Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Disease

journal homepage:www.elsevier.com/locate/apjtd

Document heading doi:10.1016/S2222-1808(11)60033-9

The accuracy of ultrasound guided 14-gauge core needle breast biopsy: Correlation with surgical excision or long term follow-up

Sumaporn Makkun, Jenjeera Prueksadee*, Jatuporn Chayakulkheeree, Darunee Boonjunwetwat

Department of Radiology, King Chulalongkorn Memorial Hospital, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand 10330

ARTICLE INFO

Article history:
Received 25 April 2011
Received in revised form 20 May 2011
Accepted 28 June 2011
Available online 28 September 2011

Keywords:
Ultrasound-guided biopsy
Core needle biopsy
Breast cancer
Ultrasound
Correlation
Sugical excision
Follow-up
Diagnostic accuracy
Breast biopsy
Pathologic result
Lesions
Sensitivity
Specificity
False negative rate
Positive predictive value
Negative predictive value

ABSTRACT

Objective: To determine the diagnostic accuracy of ultrasound-guided 14-gauge core-needle breast biopsy (CNB) correlation with surgical excision or long term follow-up. **Methods:** One hundred and fifteen breast lesions which had undergone ultrasound-guided 14-gauge core-needle breast biopsy from May 2003 to Aug 2010 in the Breast Diagnostic Center, King Chulalongkorn Memorial Hospital were included in this study. Clinical history, palpability of the lesion, site of the lesion, the prebiopsy lesion size, ultrasound characteristic, level of suspicion according to the BIRADS classification, number of samples taken and pathologic results of CNB were reviewed and correlated with pathologic results of subsequent open surgery. For benign lesions without surgery, we correlated the result of CNB with stability of the lesion at or more than two-year interval follow-up. The accuracy rate, sensitivity, specificity, false positive rate, false negative rate, positive predictive value and negative predictive value were accessed. The false-negative diagnoses of core needle biopsy were reviewed in detail. Procedural complications were also observed. **Results:** Among 115 lesions, 114 lesions were in female and 1 lesion was in male with their mean age of 50.87 years old (ranging from 27-72), 91 lesions were palpable (79.13%), 24 were non-palpable (20.87%). The prebiopsy size was 3.2 cm in diameter ranging from 0.5-20.0 cm. The pathologic results for the CNB were malignancy in 77.39% (89 lesions), high-risk in 0.87% (1 lesion) and benign in 21.17% (25 lesions). Five patients were negative for malignancy by core needle biopsy but positive for malignancy by surgical procedure. The sensitivity was 94.68%. The specificity was 100%. The false negative rate was 5.3%. The positive predictive value was 100%. The negative predictive value was 80.76%. The accuracy was 95.65%. There was no false positive case. **Conclusions:** Core needle biopsy under ultrasound guidance is a minimally invasive diagnostic tool and gives a high accuracy rate for evaluating breast lesions. This procedure reduces the surgical cases of benign breast disease. However, correlation between imaging and pathology is important for appropriate management of false negative cases.

1. Introduction

Ultrasound-guided, core needle biopsy (CNB) is the method used for initial diagnosis of suspicious breast lesions. It is less invasive, less expensive and less time consuming than surgical biopsy. It provideds a high accuracy rate that can reduce the unnecessary surgery for benign breast lesion. Its limitations are false-negative results and underestimation of disease. Thus, the correlation of ultrasound-guided core needle biopsy pathologic findings with subsequent surgical pathologic and imaging findings is considered. A long-term follow-up of lesion with a benign histology after biopsy is also warranted[1-8].

2. Materials and methods

This is a retrospective review from medical records, hospital data system and Picture Archiving and Communication System (PACS) of patients who underwent ultrasound guided 14-gauge core needle biopsy in the Department of Radiology, King Chulalongkorn Memorial Hospital from Jan 2006 to Aug 2010. One hundred and fifteen

*Corresponding author: Jenjeera Prueksadee, Department of Radiology, King Chulalongkorn Memorial Hospital, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand 10330.
Tel: +66-2256-4417
Fax: +66-2256-4417
E-mail: jenjeera@hotmail.com

lesions were recruited in this study. We excluded 50 lesions. 4 of them were due to no available ultrasound in PACS. 17 of them were due to no pathology result available in Hospital Information Symstem (HIS). 8 of them were benign lesions which required 2-year interval follow-up and 21 of them were malignant lesions which required surgery in the hospital.

