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Research Article

Impact of Personality and Experiences of Interventional Radiologists in Outcome of CT-Guided Percutaneous Lung Biopsies

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Abstract

Purpose: To investigate how personality traits and professional experience of interventional radiologists affect outcome and complications in computed-tomography (CT)-guided percutaneous transthoracic needle biopsy (PTNB) of pulmonary nodules.

Materials and Methods: A retrospective database search retrieved 1,056 PTNBs carried out by 38 interventional radiologists from 2006 through 2014, and 445 interventions performed by 14 radiologists were included in the study (exclusion criteria: lack of consent by radiologist, less than 20 PTNBs performed by the radiologist, and PTNB with incomplete data). Interventions were evaluated with regard to the occurrence of complications, technical success, and intervention-related predictors. Personality traits of interventionalists were assessed using the NEO-FFI-30 (questionnaire measuring the "Big Five") and State-Trait Anxiety Inventory. Outcome of PTNB was adjusted for intervention-related predictors and matched with factors describing the personality and experience of each of the 14 radiologists.

Results: There were no significant differences among the 14 radiologists in terms of technical success (range: 75.0-95.5%, P=0.406) and overall complication rate (range: 44.7-85.7%, P=0.088) or major (range: 15.6-

40.9%, P=0.679) and minor complications (range: 31.6-71.4%, P=0.074). Personality traits had no effect on technical success and complication rates, and there was likewise no effect of years of practical experience on technical success (P=0.254) or complications (P=0.470).

Conclusion: Personality traits and practical experience of the interventional radiologist have no impact on the technical success or complication rate of PTNB.

Keywords: Interventional radiology; Percutaneous lung biopsy; PTNB; Personality

1. Introduction

Interventional radiology is a subspecialty within radiology and includes the complete spectrum of minimal-invasive interventions ranging from image-guided diagnostic procedures to acute and elective therapeutic interventions. To become a certified interventional radiologist, a resident needs an excellent medical background and practical skills and experience. Little is known about whether the experience and personality of an interventional radiologist also affect the outcome of interventions performed by him or her. Therefore, it is not clear at present whether everyone is suitable to become an interventional radiologist.

Computed-tomography-guided percutaneous transthoracic needle biopsy (CT-guided PTNB) of the lung is a challenging intervention with several complications including serious events such as pneumothorax and pulmonary bleeding with frequencies of 17-60% [1-7] and 1-29% [8-11], respectively. Hemoptysis occurs in very few cases (0.2-4%) [8,12]. For these reasons, PTNB of suspicious pulmonary lesions is a good candidate for evaluating how the interventional radiologist's experience and personality might affect outcome. Therefore, the purpose of this study was to investigate how personality traits and practical experience of interventional radiologists affect the outcome and occurrence of complications in patients undergoing CT-guided PTNB of pulmonary nodules.

2. Materials and Methods

The local ethics committee of the University Greifswald approved this study. Written informed consent was obtained from all interventional radiologists included in our analysis. Analysis of intervention-related predictors and outcome of PTNB as well as assessment of practical experience and personality traits were performed by a medical student unrelated to the participating interventional radiologists.

2.1 CT-guided percutaneous transthoracic lung biopsy (PTNB)

Indications for CT-guided PTNB were established by a certified tumor board consisting of a surgeon, an internal medicine specialist, a pathologist, and an interventional radiologist. Individual risk assessment was performed for each patient, and an interventional radiologist finally decided about the intervention based on the following criteria: morphology and location of the lesion, length of interventional pathway, and patient comorbidities. CT-guided PTNB was randomly carried out by the radiologist who was assigned to the workplace at the time of intervention. Before the intervention, the radiologist checked the patient's laboratory values, especially coagulation parameters, planned the strategy, and ensured that informed consent to undergo biopsy was available. Thereafter, CT-guided PTNB was performed in a standardized manner using a 14-18 Gauge biopsy system (Quick-Core Biopsy needle, Cook Medical USA) with a through length of 2 cm) The interventionalist decided whether to obtain more samples for final histopathologic diagnosis. At the end of the procedure, a final CT scan was acquired to identify possible complications such as pneumothorax or hemorrhage. In addition, a postinterventional chest X-ray was performed after four hours. Figure 1demonstrates and overview of the interventional procedure.

