Original Article

Lung Lesions Biopsy in Children by Computed Tomography (CT) Fluoroscopy Guided Versus Conventional CT Scan Guided

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Abstract

Background

Computed tomography (CT)-guided biopsy of the lung is a well-established method of diagnosis. The aim of this study was to determine the success rate of fluoroscopic CT (FCT) and conventional CT (CCT) in needle navigation biopsies from the lung lesions.

Materials and Methods

A total of 78 patients were prospectively enrolled to receive CT-guided biopsy with (group I, n=23) or without (group II, n=55) fluoroscopic guidance. The mean age was 13.5, and the outcome measurements and complication rate of procedure were successful.

Results

The success rate was increased in the FCT group (87%) as compared with that of CCT group (80%, p=0.012). The complications (pneumothorax and bleeding) were not significantly different between the two groups (0 versus 8 cases, p=0.097).

Conclusion

The obtained results revealed that the FCT facilitates the CT-guided biopsy procedures, and it reduced the complications by allowing real-time visualization of the needle tip from skin entrance to the target point.

Keywords

Tomography; Spiral Computed, Biopsy; Needle, lung; complications

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Introduction

The safety and accuracy of imaging guided percutaneous needle biopsy have been well documented. But the percutaneous intervention is less invasive and more cost-effective than surgery. So, the number of radiologic procedures is continually increasing (1, 2).

Computed tomography (CT) has been used to guide interventional procedures since 1976. CT guided biopsy will provide valuable knowledge about needle entrance, needle plane, and needle location in the lesion. However, as the conventional CT (CCT) images are not available in real time lung lesion, which are more frequently during respiration, and they may be difficult to do a biopsy under CT guidance (3,4). More recently, the fluoroscopic CT (FCT) has been developed which it will provide a real time reconstruction. This modality allows the physician to continuously monitor the needle as it progresses toward the target lesion, and it will allow for manipulation in response to respiratory movement (5). As a result, this procedure would allow a faster image reconstruction, near continuous image update, and it would be convenient in a room table control and image viewing during CT guided procedures (6-9). The clinical studies have shown that CT fluoroscopy is a safe and effective tool to guide percutaneous intervention procedures in the thorax. (9-11).

The objective of this study was to determine the success rate and the complications of CCT and FCT in taking biopsies from the lung lesion.

Materials and Methods

The study took place from Feb. 2004 to Oct 2011. During this period, 78 consecutive patients with pulmonary nodule or masses were suspected to be a malignant lesion by CT clues which were prospectively enrolled in this study from two centers. The inclusion criteria's were: age < 19 years, lesion size between 11mm to 7cm and finally lesions with a solid nature (ground glass opacity components less than 50%). The following patients were excluded from this study due to: 1. a high index of suspicion for Hydatid cyst or, 2. Evidence of endobronchial disease determined by CT.

The pre-biopsy evaluations were included; a review of chest X-ray and CT, laboratory studies and the medical records.

The informed consent of all patient parents was taken before inclusion in this study.

All biopsy samples were studied by an expert pathologist who was blinded for the type of biopsy. Source of the procedure was defined as obtaining sufficient tissue to allow the pathologist to make an accurate diagnosis. The procedure was considered unsuccessful when the pathologist's report was as "re biopsy is needed ".

CT guided needle biopsy technique

One experienced radiologist performed both the fluoroscopic CT, and conventional CT guided lung biopsy. Both procedures were done under general anesthesia.

The FCT biopsy interventions were performed using 4-MDCT (somatom sensation siemens medical solutions) equipped with CARE- vision software (siemens).

The CARE vision software package includes a room monitor with last–image hold, foot pedal controlled image acquisition and a bedside joystick to move the patients in and out of the gantry. The slice thickness of all images was 5 mm. Real time imaging was limited to short glimpses to visualize the position of the advancing needle tip.

Conventional CT- guided biopsy procedures were performed with the schimadzu machine model of 7800 without CARE-vision software.