2.1. Biopsy technique

An ultrasound was used for the evaluation of lesions visible on a sonography and carried out in the supine oblique position, by using a high-resolution 12 MHz linear array transducer (GE Voluson 730 ExpertLesion™). The lesion size was assessed according to the maximum lesion diameter at ultrasound. Direct visualization of the needle tip, before and after biopsy firing was the standard, together with longitudinal and orthogonal images to ensure that the needle was within the lesion (Figure 1). Ultrasound-guided 14-gauge CNB was performed by three radiologists. Two to five pieces of specimen were carried. Core biopsies were formalin fixed, paraffin embedded and sent to the pathological department.

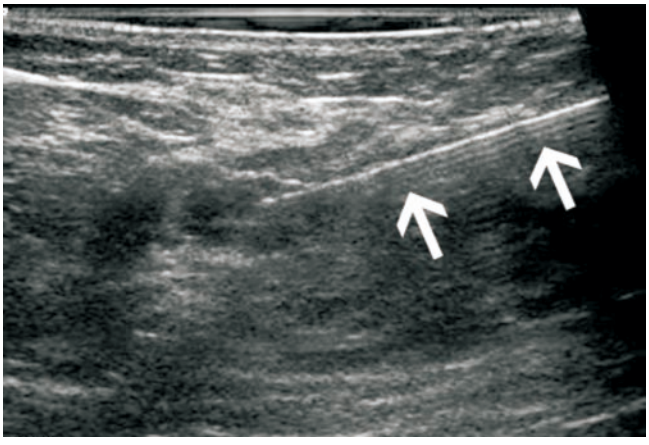

Figure 1. Needle line (arrows) and tip should be seen during the biopsy procedure.

2.2. Patients

Ultrasound guided 14 gauge CNB was offered to patients who present to both symptomatic and screening services for histologic assessment of suspicious lesions [Breast Imaging Reporting and Data System (BI-RADS category 4A-C)] and lesions highly suggestive of malignancy [Breast Imaging Reporting and Data System (BI-RADS category 5)][9].

2.3. Treatment protocol

Subsequent to ultrasound-guided 14 gauge CNB, the histologic examination results for each lesion were compared with imaging results. If the histopathology report indicated malignant changes, the patients underwent surgical treatment with no further diagnostic attempt. In this group, tissue diagnosis made from CNB was compared with the final pathology report of the surgical specimen. Those with benign pathology report were followed by ultrasound every 6 months and mammography annually. Those who did not have surgery, were reviewed for clinical and imaging follow-up for at least 2 years. Clinical presentations, characteristic of pre-biopsy lesions from breast ultrasound, BI-RADS classifications, histological findings from core needle breast biopsy, histological findings from surgical procedure, type of operation, follow-up imaging findings, time between CNB and surgery and immediate complication for each patients were reviewed and recorded on review record form. The overall accuracy, sensitivity, specificity, false positive rate, false negative rate, positive and negative predictive value of core needle biopsy were evaluated. The false-negative diagnoses of core needle biopsy were reviewed in detail. In cases of discordance between imaging result and histologic finding, after multidisciplinary review, the patients were referred for surgical excision of the suspicious lesions.

2.4. Data collection and analysis

Medical records were reviewed by one resident and one radiologist who specialized in breast imaging to determine the ultrasound characteristic and level of suspicion according to the BIRADS classification. Medical records and histological findings were reviewed to determine surgical outcomes.

2.5. Statistical analysis

Data were analyzed with commercially available software (SPSS for windows version 17). The diagnostic accuracy of sonographically guided core needle biopsy was assessed using a 2×2 table method with which we could make pathologic comparisons between core needle biopsy and the gold standard. The gold standard diagnosis was composed of the results of surgical excision, or long-term imaging follow-up.

3. Results

Core needle biopsies of 115 breast lesions were included in this study. The patients ranged in age from 27 to 72 years with mean age of 50. The mass ranged from 0.5-20 cm in maximum diameter with a mean of 3.2 cm. In all cases, 91 (79.13%) lesions were palpable and 24 (20.87%) lesions were not palpable. The mean number of sampling obtained per lesion was 2.3 (ranging from 2-5 samplings). The was no complication rate. There was no insufficient core biopsy sampling for diagnosis.