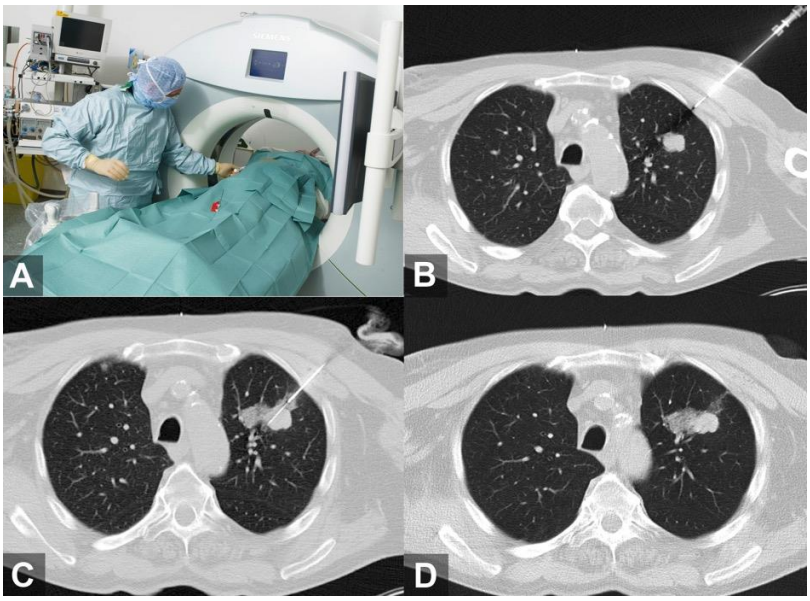

Figure 1: Procedure of computer tomography-guided PTNB. A) Setting of an image-guided PTNB under sterile conditions. B) After local anesthesia a coaxial needle system was placed in the direction of the suspected pulmonary nodules. C) Thereafter, biopsy cannula/stylet was placed within the nodule, especially in the boundary of the tumor. D) Finally, computer tomography was performed after biopsy to exclude complications. In this case a hemorrhage as minor complication was observed, which required no further treatment.

2.2 Patients and interventional radiologists

From 2006 through 2014, a total of 1,056 clinically indicated CT-guided PTNB of potential malignant pulmonary nodules in 981 patients were performed. The study center is a training facility for radiologists subspecializing in interventional radiology. During the 8-year study period, 38 radiologists performed CT-guided PTNB. Transthoracic biopsies performed by radiologists not consenting to study participation or who had an experience of less than 20 prior PTNBs and PTNB with incomplete data were excluded, resulting in 445 interventions performed by 14 radiologists that were included in our retrospective analysis. Characteristics of the 14 radiologists are presented in Table 1.

Interventionalist	Experience; months	Number of PTNBs	Technical success; %	Complications; %	Major complications; %	Minor complications; %
1	<60	22	95.5	63.6	22.7	59.1
2	<60	24	75.0	79.2	25.0	62.5
3	60	22	90.9	56.5	39.1	39.1
4	60	40	95.0	55.0	17.5	40.0
5	67	24	83.3	66.7	20.8	54.2
6	72	40	82.5	72.5	17.5	67.5
7	73	28	89.3	85.7	21.4	71.4

8	96	52	88.5	63.5	17.3	53.9
9	109	32	75.0	78.1	15.6	65.6
10	120	38	81.6	44.7	15.8	31.6
11	>120	25	88.0	64.0	24.0	52.0
12	>120	32	81.3	56.3	21.9	40.6
13	>120	38	86.8	65.8	15.8	57.9
14	>120	28	82.1	71.4	25.0	50.0

Table 1: Characteristics of the 14 interventional radiologists.

2.3 Definition of outcome and procedure-related predictors

The outcome of each intervention was defined by the technical success and the occurrence of overall complications and minor and major complications. Following the new CIRSE (Cardiovascular and Interventional Radiological Society) recommendations regarding the classification of complications in the setting of quality assurance [13], minor complications correspond to grades 1 and 2 and major complications to grade 3 and above. We defined technical success, if histopathology confirmed a malignant lesion. Histopathologically benign lesions were followed up after 3 - 6 months. Technical success of these benign lesions was finally verified if the tumor demonstrated no progression in the follow-up.

