Adequacy and Complications of CT-Guided Percutaneous Biopsy: A study of 334 Cases in Srinagarind Hospital

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Objective: *To evaluate the adequacy and complications of automated biopsy gun under CT-guided percutaneous needle biopsy.*
Material and Method: *The medical records, radiological records, and images of 334 patients who underwent CT-guided percutaneous needle biopsyin Srinagarind Hospital between January 2003 and June 2007 were retrospectively reviewed. The biopsies were performed by two groups, radiologists (44 procedures) and residents in training (290 procedures). The specimens were sent for histologic diagnosis. The immediate and late complications from the biopsies and diagnostic adequacy were analyzed.*
Results: *Fifty, 215, and 69 patients underwent CT-guided percutaneous needle biopsies using 16, 18, and 20-gauge needles respectively. There was no statistically significant difference among the various needle sizes with complication rate (p = 0.291). Three pneumothorax and one abdominal infection occurred after procedures performed by residents. The overall diagnostic adequacy of the biopsy materials was low and varied by size of needle, 52%, 61.4%, and 52.1%, respectively.*
Conclusion: *CT-guided needle biopsy using automated biopsy device is safe. The diagnostic adequacy in the present series is low, probably caused by single histologic analysis. Some complications occurred after the procedures are performed. Therefore, the authors recommend fellowship training in interventional radiology or periodic post-residency training in image-guided biopsy. To optimize the diagnostic adequacy, the authors suggest combined cytologic and histologic analysis from a single core biopsy sample.*

Keywords: *Biopsy, Needle, Complications, Radiography, Interventional, Tomography, X-ray computed*

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Computed tomography (CT) has improved the ability to detect and perform needle biopsy of thoracic and abdominal lesions. The automated biopsy gun (spring-mechanism device) has become popular for biopsy of various organs. The use of CT-guided needle biopsy has been widely used with high accuracy and safety[1-18].

Percutaneous needle biopsy of the lung is a well-established method for pathologic diagnosis of pulmonary and mediastinal lesions. Pneumothorax and bleeding are the two most frequently encountered complications of transthoracic biopsy[1-11,13-16]. Fatal complications due to systemic air embolism, hemorrhage, or pericardial tamponade have been documented[12], but these are rare.

Percutaneous liver biopsy guided by CT has become a valuable tool for diagnosing various liver abnormalities. The procedure has been accepted, but questions about the complication rate of various needle sizes remains unanswered. Many authors had reported the advantages of larger caliber needles. They concurred that it yielded a large amount of tissue for histologic evaluation with a high accuracy rate and acceptable incidence of complications[16-18].

The automated gun biopsy system diminishes the number of needle passes through the visceral pleura and theoretically reduces the likelihood of pneumothorax, although, to the authors' knowledge,

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this has not been statistically proved. Now, there has been a trend toward the use of smaller needles (19 gauge or smaller). This change was driven by reports of clinically important bleeding associated with large cutting needles, not by unacceptable rates of pneumothorax[1,4,5]. The reports indicated that the incremental use of fine (19 gauge or smaller) needles had reduced bleeding complications and allowed easier access to lesions that were previously deemed too small for sampling without an associated loss of diagnostic accuracy. The diagnostic accuracy has been reported as greater than 80% for benign disease and greater than 90% for malignant disease[1,2,9].

Patients and Method

Study population

The records and images of 334 patients who underwent CT-guided needle biopsy of thoracic and abdominal lesions at Srinagarind Hospital were retrospectively reviewed. All biopsies were performed between January 1, 2003 and June 30, 2007. Prior to each procedure, the risks and benefits of needle biopsy were discussed, and informed consent was obtained from each patient. The blood samples for platelet count, PT, PTT, INR and creatinine were evaluated. The authors' exclusion criteria were the patients who could not follow verbal or visual instructions, and patients or their family members who could not accept procedure-related risks. The present study was approved by the Institutional Review Board of Srinagarind Hospital.

Biopsy procedure

All patients underwent a diagnostic CT examination prior to biopsy. At the time of the procedure, the images were obtained at the area of interest with 10 mm-thick contiguous axial computed tomographic sections, depending on the size of the lesion by a single slice helical CT scanner (Exvision/Ex: Toshiba cooperation medical system division, Tokyo, Japan) with 5 mm collimation and a pitch of 1, or a multislice CT scanner (Somatom plus 4 Volume zoom: Siemens, Forchheim, Germany) with 2.5 mm collimation and a pitch of 0.25. The diameters of the lesions ranged from 1 to 15 cm (mean 6.4 cm). The biopsy paths were planned to avoid vital organs and vascular structures.

