGN	4.5	0.527–38.446	0.17
Lung side	Left	1	–	–
	Right	1.784	0.681–4.673	0.24
Lobe	Nonupper	1	–	–
	Upper	3.124	1.103–8.847	0.03
PN depth		0.964	0.912–1.019	0.2
Localization time		0.97	0.855–1.101	0.64
Localization material	Tailed coil	1	–	–
	Suture anchor	1.138	0.439–2.95	0.79

Abbreviations: see **FIGURE 1** and **TABLE 1**

time.[6,11] In contrast, the tail-like design of tailed coils and suture anchors simplifies deployment and reduces technical difficulty. This feature may also make these devices particularly suitable for operators with limited experience in PN localization.

Pneumothorax and pulmonary hemorrhage remain the most frequently reported complications associated with CT-guided PN localization.[4,12,13] In this study, the incidence of both complications was comparable between the groups. Furthermore, the incidence rates of pneumothorax (21.3% for tailed coil vs 23.5% for suture anchor) and pulmonary hemorrhage (21.3% for tailed coil vs 11.8% for suture anchor) were both comparable to those reported in previous studies (16.1%–16.7% for pneumothorax vs 11.9%–23.7% for pulmonary hemorrhage).[6,9] Logistic regression indicated that the type of localization material was not an independent risk factor for either complication, indicating comparable safety profiles of the 2 techniques.

Upper-lobe PN location emerged as an independent predictor of pneumothorax. This finding may be explained by differences in respiratory mechanics, as the lower lung regions contribute more significantly to respiratory motion than the upper lobes.[14,15] Smaller nodule size and greater lesion depth were identified as predictors of pulmonary hemorrhage. Localization of small or deeply situated PNs often requires multiple needle adjustments or longer intrapulmonary needle paths, which may increase the likelihood of vascular injury. These observations are consistent with prior studies of CT-guided lung biopsy, which also identified smaller lesion size and greater depth as significant risk factors for pulmonary hemorrhage.[16-18]

A previous meta-analysis found that suture anchor localization exhibited markedly lower rates of total complications ($P = 0.01$), pneumothorax ($P = 0.003$), and pulmonary hemorrhage ($P = 0.004$) than hook-wire in PN localization.[10] These findings may indicate that suture anchors exhibit better safety than hook-wires. However, neither suture anchors nor tailed coils were superior to traditional microcoil in terms of PN localization-related safety.[6,11]

Historically, detection of invasive lung cancer on intraoperative pathology mandated completion lobectomy following sublobar resection.[8] However, a growing body of evidence suggests that sublobar resection may provide oncologic outcomes comparable to those of lobectomy for small (≤2 cm), peripheral invasive lung cancers.[19,20] Here, only a small proportion of cases in either group required additional lobectomy, while the majority were adequately treated with sublobar resection alone. These findings underscore the role of accurate preoperative localization in facilitating precise surgical resection, avoiding unnecessary lobectomy and preserving postoperative lung function.

Preoperative PN localization offers more benefits to patients with multiple PNs.[12] Gong et al[21] have found that suture anchor placement is a reliable and safe method for preoperative localization of multiple PNs. However, the tailed coil localization for multiple PNs has not been reported. This topic should be addressed in further clinical trials.

There are several limitations to this study. First, it was retrospective, leading to potential selection bias, although the baseline features of the 2 cohorts were similar. Second, both localization techniques were implemented at different times, which may further increase the risk of bias related to temporal factors. Finally, the investigation was undertaken at a single institution and had a relatively restricted sample size. Larger, prospective, multicenter trials are required to confirm our findings.

CONCLUSIONS In summary, the findings demonstrate that CT-guided tailed coil and suture anchor localization techniques provide comparable clinical effectiveness and safety for preoperative PN localization.