Complications were assessed during hospitalization. Intervention-related complications not requiring treatment, e.g., small pneumothorax, were defined as minor complications. Major complications were intervention-related complications requiring treatment or resulting in a longer hospital stay, e.g., pneumothorax requiring chest tube placement. In addition, potential predictors influencing technical success and rate of complications were assessed. These included lesion size, tumor localization, pleural contact of the tumor, length of interventional pathway, needle size, and number of pleural passes.

2.4 Interventionalists' experience and personality traits

Two features related to interventionalists were assessed: professional experience and personality traits. Professional experience was assessed based on the start of residency. The *State-Trait Anxiety Inventory* (STAI-TRAIT) was used to assess anxiety. The inventory consists of two subscales measuring anxiety as both state and trait. Here, we only assessed trait-anxiety, i.e., transsituational, persistent anxiety as a general condition. This subscale contains 20 items and scores range from 20 (no anxiety) to 80 (maximum manifestation of anxiety) [14]. The *Big-Five Inventory* (BFI) is a tool to assess the well-known five dimensions of personality - openness, conscientiousness, extraversion, agreeableness and neuroticism - defined by the Five Factor Theory of Personality [15, 16]. Radiologists were asked to rate 44 items on a Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree).

2.5 Statistics

Intervention-related predictors were associated with technical success and complications in multivariable logistic regressions. Differences in technical success or complications between individual interventional radiologists were evaluated by likelihood ratio tests comparing two logistic regression models – the first adjusted for lesion size, interventional pathway, and pleural contact, and the second with the interventional radiologists. Associations of personal traits with technical success and complications were

investigated by mixed-effects logistic regression models. Here, the respective personal trait was set as fixed effect and the confounders, i.e., lesion size, length of interventional pathway, and pleural contact, were set as random effects. For calculation, we used the meqrlogit command in Stata with Laplacian approximation.

Since multiple tests were performed (n=24) to associate personality traits with technical success and complications, we used a Bonferroni correction for the level of significance. Thus, a P-value <0.002 was considered to indicate statistically significant differences in all analyses. All analyses were conducted using Stata 14.1 (Stata Corporation, College Station, TX, USA).

3. Results

Fourteen interventional radiologists with a prior experience of more than 20 PTNB who consented to participate in this study and undergo testing of personality traits were analyzed. The study results are based on the analysis of 445 interventions in 442 patients. Exclusion criteria for CT-guided PTNB interventions and for interventional radiologists performing the procedures are summarized in Figure 2.

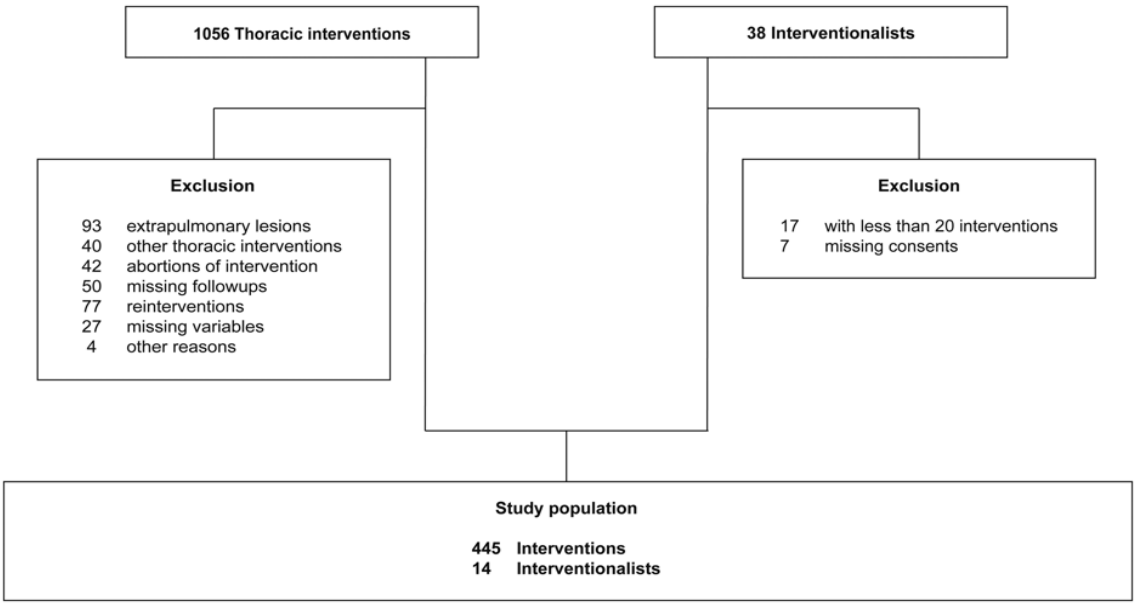

Figure 2: Flow chart of inclusion and exclusion criteria.