The slice thickness of all images were 5mm. Images viewed on a console in the room next door. Therefore, the physician

had to exit the examination room to evaluate the introducing needle position. The physician advanced the coaxial needle in small steps to the pulmonary lesion, with interval images to assess the position.
All the procedures were performed within a prone or supine patient position depending on the location of the lesion. For all procedures, preliminary imaging limited to the target region was obtained with the patient positioned appropriately for the intervention procedure. All biopsy specimens were obtained using an 18 gauge semiautomatic Trucut biopsy Gallini brand and specimens were then placed in formalin and immediately transferred to a pathology department for diagnosis.
If the CT images during the biopsy showed an apparent pneumothorax, a 1 hour follow up radiograph was obtained. However, in the absence of pneumothorax during the biopsy; a 4 hour follow up radiograph was obtained. A minimal pneumothorax does not need any treatment. If it was mild to moderate only aspiration of air with a coaxial needle at the end of the procedure was needed.
Thoracostomy tubes were inserted for a moderate to large pneumothorax (> 25% of one lung volume) based on the distance from the lung apex to the cupola, a continuous size increase on follow-up radiographs or if the patient oxygen saturation was with a minimal pneumothorax.
Hemoptysis, as one of the complication of this method defines as if it is visible immediately after the biopsy is taken or if the patient has a sign and symptom related to hemorrhage within four hours after the biopsy is done. The research study coordinator and staff radiologist who performed the biopsies were asked to complete a questionnaire during and after each procedure. The included data was: the patient base line demographic and clinical characteristics (age, sex and history of fever, immunosuppressive agent) and important prognostic procedure – related variables (lesion size defined as maximal diameter distance from the pleural surface to the nodule along the planned needle path and location). The other data was the patient position number of pleural passes.

Statistical Analysis

Comparisons between continuous data for the two procedures were analyzed using an independent two-sample *t*-test. The data's was analyzed using Fisher exact. A p-value less than 0.05 were considered statistically to be significant.

Results

This study is considered to be a cross sectional study. The final sample was consisted of 54 boys, and 24 girls aged from 3 to 18 years (the mean age was 14.3 years). Of these 23 patients, 17 male patients, with a mean age of 16.1 years were underwent CT fluoroscopy – guided NB procedures (group I) at Emam Jaa-far Sadegh hospital in Meibud. The other 55 patients (37 males with a mean age of 12.3 years) underwent conventional CT guided NB procedures (group II) at the Shahid Sadoughi hospital in Yazd. The baseline demographic data is presented in table 1.
The success rates of biopsies, lesion size, depth and location of biopsies in FCT (group I) and CCT (group II) is presented in table 2. The success rate of FCT (87%) however, was significantly (p=0.012) higher than CCT (80%) rates.
The frequency of pneumothorax was differed significantly in group I (zero) and group II (3 cases; 5.4%, p=0.701). Of the 3 cases of pneumothorax in group II, only 1.8% patient required thoracostomy tube replacement.
The frequency of mild hemoptysis differed significantly between group I (zero) and in group II there were 5 cases (9.1%), with p=0.314 .Of these, none of them required medical intervention.

Table 1: baseline data of patients

CT Scanner	female	male	mean age(range)
	n(%)		n(%)
Fluoroscopy	6 (26.1)	17 (73.9)	16.1 (4-18.5)
Conventional	18 (32.7)	37 (67.3)	12.3 (1-17)
Total	24 (30.8)	54 (69.2)	13.5 (1-18.5)

Table 2: demographic of lung lesions and complications comparisons between FCT-guided needle biopsy and conventional CT-guided needle biopsy of 78 pulmonary lesions

Characteristics	**group I n=23**	**group II n=55**	**p-value**
Lesion size (mm)	29	36	0.430
Lesion depth			
Pleura-lesion depth (mm)	24	23	0.914
Needle path length (mm)	51	54	0.718
Location			
Upper/Middle lobe	14	27	0.627
Lower lobe	9	28	
Position			
Prone	16	33	0.541
Supine	7	22	
Complication			
Pneumothorax	0	3	0.701
hemoptysis	0	5	0.314

Group I: fluoroscopic CT-guided needle biopsy
Group II: conventional CT-guided needle biopsy