TABLE 4 Logistic regression analysis of pulmonary hemorrhage predictors

Variable		Univariable analysis			Multivariable analysis		
		Odds ratio	95% CI	*P* value	Odds ratio	95% CI	*P* value
Age		1.018	0.963–1.076	0.54	–	–	–
Sex	Men	1	–	–	–	–	–
	Women	1.269	0.402–4.003	0.68	–	–	–
Smoking history		1.105	0.319–3.829	0.88	–	–	–
Malignancy history		0.844	0.095–7.532	0.88	–	–	–
PN diameter		0.752	0.588–0.96	0.02	0.741	0.554–0.99	0.04
Nature of PN	Solid	1	–	–	–	–	–
	Mixed GGN	0.463	0.094–2.278	0.34	–	–	–
	Pure GGN	0.741	0.165–3.321	0.7	–	–	–
Lung side	Left	1	–	–	1	–	–
	Right	0.302	0.09–1.016	0.05	0.424	0.113–1.585	0.2
Lobe	Nonupper	1	–	–	1	–	–
	Upper	0.356	0.113–1.116	0.08	0.427	0.122–1.494	0.18
PN depth		1.057	1.009–1.108	0.02	1.06	1.008–1.115	0.02
Localization time		1.089	0.941–1.260	0.25	–	–	–
Localization material	Tailed coil	1	–	–	–	–	–
	Suture anchor	0.493	0.164–1.484	0.21	–	–	–

Abbreviations: see **FIGURE 1** and **TABLE 1**

TABLE 5 Video-assisted thoracic surgery outcomes

Variable		Tailed coil group (n = 47)	Suture anchor group (n = 51)	*P* value
Types of sublobar resection	Wedge	40 (85.1)	35 (68.6)	0.05
	Segmental	7 (14.9)	16 (31.4)	
Additional lobectomy		5 (10.6)	6 (11.8)	0.86
Final diagnoses	Malignant	33 (70.2)	30 (58.8)	0.24
	Benign	14 (29.8)	21 (41.2)	

Data are presented as number (percentage).

ARTICLE INFORMATION

ACKNOWLEDGMENTS None.

FUNDING This study was funded by the S&T Program of Zhangjiakou (2421085D; to JS).

CONTRIBUTION STATEMENT C-SZ conceived the concept of the study. W-TZ and C-SZ contributed to the design of the research. CH, JL, X-XM, and JS were involved in data collection. JS analyzed the data. All authors edited and approved the final version of the manuscript.

CONFLICT OF INTEREST None declared.

AI STATEMENT Artificial intelligence was not used in the preparation of this manuscript.

HOW TO CITE Shan J, Ma X-X, Zhang W-T, et al. Preoperative computed tomography–guided localization of pulmonary nodules: comparison between tailed coil and suture anchor localization. Wideochir Inne Tech Maloinwazyjne. 2026; 21: 184-190. doi:10.20452/wiitm.2026.18013

JOURNAL INFORMATION

Videosurgery and Other Miniinvasive Techniques is an official journal of the Videosurgery Foundation.

REFERENCES

1 Nardini M, Dunning J. Pulmonary nodules precision localization techniques. Future Oncol. 2020; 16: 15-19.

2 Wang Y, Chen E. Advances in the localization of pulmonary nodules: a comprehensive review. J Cardiothorac Surg. 2024; 19: 396.

3 Melo RAB, Travesso DJ, Pinto PNV, et al. CT-guided preoperative localization of nonpalpable pulmonary lesions with a specifically designed device: evaluation of safety and efficacy. Einstein (Sao Paulo). 2025; 23: eAO1622.

4 Park CH, Han K, Hur J, et al. Comparative effectiveness and safety of preoperative lung localization for pulmonary nodules: a systematic review and meta-analysis. Chest. 2017; 151: 316-328.

5 Fan SZ, Ma YY, Sun Y, et al. Preoperative computed tomography-guided localization of pulmonary ground glass nodules: a comparison of conventional and soft hook wires. Wideochir Inne Tech Maloinwazyjne. 2024; 19: 470-475.