The intervention-related predictors investigated had no significant influence on technical success: lesion size (OR: 1.10; P=0.259), pleural contact of the tumor (OR: 1.42; P=0.273), length of interventional pathway (OR: 0.97; P=0.622), needle size with reference 18 Gauge (OR: 1.20; P=0.567), tumor localization (right/left) (OR: 0.89; P=0.664), and tumor localization (peripheral/central) (OR: 0.84; P=0.721).

In contrast, the rate of complications was significantly influenced by lesion size (OR: 0.77; $P \leq 0.001$), length of interventional pathway (OR: 1.33; $P \leq 0.001$), and pleural contact of the tumor (OR: 0.23; $P \leq 0.001$). A summary of predictors' influence on technical success and rate of complications, including minor and major complications, is given in Table 2.

	Technical success		**Complications**		**Minor complications**		**Major complications**	
	OR (95%-CI)	**p**	**OR (95%-CI)**	**p**	**OR(95%-CI)**	**p**	**OR(95%-CI)**	**p**
Diameter of punctured lesion, cm	1.10 (0.93; 1.29)	0.259	**0.78 (0.69; 0.88)**	**<0.001**	**0.83 (0.74; 0.92)**	**0.001**	0.86 (0.74; 1.01)	0.064
Pathway from skin to lesion, cm	0.97 (0.87; 1.08)	0.622	**1.33 (1.20; 1.47)**	**<0.001**	**1.17 (1.08; 1.27)**	**<0.001**	**1.17 (1.06; 1.29)**	**0.002**
Needle size, ref. 18Gauge	1.21 (0.64; 2.28)	0.567	0.79 (0.47; 1.31)	0.363	0.98 (0.62; 1.54)	0.918	0.82 (0.46; 1.46)	0.503
Localization, right/left	0.89 (0.51; 1.53)	0.664	0.87 (0.54; 1.39)	0.557	0.87 (0.58; 1.31)	0.511	0.93 (0.57; 1.53)	0.788
Localization, pleural contact	1.42 (0.76; 2.68)	0.273	**0.23 (0.13; 0.40)**	**<0.001**	**0.45 (0.28; 0.73)**	**0.001**	**0.47 (0.26; 0.83)**	**0.010**
Localization, central/peripheral	0.84 (0.32; 2.12)	0.721	2.32 (0.94; 5.74)	0.068	1.38 (0.66; 2.90)	0.390	0.98 (0.40; 2.37)	0.963

OR=odds ratio; 95%-CI=confidence interval; p=level of significance

Table 2: Predictors of technical success and rate of complications.

After adjustment for relevant predictors, i.e., lesion size, length of interventional pathway, and pleural contact of the tumor, we found no significant difference among the 14 interventional radiologists in terms of technical success, which ranged from 75.0% to 95.5% with a mean ± SD of 85.3 ± 6.4% (P=0.406). We also found no significant difference among the interventional radiologists in terms of complication rates, which ranged from 44.7% to 85.7%, mean ± SD: 66.1 ± 10.8% (P=0.088). This applied to both major complications (range 15.6 - 40.9%; mean ± SD: 21.5 ± 6.6%; P=0.679) and minor complications (31.6-71.4%; mean ± SD: 53.4 ± 11.8%; P=0.074).

Interventionalists varied in their experience, ranging from 1.3 to 21.8 years (mean ± SD: 8.3 ± 5.0 years), but years of experience in radiology had no significant influence on technical success (OR: 1.00; (0.99; 1.00); P=0.254) or on the rate of overall complications (OR: 1.00; (0.99; 1.02); P=0.470), minor complications (OR: 1.00; (0.99; 1.00); P=0.381) and major complications (OR: 1.00; (1.00; 1.00); P=0.866). The personality test scores for the five items of the STAI-TRAIT were as follows: anxiety: 27-57 points (mean 37.8 ± 9.6 points): openness to experience: 7-19 points (mean 12.5 ± 2.9 points); conscientiousness: 12-18 points (mean 14.8 ± 2.1 points); extraversion: 8-16 points (mean 10.3 ± 2.1 points); agreeableness: 7-18 points (mean

14.1 ± 2.8 points); and neuroticism: 8-16 points (mean 8.3 ± 2.7 points) (Table 3; Figure 3).