The pathologic results for the CNB were benign lesions in 25 biopsies (21.17%), including 5 fibroadenoma, 4 benign phyllodes tumor, 1 fibrocystic change, 2 infection/

inflammation, 1 proliferative change, 2 sclerosing adenosis, 9 benign breast tissue and 1 negative for malignancy. High-risk lesion was diagnosed in 1 lesion (0.87%) of 1 atypical ductal hyperplasia. Malignancy was identified in 89 biopsies (77.39%), including 67 invasive ductal carcinoma, 9 DCIS, 7 invasive lobular carcinoma, 1 mixed ductal and lobular carcinoma, 1mucinous carcinoma, 1 malignant phyllodes tumor, 1 low grade fibromyxoid sarcoma, 1 invasive cribriform carcinoma and 1 suspected malignancy.

One hundred and three patients underwent surgical procedure. 2 lesions underwent surgery after follow-up with mammogram and ultrasound because the imaging characteristic changed to malignant. Malignancy was found at subsequent surgery in 94 lesions (invasive ductal carcinoma 75 lesions, invasive lobular carcinoma 7 lesions, mixed invasive ductal and lobular carcinoma 1 lesion, DCIS 6 lesions, low grade fibromyxoid tumor 1 lesion, mucinous carcinoma 1 lesion, malignant phylloid tumor 1 lesion, tubular carcinoma 1 lesion, invasive cribriform carcinoma 1 lesion). Benign lesions were correctly proved by surgical procedure in 9 (3 patients with fibroadenoma, 4 patients with benign phyllode, 1 patient with sclerosing adenosis, 1 patient with granulomatous). Ninety eight patients were correctly diagnosed by core needle biopsy compared with surgical

Table 1
False negative diagnoses after ultrasound guided 14 gauge core needle biopsy.

No	Age	Size of lesion (cm)	BI-RADS category	Core needle biopsy result	Initial surgery	Interval (mo)	Final diagnosis
1	49	1.5	5	Benign breast tissue	–	20	Invasive ductal CA
2	48	1.6	5	Negative for malignancy	–	6	Invasive ductal CA
3	49	1.8	4c	Fibrocystic change	10 day after CNB	–	Invasive ductal CA
4	48	0.8	5	granulomatous lesion	23 day after CNB	–	Invasive ductal CA
5	58	1.2	5	Atypical ductal carcinoma	20 day after CNB	–	Tubular CA

CA: carcinoma.

Table 2
Correlation between BI-RADS category and pathological result from core biopsies.

Category/number of lesion	No cancer	Cancer
4a=17 lesions	14 lesions (3 benign phyllodes, 5 fibroadenoma, 6 benign breast tissue)	3 lesions (invasive ductal carcinoma)
4b=12 lesions	4 lesions (1 benign to borderline phyllodes, 1 sclerosing adenosis, 1 benign breast tissue, 1 proliferative change)	8 lesions (5 invasive ductal carcinoma lesions, 2 DCIS lesions, 1 low grade fibromyxoid sarcoma lesion)
4c=15 lesions	3 lesions (1 sclerosing adenosis, 1 fibrocystic change and 1 benign breast tissue)	12 lesions (7 invasive ductal carcinoma lesions, 1 invasive lobular carcinoma lesion, 1 mucinous CA lesion, 2 DCIS lesions, 1 malignant phyllodes lesion)
5=71 lesions	5 lesions (1 benign breast tissue, 2 granulomatous, 1 atypical ductal hyperplasia and 1 negative for malignancy)	66 leions (52 invasive ductal carcinoma lesions, 6 invasive lobular carcinoma lesions, 1 mixed invasive ductal and lobular carcinoma, 5 DCIS, 1 invasive cribiform, 1 suspicious malignancy)
	26 lesions	89 lesions

Table 3
Final diagnosis compared with core needle biopsy results.