The biopsies were performed by two groups of radiologists with a wide variation of training: group one, two staff members with 23 and 12 years of experience after radiology residency and periodic postresidency training in interventional radiology and image-guided biopsy; and group two, 1st, 2nd, and 3rd year-residents. All resident's performances were under staff supervision, in accordance with the protocol of the Interventional Radiology Section at our institution. The procedure was performed with the patient in a supine, prone, or lateral decubitus position, depending on the location of the lesions (Fig. 1-6). A subcutaneous injection of 1% lidocaine for local anesthesia was administered in all cases. However, some patients needed additional intravenous pethidine 25 mg. All biopsies were performed by 16, 18, or 20-gauge automated gun biopsy method (Cook quick-core or Temno automated biopsy needle) (Fig. 7). Imaging was performed immediately before needle biopsy to document the position of the biopsy gun within the lesion. Most patients had contrast-enhanced CT scans available for review before the procedures. From the preview of existing or new localization CT scans, an optimal needle path was planned. After local anesthesia and a small incision, an automated biopsy gun was inserted under intermittent CT guidance with its trajectory pointing toward the lesion. A final quick pierce was made. Most biopsies were performed with a single puncture. Each radiologist had a free choice of needle size ranging from 16, 18, to 20-gauge, but an 18-gauge cutting needle was most commonly used. At least one core specimen was obtained by cutting a fixed 1 or 2-cm long specimen via an automated biopsy gun that was inserted into the lesion.

The specimens were fixed and sent to the Pathology department for histologic examination (Fig. 8). No on-site cytopathologist was available.

Post procedure imaging and care

After the procedure, the patients were monitored in an inpatient ward. They were observed for symptoms of complications such as dyspnea, respiratory distress, abdominal discomfort, or fever. A chest X-ray was obtained immediately if pneumothorax was suspected clinically. Conservative treatment was given by monitoring the vital signs, supplemental oxygen, and follow-up chest radiography for evaluation of the status of pneumothorax.

Definitions

The pathologist performed the histological examination and made the diagnosis of all specimens. The biopsy sample was concluded as "adequate" if the interpretation was malignant or benign disease. If the tissue was insufficient or inconclusive (*i.e.* necrotic tissue or atypical cells), the sample was labeled as "inadequate".

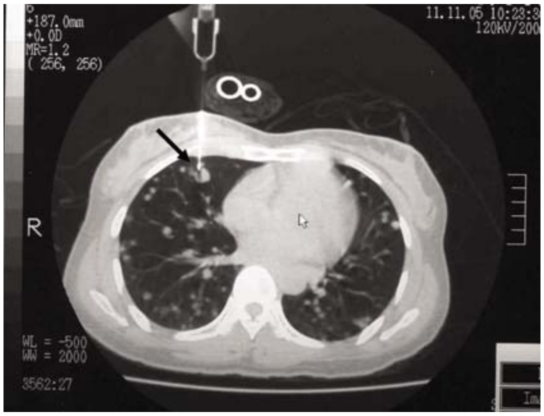

Fig. 1 Needle biopsy of a 2 cm right pulmonary nodule. The needle tip (arrow) is placed in the lung nodule

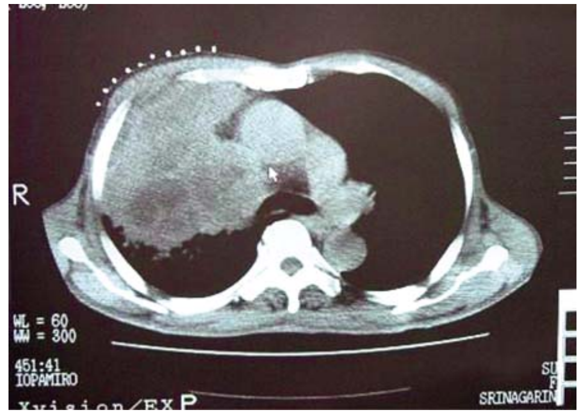

Fig. 2 A large right pulmonary mass. A marker is placed at the chest wall

Fig. 3 A 43 year-old woman with right lobe liver mass 5 cm in size. Sixteen gauge biopsy needle (arrow) is placed in the mass to obtain a core specimen