Overall personality traits had no effect on technical success or the occurrence of complications (Table 4). Categorizing interventional radiologists in groups according to lower 25th percentile and higher 75th percentile confirmed this result (data not shown).

	Technical Success		**Complications**	
	Yes	No	Yes	No
Experience	96 (60; 132)	109 (72; 132)	96 (67; 132)	96 (60; 132)
Neuroticism	9 (6; 10)	9 (7; 9)	9 (6; 10)	9 (7; 10)
Extraversion	10 (9; 11)	10 (9; 11)	10 (9; 11)	10 (9; 11))
Openness	12 (11; 13)	12 (11; 13)	12 (11; 13)	12 (11; 14)
Agreeableness	15 (13; 16)	14 (13; 16)	14 (13; 16)	15 (13; 16)
Conscientiousness	14 (13; 17)	14 (13; 17)	15 (13; 17)	14 (13; 17)
Anxiety	34 (31; 47)	34 (34; 45)	34 (31; 47)	34 (30; 47)

Data are expressed as median, 25th and 75th percentile

Table 3: Personal traits in relation to technical success and rate of complications.

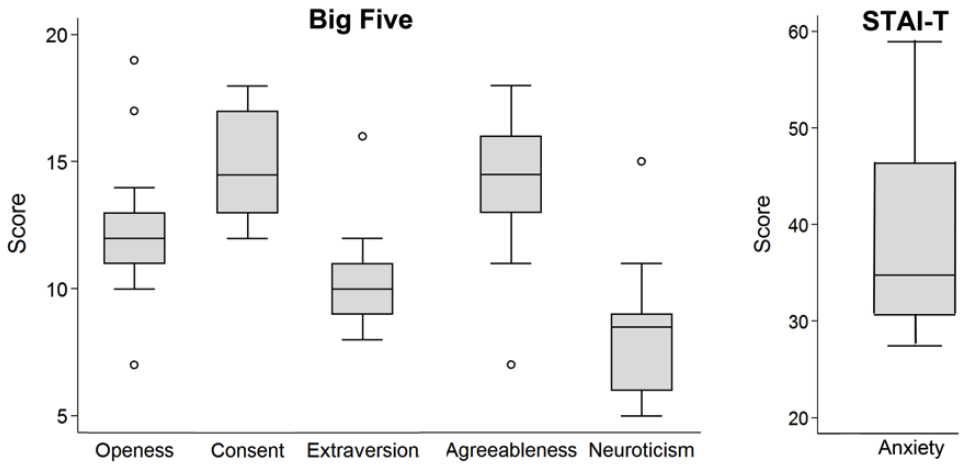

Figure 3: Distribution of personality and mental traits (A - Big-Five; B - STAIT-TRAIT) of 14 interventional radiologists. A higher score indicates a higher expression of the trait.

Personality Trait	Technical Success	Complications		
		Total	Minor	Major
	OR (95%-CI) p	OR (95%-CI) p	OR (95%-CI) p	OR (95%-CI) p
STAIT-TRAIT				
Anxiety	1.00 (0.97; 1.02); 0.829	1.09 (1.00; 1.19); 0.053	1.02 (0.99; 1.05); 0.269	1.00 (0.97; 1.03); 0.867
BIG-FIVE				
Openness	1.03 (0.93; 1.15); 0.537	0.74 (0.55; 20.99); 0.045	0.92 (0.82; 1.03); 0.142	1.00 (0.91; 1.12); 0.774
Conscientiousness	1.05 (0.93; 1.19); 0.436	1.50 (0.99; 2.27); 0.052	1.10 (0.94; 1.27); 0.233	1.03 (0.90; 1.17); 0.678
Extraversion	0.99 (0.87; 1.14); 0.921	1.41 (0.91; 2.20); 0.128	1.09 (0.92; 1.30); 0.312	0.96 (0.83; 1.11); 0.574
Agreeableness	1.03 (0.94; 1.13); 0.494	0.76 (0.58; 1.01); 0.063	0.92 (0.82; 1.04); 0.174	1.01 (0.92; 1.12); 0.820
Neuroticism	1.05 (0.96; 1.15); 0.312	1.08 (0.81; 1.45); 0.593	1.04 (0.92; 1.17); 0.559	0.97 (0.88; 1.08); 0.636

OR=odds ratio; 95%-CI=confidence interval; p=level of significance

Table 4: Influence of personality traits on technical success and complication rate.