Core biopsy finding	Final diagnosis		Total
	Cancer	No-cancer	115
Cancer	89	0	89
No-cancer (benign + high risk)	5	21	26
Total=115	94	21	115

Table 4
Final diagnosis compared with core needle biopsy results. (n= 115)

Core biopsy finding	Non-palpable lesions			Palpable lesions		
	Cancer	No-cancer	Total	Cancer	No-cancer	Total
Cancer	11	0	11	78	0	78
No-cancer (benign + high risk)	5	8	13	0	13	13
Total	16	8	24	78	13	91

result. Five patients (4.3%) were negative for malignancy by core needle biopsy but positive for malignancy by surgical procedure including 4 invasive ductal carcinoma and 1 tubular carcinoma (Figure 1, Table 1). All false-negative findings were identified owing to discordance between imaging results and US-guided 14 gauge CNB histologic findings (Table 1).

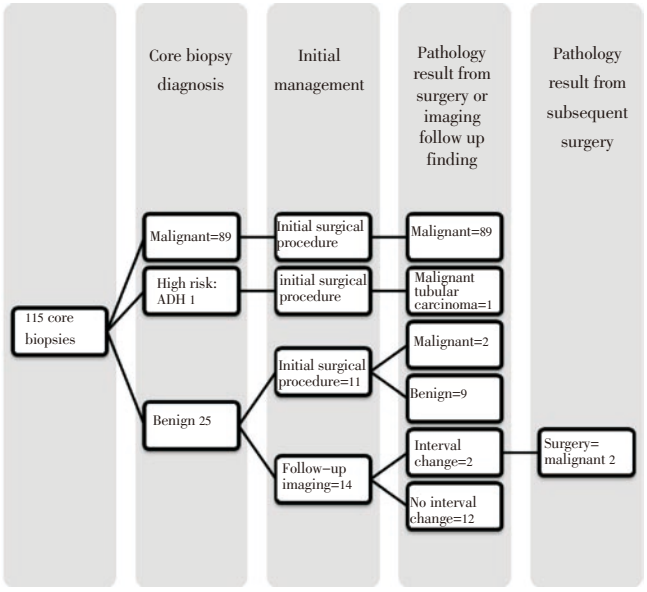

Figure 2. Follow up outcome of all core needle biopsies.

There was a high cancer rate in a lesion of BI-RADS 5 (malignancy rate of BI-RADS 4a=17.64%, BI-RADS 4b=66.66%, BI-RADS 4c=80.00% and BI-RADS 5=92.29%) (Table 2, Figure 2).

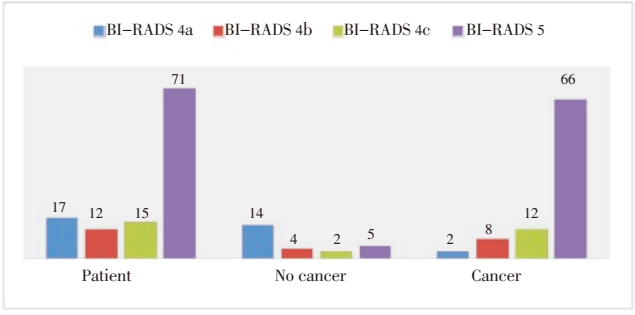

Figure 3. Correlation between BI-RADS category and pathological result from core biopsy.

The sensitivity was 94.68%, specificity 100%, false negative rate 5.3%, false positive rate 0%, positive predictive value 100%, negative predictive value 80.76%, accuracy 95.65% (Table 3). There was no false positive case.

The accuracy of US-guided 14 gauge CNB in non palpable lesions was 79.16% (Table 4). The accuracy rate of US-guided 14 gauge CNB in palpable lesion was 100% (Table 4).

4. Discussion

The results of our study showed the use of US-CNB sufficient material for histopathological diagnosis. There is high accuracy of ultrasound guided 14 gauge core needle breast biopsy for diagnosing a breast mass. The sensitivity was 94.68%, specificity 100%, positive predictive value 100%, negative predictive value 80.76% and accuracy 95.65% for breast mass diagnosis. However, false-negative diagnoses (false negative rate 5.3%) are demonstrated. False negative diagnoses result in delaying the diagnosis and treatment of breast cancer. Our study found that the false positive rate did not differ from previous studies whose false positive rate was in the range of 0%-9%[1-8,10-12]. Our study showed that false diagnoses with an average size of 1.3 cm which may be difficult to see in the ultrasound, especially in fatty breast tissue and deep location. In addition, granulomatous and fibrocystic change background might affect visibility in ultrasound. Our study found that the diagnosis of ADH by ultrasound guided core needle breast biopsy is not credible that a case diagnosis of ADH from core biopsy received surgery 20 days later which was diagnosed as a tubular carcinoma. Therefore, special attention is necessary when ADH is found. Mijung Jang *et al* found the rate of underestimation of ADH was 48% notably for lesions 20 mm or smaller lesions[13].