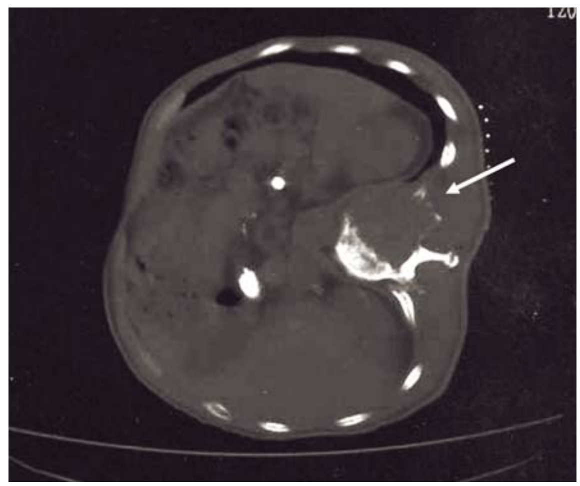

Fig. 4 A 51 year-old man with CA thyroid and T12 vertebral destruction (arrow) with soft tissue mass, about 5 cm in size

Fig. 5 A 53 year-old man with right renal mass, about 5.5 cm in size. The tip of 18-gauge biopsy needle (arrow) was placed in the mass (prone position)

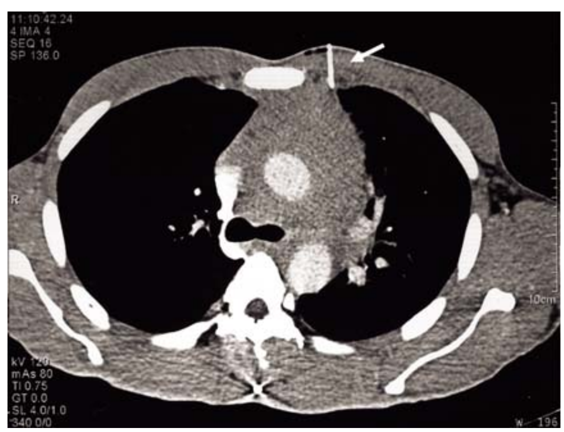

Fig. 6 A 31 year-old man with mediastinal mass. The biopsy was performed with 18-gauge needle

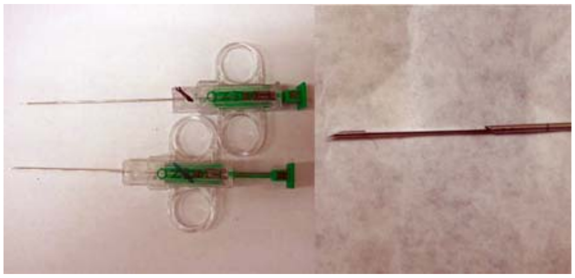

Fig.7 Photograph shows the automated biopsy system: a 18-gauge needle is an outer cannula, performs as a cutting needle around a central notched stylet. The central notched stylet is detachable 2 cm long

Fig. 8 Core specimen from needle guided biopsy

Data analysis

Demographic data was expressed as mean value. The type and frequency of all complications and diagnostic adequacy associated with the 334 needle biopsy procedures were recorded. The complication rate and diagnostic adequacy of the biopsies performed by radiologists with different levels of experience using different sizes needle were analyzed. Chi-square tests were used to compare the three groups. A p-value of less than 0.05 was considered statistically significant difference.

Results

Of 334 patients who underwent CT-guided percutaneous needle biopsy, 16-gauge needles were used in 50 patients, 18-gauge in 215 patients and 20-gauge in 69 patients. The mean lesion size was 7.6, 6.4, and 5.8 cm and mean lesion depth was 0.25, 0.19, and 0.24 cm. for needle size No. 16, 18, and 20 respectively (Table 1). The procedures were performed for pulmonary lesions more than other sites, 52%, 55%, and 59.4% for needle number 16, 18, and 20, respectively (Table 2). The majority of the procedures were performed by residents in training under staff supervision (Table 3).

There was no statistically significant difference between occurrence of complications and the needle size used (p = 0.291). All were immediate complication. None occurred with use of 16-gauge needle (Table 4). Only four cases developed complications after residents' procedures (Table 5). There was no statistically significant difference in the needle size used in either, thorax or abdomen (Table 6). When comparing between 16 and 20-guage needles, it showed a significant difference between the experienced and inexperienced operators (Table 7).