4. Discussion

Our study investigated how the personality and experience of interventional radiologists affected the technical success and complication rates of CT-guided percutaneous transthoracic pulmonary biopsies (PTNB). We found no significant influence of interventionalists' experience and the personality traits investigated here on technical success or complications. Psychological testing is increasing being used to select residents for the different medical specialties. The Department of Radiology of Baylor College of Medicine (Houston, Texas) developed a structured interview procedure to measure both noncognitive and cognitive qualities of candidates [17]. The authors defined five attributes – interpersonal skills, recognition of limits, curiosity, conscientiousness, and confidence level – as most essential for a radiology resident's performance and were able to select better residents from a personality point of

view based on these criteria. This was the rationale for our study, as psychological concepts might also be helpful in selecting suitable candidates for training in interventional radiology.

Several studies have shown that personality traits play a role in the selection of subspecialties by physicians. For instance, Warschkow et al. show that surgeons are characterized by an excess of achievement orientation and extraversion, whereas internists have decreased aggressiveness [18]. Interestingly, their study reveals a discrepancy between self- and external assessment of personality only among surgeons. Another study comparing surgeons and other physicians by McCulloch et al. demonstrated that surgeons were significantly more extraverted, more intolerant of uncertainty, and less neurotic than their internal medicine colleagues [19]. Likewise, surgical residents were found to score higher for conscientiousness, extraversion, and openness than the general population [20]. However, all studies conducted so far have investigated personality traits in terms of differences between specialties but not with regard to how they might affect the outcome of treatment or interventional procedures. For the reasons outlined above, transthoracic biopsy is a good case in point to evaluate the influence of the interventionalist's experience and personality on outcome.

PTNB is routinely used for lesion characterization as it has fewer complications than open surgery. The most common complications after PTNB are pneumothorax with an incidence of up to 50-60% [1-6] and pulmonary hemorrhage with 1-29% [8-11]. To reduce these high rates, recent research has focused on identifying possible predictors of PTNB-related complications. These studies have revealed that the rate of complications is predominantly affected by lesion size, length of interventional pathway, and pleural contact of the tumor [21, 22]. Other possible intervention-related risk factors include presence of pulmonary emphysema and body position [1, 21, 23]. To the best of our knowledge, the possible role of personality traits or experience of the radiologist performing PTNB has not been investigated before.

We found no significant influence of interventionalists' experience and five major personality traits - anxiety, openness, conscientiousness, extraversion, agreeableness. and neuroticism - on technical success and complication rates. Our study has several limitations. We retrospectively analyzed patient data from interventions performed over an eight-year period. In contrast, personality traits of the interventionalists were prospectively assessed at a single point in time and might have changed over time, for example through further training or growing experience. It is possible that, in some instances, difficult biopsies were performed by more experienced radiologists or by a junior interventional radiologist assisted by an experienced interventionalist. Such cases might have biased our results. To increase the robustness of our results, we considered influencing confounders as described above. However, other possible predictors not investigated, e.g., pulmonary emphysema, could also have had an impact on our findings. Finally, we defined technical success if a malignant result was obtained or if in the case of benign result, the lesion was stable on a 3-6 month follow-up. The time interval of less than 6 months might be too short for a final diagnosis.

5. Conclusion

In conclusion, PTNB is a clinically accepted procedure with a high technical success and a moderate rate of complications. Lesion size, tumor localization, and length of interventional pathway are predictors of technical success of PTNB but appear to have no influence on the complication rate. Personality traits and professional experience of the interventional radiologist have no impact on the technical success or complication rate of PTNB.

6. Main Points

- CT-guided percutaneous transthoracic needle biopsy of pulmonary nodules has a high technical success and a moderate complication rate.
- Lesion size, tumor localization, and length of interventional pathway are predictors of technical success of PTNB but appear to have no influence on the complication rate.
- Years of experience and personality traits of interventional radiologists play a minor part in the outcome of PTNB.

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