Discussion

Conventional CT (CCT) is proven to be safe and effective to perform a percutaneous interventional procedure (12, 13, and 14). In contrast to ultrasonography or fluoroscopy, CCT guided procedures are limited due to a lack of real time capability and the imaging steps required to monitor and document the needle placement which are often time consuming(5). Compared with CCT, the fluoroscopic CT (FCT) is faster and it will require fewer needle passes than conventional CT guided technique (6-9). FCT is valuable and it will provide an excellent real time view of percutaneous intervention, which was first described for clinical use by Katada, et al, in 1994 (14). The time saving predominantly is a result of the increased speed of needle localization provided by FCT (6, 15). Even the time of the procedure can be shortened by gaining more experience in placement of the needle (16). The time saving

predominantly results from the increased speed of needle localization using FCT. Fluoroscopic CT procedures required fewer punctures to target the lesion compared with conventional CT guided procedures. Although FCT is a useful targeting technique, significant radiation dose may hamper it's to both the patient and the radiologist (17). Therefore, radiologists should be aware of different methods of FTC guidance and the factors contributing to radiation exposure (18, 19). In our study according to table 2, the overall accuracy to diagnose a pulmonary nodule were 87% and 80% for FCT and CCT guided needle biopsy, respectively. Although this difference between the two figures is not very significant; for this, one probable reason may be the difficultly of the patients who were referred for FTC guided biopsies. The high levels of diagnostic accuracy with or without FCT are comparable to those of previous reports, ranging from 81% to 94 % (20-22). Heck et al. were documented fewer post-procedure pneumothorax using the FCT than CCT method (23). Our study showed a similar trend of complication's rates between these techniques. IN both studies the difference was not statistically significant (p=0.701). Although many factors, such as lesion size, needle-path length and lesion location influenced the complications rate. The number of punctures also could affect significantly the complication rates as well (24-26). In our study the analyzed complicated patients have shown that they have more than two biopsy punctures by using CCT method. There are two limitations to our study; first, we did not measure the radiation dose to the patient and radiologist who has an important role in choosing one of these methods, second, although we applied the same inclusion and exclusion criteria to the consecutive patients at each centre, the patient assignments to the two groups were not strictly randomized using computerized randomization program. In our conclusion, the needle biopsy of pulmonary nodule by CT-fluoroscopy versus conventional CT guided results in higher success rates of biopsy. Also it can be performed safely, in a shorter time with a significant fewer complications than with CCT procedures, but unfortunately, radiation exposure to the patient and physician, who was performed the procedure exam, was significantly higher when using the FCT method than the CCT guided needle biopsy.

Acknowledgment

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Conflict of Interest

The authors have no conflict of interest.

References

1-Welch TJ, Sheedy PF, Johnson CD, Johnson CM, Stephens DH. CT-guided biopsy: prospective analysis of 1,000 procedures. Radiology. 1989 ;171(2):493-6.

2-Ghanaati H, Firouznia K, Motevalli M, Mirdamadi L, Jalali AH. Fluoroscopic versus conventional CT guided biopsy. Iran. J. Radiol 2008;5:39-42.

3-Haaga JR, Alfidi RJ. Precise biopsy localization by computer tomography. Radiology 1976;118:603-7.

4-Katada K, Kato R, Anno H, Ogura Y, Koga S,et al. Guidance with real-time CT fluoroscopy: early clinical experience. Radiology. 1996;200(3):851-6.

5-Kim GR, Hur J, Lee SM, Lee HJ, Hong YJ, Nam JE, et al. CT fluoroscopy-guided lung biopsy versus conventional CT-guided lung biopsy: a prospective controlled study to assess radiation doses and diagnostic performance. Eur Radiol. 2011 ;21(2):232-9.

6-Daly B, Templeton PA. Real-time CT fluoroscopy: evolution of an interventional tool. Radiology 1999; 211:309-15.

7-Gianfelice D, Lepanto L, Perreault P, Chartrand-Lefebvre C, Milette PC. Value of CT fluoroscopy for percutaneous biopsy procedures. J Vasc Interv Radiol. 2000 ;11(7):879-84.

8-Froelich JJ, Ishaque N, Regn J, Saar B, Waithers EM, Klose KJ. Guidance of percutaneous pulmonary biopsies with real-time CT fluoroscopy. Eur J Radiol 2002; 42: 74-9.