Table 1. Patient characterization in CT guided percutaneous needle biopsy

Characteristic	16-G needle (n = 50)	18-G needle (n = 215)	20-G needle (n = 69)
Mean age (range) (year)	48 (1-78)	54.3 (4mo-84)	51.9 (6-80)
Male sex (%)	33 (66%)	150 (69.7%)	44 (63.7%)
Mean lesion size (range) (cm)	7.6 (1-14)	6.4 (1.5-18)	5.8 (1-15)
Mean lesion depth (range) (cm)	0.25 (0-2)	0.19 (0-5)	0.24 (0-5)
Mean No. of attempt (range)	1.0 (1-2)	1.1 (1-3)	1.2 (1-4)
Mean follow-up (week)	18.3	16.5	24.3

Table 2. Lesion sites and needles used

Biopsy site	16-G needle (n = 50)	18-G needle (n = 215)	20-G needle (n = 69)
Lung	26 (52%)	119 (55.3%)	41 (59.4%)
Mediastinum	4 (8%)	41 (19%)	15 (21.7%)
Liver	18 (36%)	48 (22.3%)	11 (15.9%)
Retroperitoneum	2 (4%)	7 (3.2%)	2 (2.8%)

Table 3. Number of procedures performed by residents and staffs

Operator	16-G needle (n = 50)	18-G needle (n = 215)	20-G needle (n = 69)
1st year residents	11 (22%)	55 (25.6%)	12 (17.4%)
2nd year residents	13 (26%)	79 (36.7%)	18 (26.1%)
3rd year residents	15 (30%)	61 (28.3%)	26 (37.7%)
1st radiologist (12 years of experience)	8 (16%)	15 (7%)	10 (14.5%)
2nd radiologist (23 years of experience)	3 (6%)	5 (2.4%)	3 (4.3%)

Table 4. Overall complications and location of lesions

Complication	Location	16-G needle (n = 50)	18-G needle (n = 215)	20-G needle (n = 69)	p-value
Immediate	Thorax	0	2/160 (1.25%)	1/56 (1.17%)	0.291
	Abdomen	0	0	1/13 (7.69%)	
Late		0	0	0	

Table 5. Immediate complications related to radiologist experience

Operator	16-G needle	18-G needle	20-G needle
Residents (n = 290)	0	2/195 (1%)	2/56 (3.57%)
Staff radiologists (n = 44)	0	0	0

Table 6. The relationship between overall diagnostic adequacy and size of biopsy gun

Location	16-G needle	18-G needle	20-G needle	p-value
Total	26/50 (52%)	132/215 (61.4%)	36/69 (52.1%)	0.349
Thorax	17/30 (56.6%)	97/160 (60.6%)	28/56 (50%)	0.380
Abdomen	9/20 (45%)	35/55 (60%)	8/13 (61.5%)	0.342

Table 7. Comparison of diagnostic adequacy achieved from residents and staffs

Needle size	Residents	Staff radiologists	p-value
16-g needle	19/39 (48.7%)	7/11 (63.6%)	0.046
18-g needle	121/195 (62%)	11/20 (55%)	0.389
20-g needle	26/56 (46.4%)	10/13 (76.9%)	0.000

Discussion

CT-guided biopsies now play an important role in diagnosing focal abnormalities in organs and tissues throughout the body, without the need for surgical laparotomy. It is important to emphasize that the presented favorable results are directly related to the use of CT-guided techniques. Direct visualization of the needle and the lesion by CT facilitates accurate guidance. Perhaps the most valuable asset of the technique is the ability to assess vascularity by bolus injection.

There were two mild pneumothorax in the 18-gauge needle group, mild pneumothorax, and intra-abdominal infection in the 20-gauge needle group.

This rate was in agreement with those reported in the literatures, 6-71% transthoracic, and 0-5.3% transabdominal biopsy(1-11,13-18). The authors found that the patients with pneumothorax recovered without any specific treatment or chest tube, while the rate of thoracic drainage varied from 0.02-15% in other studies(1-10). The present study demonstrates no significant difference in needle size number 16, 18, and 20 on complication rate with an automated gun biopsy technique. This is in accordance with the results in other reports(3,15,18). The most frequent complication in the present study was pneumothorax (75%; 3 of 4 complications, using 18 and 20 gauge needle). This rate is in agreement with those reported in the literature on automated biopsy systems.