6 Shan J, Sun MC, Zhang WT, et al. Preoperative CT-guided localization for pulmonary nodules: a comparative study between conventional and novel tailed coil. Quant Imaging Med Surg. 2025; 15: 11 058-11 065.

7 Wang JL, Xia FF, Dong AH, et al. Comparison between coil and hook-wire localization before video-assisted thoracoscopic surgery for lung nodules: a systematic review and meta-analysis. Wideochir Inne Tech Maloinwazyjne. 2022; 17: 441-449.

8 Fu YF, Zhang M, Wu WB, et al. Coil localization-guided video-assisted thoracoscopic surgery for lung nodules. J Laparoendosc Adv Surg Tech A. 2018; 28: 292-297.

9 Zhou WJ, Chen G, Huang YY, et al. Preoperative computed tomography-guided localization for pulmonary nodules: comparison between hook-wire and anchored needle localization. Wideochir Inne Tech Maloinwazyjne. 2024; 19: 91-99.

10 Wang G, Ren CJ, Shi YB, et al. CT-guided anchored needle versus hook-wire localization for pulmonary nodules: a meta-analysis. J Comput Assist Tomogr. 2026; 50: 448-453.

11 Lv YN, Zhang WT, Wang Y, et al. Preoperative computed tomography-guided localization for pulmonary nodules: a randomized controlled trial of coil and anchored needle localization. Wideochir Inne Tech Maloinwazyjne. 2024; 19: 178-186.

12 Tang X, Jian HM, Guan Y, et al. Computed tomography-guided localization for multiple pulmonary nodules: a meta-analysis. Wideochir Inne Tech Maloinwazyjne. 2021; 16: 641-647.

13 Lin J, Wang LF, Wu AL, et al. Preoperative lung nodule localization: comparison of hook-wire and indocyanine green. Wideochir Inne Tech Maloinwazyjne. 2023; 18: 149-156.

14 Zhao Y, Bao D, Wu W, et al. Development and validation of a prediction model of pneumothorax after CT-guided coaxial core needle lung biopsy. Quant Imaging Med Surg. 2022; 12: 5404-5419.

15 Zhou F, Tao J, Shen F, et al. Preoperative computed tomography-guided localization pulmonary nodules: comparison between accura and soft anchored wires. Front Surg. 2025; 12: 1545503.

16 Li GC, Fu YF, Cao W, et al. Computed tomography-guided percutaneous cutting needle biopsy for small (≤20 mm) lung nodules. Medicine (Baltimore). 2017; 96: e8703.

17 Li EL, Ma AL, Wang T, et al. Low-dose versus standard-dose computed tomography-guided biopsy for pulmonary nodules: a randomized controlled trial. J Cardiothorac Surg. 2023; 18: 86.

18 Nour-Eldin NE, Alsubhi M, Naguib NN, et al. Risk factor analysis of pulmonary hemorrhage complicating CT-guided lung biopsy in coaxial and non-coaxial core biopsy techniques in 650 patients. Eur J Radiol. 2014; 83: 1945-1952.

19 Kamel MK, Lee B, Harrison SW, et al. Sublobar resection is comparable to lobectomy for screen-detected lung cancer. J Thorac Cardiovasc Surg. 2022; 163: 1907-1915.

20 Saji H, Okada M, Tsuboi M, et al. Segmentectomy versus lobectomy in small-sized peripheral non-small cell lung cancer (JCOG0802/WJOG4607L): a multicentre, open-label, phase 3, randomised, controlled, non-inferiority trial. Lancet. 2022; 399: 1607-1617.

21 Gong Z, Zhou T, Gao YG. Computed tomography-guided suture anchor localizer placement for multiple pulmonary nodule localization. Wideochir Inne Tech Maloinwazyjne. 2025: 20: 451-455.