9-Silverman SG, Tuncali K, Adams DF, Nawfel RD, Zou KH, Judy PF. CT fluoroscopy-guided abdominal interventions: techniques, results, and radiation exposure. Radiology. 1999; 212(3):673-81.

10-Meyer CA, White CS, Wu J, Futterer SF, Templeton PA. Real-time CT fluoroscopy: usefulness in thoracic drainage. AJR Am J Roentgenol. 1998;171(4):1097-101.
11-Daly B, Krebs TL, Wong-You-Cheong JJ, Wang SS. Percutaneous abdominal and pelvic interventional procedures using CT fluoroscopy guidance. AJR Am J Roentgenol. 1999;173(3):637-44.
12-Yamagami T, Iida S, Kato T, Tanaka O, Nishimura T. Combining fine-needle aspiration and core biopsy under CT fluoroscopy guidance: a better way to treat patients with lung nodules? AJR Am J Roentgenol. 2003;180(3):811-5.
13-Mueller PR, vanSonnenberg E. Interventional radiology in the chest and abdomen. N Engl J Med. 1990;322(19):1364-74.
14-Katada K, Anno H, Takeshita G, Ogura Y, Koga S, Ida Y, et al. [Development of real-time CT fluoroscopy]. Nihon Igaku Hoshasen Gakkai Zasshi. 1994 Oct 25; 54(12):1172-4.
15-Froelich JJ, Saar B, Hoppe M, Ishaque N, Walthers EM, Regn J,et al. Real-time CT-fluoroscopy for guidance of percutaneous drainage procedures. J Vasc Interv Radiol. 1998; 9(5):735-40.
16-Paulson EK, Sheafor DH, Enterline DS, McAdams HP, Yoshizumi TT. CT fluoroscopy--guided interventional procedures: techniques and radiation dose to radiologists. Radiology. 2001; 220(1):161-7.
17-Stoeckelhuber BM, Schulz E, Melchert UH, Blobel J, Gellissen J, Gehl H, et al. Procedures, spectrum and radiation exposure in CT-fluoroscopy. Rontgenpraxis. 2003; 55(2):51-7.
18-Bauer B, Corbett RH, Morres BH, Schibilla H, Teunen D. Proceedings of a workshop on reference Doses and quality in medical imaging, Luxembourg, October 23-25 1997.Radiation protection Dosimetry 80, Nos 1-3(1998).
19-Carlson SK, Felmlee JP, Bender CE, Ehman RL, Classic KL, Hoskin TL, et al. CT fluoroscopy-guided biopsy of the lung or upper abdomen with a breath-hold monitoring and feedback system: a prospective randomized controlled clinical trial. Radiology. 2005 ;237(2):701-8.
20-Kirchner J, Kickuth R, Laufer U, Schilling EM, Adams S, Liermann D. CT fluoroscopy-assisted puncture of thoracic and abdominal masses: a randomized trial. Clin Radiol. 2002 ;57(3):188-92.
21-Yeow KM, See LC, Lui KW, Lin MC, Tsao TC, Ng KF, et al. Risk factors for pneumothorax and bleeding after CT-guided percutaneous coaxial cutting needle biopsy of lung lesions. J Vasc Interv Radiol. 2001;12(11):1305-12.
22-Heck SL, Blom P, Berstad A. Accuracy and complications in computed tomography fluoroscopy-guided needle biopsies of lung masses. Eur Radiol. 2006;16(6):1387-92.
23-Tsukada H, Satou T, Iwashima A, Souma T. Diagnostic accuracy of CT-guided automated needle biopsy of lung nodules. AJR Am J Roentgenol. 2000;175(1):239-43.
24-Kazerooni EA, Lim FT, Mikhail A, Martinez FJ. Risk of pneumothorax in CT-guided transthoracic needle aspiration biopsy of the lung. Radiology. 1996;198(2):371-5.
25-Hiraki T, Mimura H, Gobara H, Shibamoto K, Inoue D, Matsui Y, et al. Incidence of and risk factors for pneumothorax and chest tube placement after CT fluoroscopy-guided percutaneous lung biopsy: retrospective analysis of the procedures conducted over a 9-year period. AJR Am J Roentgenol. 2010;194(3):809-14.
26-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(2):491-6.