There was no statistically significant difference in the needle used with the overall diagnostic adequacy. The presented adequacy rate was 52%, 61.4%, and 52.1% in 16, 18, and 20-gauge needle groups respectively. This rate is much lower than many other reports (92-94%)(4-8). It may result from many factors: (1), the majority of the presented biopsies (290 of 334 procedure: 86.8%) were performed by 1st, 2nd, and 3rd year residents in training, although under supervision, are considered inexperience; (2), only one attempt biopsy was made mostly; (3), and only histologic diagnosis was obtained, cytologic analysis was not available. Regardless of the needle type and size used, the adequacy rate depends on competency of the radiologists to submit sufficient specimens for detailed pathologic analyses (both cytology and histology). The architecture and growth pattern of the tumor can be obtained at histologic analysis. The main cause of negative histologic diagnostic is extensive necrosis of the lesion. The desquamation of cells into necrosis needs cytologic analysis. Combined cytologic and histologic analysis will help improve the diagnostic adequacy(19,20).

The main limitation of the present study was its retrospective nature. The presented series represents a large number of patients that underwent percutaneous biopsy. The authors may have lost some data that was not carefully recorded. Needle path selection among radiologists may vary for a particular lesion. As such, a different needle path will affect all of the variables selected for statistical analysis in this model. It is apparent that the selection of needle size is partly determined by lesion size and is influenced by the radiologist's preference and by whether lesions are surrounded by vital structure.

Conclusion

The present result shows that CT-guided needle biopsy using automated biopsy device is safe even in inexperienced but careful hands. However, the presented diagnostic adequacy is low compared to many other reports. The problem is probably partly because 87% of the biopsies were performed by residents in training. The authors considered it understandable and acceptable for the operator at residency level. The authors' other problem is probably because all pathologic diagnoses were from histologic analyses only.

To be skillful, the authors recommend fellowship training in interventional radiology or periodic post-residency training in image-guided biopsy. To optimize the diagnostic adequacy, the authors suggest combined cytologic and histologic analysis from a single core biopsy sample.

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References

1. Geraghty PR, Kee ST, McFarlane G, Razavi MK, Sze DY, Dake MD. CT-guided transthoracic needle aspiration biopsy of pulmonary nodules: needle size and pneumothorax rate. Radiology 2003; 229: 475-81.
2. Lucidarme O, Howarth N, Finet JF, Grenier PA. Intrapulmonary lesions: percutaneous automated biopsy with a detachable, 18-gauge, coaxial cutting needle. Radiology 1998; 207: 759-65.
3. Yeow KM, Su IH, Pan KT, Tsay PK, Lui KW, Cheung YC, et al. Risk factors of pneumothorax and bleeding: multivariate analysis of 660 CT-guided coaxial cutting needle lung biopsies. Chest 2004; 126: 748-54.
4. vanSonnenberg E, Goodacre BW, Wittich GR, Logrono R, Kennedy PT, Zwischenberger JB. Image-guided 25-gauge needle biopsy for thoracic lesions: diagnostic feasibility and safety. Radiology 2003; 227: 414-8.
5. Klein JS, Salomon G, Stewart EA. Transthoracic needle biopsy with a coaxially placed 20-gauge automated cutting needle: results in 122 patients. Radiology 1996; 198: 715-20.
6. Satoh S, Ohdama S, Matsubara O, Okochi Y, Tanaka R, Kimula Y. CT-guided automated cutting needle biopsy by a combined method for accurate

specific diagnosis of focal lung lesions. Radiat Med 2005; 23: 30-6.
7. Bressler EL, Kirkham JA. Mediastinal masses: alternative approaches to CT-guided needle biopsy. Radiology 1994; 191: 391-6.
8. Haramati LB. CT-guided automated needle biopsy of the chest. Am J Roentgenol 1995; 165: 53-5.
9. Tsukada H, Satou T, Iwashima A, Souma T. Diagnostic accuracy of CT-guided automated needle biopsy of lung nodules. Am J Roentgenol 2000; 175: 239-43.
10. Laurent F, Michel P, Latrabe V, Tunon de Lara M, Marthan R. Pneumothoraces and chest tube placement after CT-guided transthoracic lung biopsy using a coaxial technique: incidence and risk factors. Am J Roentgenol 1999; 172: 1049-53.
11. Haramati LB, Austin JH. Complications after CT-guided needle biopsy through aerated versus nonaerated lung. Radiology 1991; 181: 778.
12. Tolly TL, Feldmeier JE, Czarnecki D. Air embolism complicating percutaneous lung biopsy. AJR Am J Roentgenol 1988; 150: 555-6.
13. Ko JP, Shepard JO, Drucker EA, Aquino SL, Sharma A, Sabloff B, et al. Factors influencing pneumothorax rate at lung biopsy: are dwell time and angle of pleural puncture contributing factors? Radiology 2001; 218: 491-6.
14. Westcott JL, Rao N, Colley DP. Transthoracic needle biopsy of small pulmonary nodules. Radiology 1997; 202: 97-103.
15. Swischuk JL, Castaneda F, Patel JC, Li R, Fraser KW, Brady TM, et al. Percutaneous transthoracic needle biopsy of the lung: review of 612 lesions. J Vasc Interv Radiol 1998; 9: 347-52.
16. Welch TJ, Sheedy PF, Johnson CD, Johnson CM, Stephens DH. CT-guided biopsy: prospective analysis of 1,000 procedures. Radiology 1989; 171: 493-6.
17. Martino CR, Haaga JR, Bryan PJ, LiPuma JP, El Yousef SJ, Alfidi RJ. CT-guided liver biopsies: eight years' experience. Work in progress. Radiology 1984; 152: 755-7.
18. Pagani JJ. Biopsy of focal hepatic lesions. Comparison of 18 and 22 gauge needles. Radiology 1983; 147: 673-5.
19. Moulton JS, Moore PT. Coaxial percutaneous biopsy technique with automated biopsy devices: value in improving accuracy and negative predictive value. Radiology 1993; 186: 515-22.
20. Hahn PF, Eisenberg PJ, Pitman MB, Gazelle GS, Mueller PR. Cytopathologic touch preparations (imprints) from core needle biopsies: accuracy compared with that of fine-needle aspirates. Am J Roentgenol 1995; 165: 1277-9.

ความเพียงพอของชิ้นเนื้อและภาวะแทรกซ้อนจากการเจาะตัดชิ้นเนื้อผ่านผิวหนัง ภายใต้เครื่องเอกซเรย์คอมพิวเตอร์: ประสบการณ์ 334 รายในโรงพยาบาลศรีนครินทร์

วัลลภ เหล่าไพบูลย์, ชลิดา อภินิเวศ, กอบกุล ศุภรตรีทิเทศ

วัตถุประสงค์: *เพื่อศึกษาความเพียงพอของชิ้นเนื้อและภาวะแทรกซ้อนจากการเจาะตัดชิ้นเนื้อผ่านผิวหนัง ภายใต้เครื่องเอกซเรย์คอมพิวเตอร์*

รูปแบบการศึกษา: *สังเกตการณ์เปรียบเทียบ (Observation: analytical study)*

วัสดุและวิธีการ: *ผู้ป่วยจำนวน 334 รายได้รับการเจาะตัดชิ้นเนื้อผ่านผิวหนัง ภายใต้เครื่องเอกซเรย์คอมพิวเตอร์ ระหว่าง มกราคม พ.ศ. 2546 ถึง มิถุนายน พ.ศ. 2550 โดยแพทย์ 2 กลุ่ม ได้แก่ รังสีแพทย์ 2 คน และแพทย์ที่กำลังฝึกอบรมทางรังสีวิทยา*

ผลการศึกษา: *ผู้ป่วยจำนวน 50, 125 และ 69 ราย ได้รับการเจาะตัดชิ้นเนื้อ ด้วยเข็มหมายเลข 16, 18 และ 20 ตามลำดับ พบว่าไม่มีความแตกต่างทางสถิติ (p = 0.291) ระหว่างขนาดเข็มที่ใช้กับภาวะแทรกซ้อนที่เกิดขึ้น ชิ้นเนื้อที่ได้จากการเจาะตัดด้วยเข็มขนาดต่าง ๆ มีจำนวนเพียงพอสำหรับการวินิจฉัยในอัตราร้อยละ 52, 61.4 และ 52.1 ตามลำดับ ซึ่งเมื่อคำนวณทางสถิติแล้ว ไม่พบว่ามีความแตกต่างกันอย่างมีนัยสำคัญ*

สรุป: *การเจาะตัดชิ้นเนื้อผ่านผิวหนังภายใต้เครื่องเอกซเรย์คอมพิวเตอร์ ด้วยเข็มเจาะอัตโนมัติ (automated biopsy device) เป็นวิธีที่มีประสิทธิภาพและปลอดภัย แม้ว่าประสิทธิภาพในการวินิจฉัยต่ำ อาจเป็นเพราะในการศึกษานี้ส่งตรวจเฉพาะ histologic analysis เพียงอย่างเดียว และร้อยละ 87 ของภาวะแทรกซ้อนที่เกิดขึ้น เกิดจากแพทย์ที่กำลังฝึกอบรมทางรังสีวิทยา ซึ่งอาจเป็นเพราะความเข้าใจและประสบการณ์ที่ยังน้อยอยู่*