Number of core biopsy in our study was enough (ranging from 2-5 samplings). There was no insufficient core biopsy sampling for diagnosis. Sauer *et al* demonstrated that at least three core needle specimens performed under three-dimensional (3D) US guidance may be sufficient[14].

As same as previous study, this study shows size of lesion and palpability can affect diagnostic accuracy (the accuracy in non-palpable lesion was 79.16% and 100% in palpable lesion)[11,12].

In this study, two cancers of false-negative diagnosis had delayed surgery. These lesions had increased size on US follow-up at 6 months and 20 months after initial biopsy. To reduce treatment delaying because of false negative diagnosis should be considered, the imaging-histological correlation is substantial in ultrasound guided 14 gauge core needle breast biopsy specimens to confirm that the lesion actually because of false negative diagnoses were imaging-histologic discordance, mostly[11].

Therefore, the radiologist performing ultrasound guided 14 gauge core needle biopsy must be aware that technical difficulties, resulting from inaccurate tissue sampling may be a contributing factor in false-negative diagnoses. These difficulties including targeting errors due to poor lesion visualized from fatty breast tissue or poor needle visualization, lesion movement, deeply located lesions, central lesions in a large breast, dense fibrotic tissue resistant to needle traversing, patient motion or incomfortable to the procedure, small sized (<5 mm) lesions, and obscuring of the lesion by accumulating blood[10]. Additional, the radiologist should accentuate to the patient the seriousness of follow-up mammography and

ultrasound after benign biopsy, so that any interval change can be identified and evaluated soon afterwards. Short follow-up 6 months after a concordant benign diagnosis is reasonable[15,16]. Lee *et al* suggested annual follow-up in the benign specific histologic result (*e.g.* Fibroadenoma, lymph node, cyst) that concordant with the imaging and short interval follow-up mammography of the ipsilateral breast at 6 months and both breasts at 12 and 24 months if histologic revealed nonspecific (*e.g.* Fibrocystic change, apocrine metaplasia, benign or fibrous breast tissue)[17-20]. Most of the previous studies did not provide long term follow-up for patient who did not have surgery.

The limitations of our study, firstly, there is incomplete research data due to retrospective design. Secondly, ultrasound is the operator dependent imaging procedure causing limitation in retrospective study for demonstrating some ultrasound finding of this study. Finally, benign biopsy results that were not proven by surgical procedure and did not have at least a 2-year follow-up were excluded. Therefore, a selection bias may exist. Further prospective study should be warranted to establish the proper criteria.

Core needle biopsy under imaging guidance is a minimally invasive diagnostic tool and gives a high accuracy diagnostic rate. Core biopsy pathologic results should be considered with clinical and radiological findings for the appropriate treatment. Multidisciplinary teamwork is necessary to detect false negative core biopsy results at the earliest opportunity.

Conflict of interest statement

We declare that we have no conflict of interest.

References

[1] Schueller GC, Schueller W, Helbich TH. Accuracy of ultrasound-guided, large-core needle breast biopsy. *Eur Radiol* 2008; **18**: 1761-1773.

[2] Schueller GC, Jaromi S, Ponhold L, Fuchsjaeger M, Memarsadeghi M, Rudas M, et al. US-guided 14-gauge core-needle breast biopsy: results of a validation study in 1352 cases. *Radiology* 2008; **248**(2): 406-413.

[3] Nguyen M, McCornbs MM, Ghandehari S, Kim A, Wang H, Barsky SH, et al. An update on core needle biopsy for radiologically detected breast lesions. *Cancer* 1996; **78**: 2340-2345.

[4] Liberman L. Clinical management issues in percutaneous core breast biopsy. *Radiol Clin North Am* 2000; **38**(4): 791-807.

[5] Margenthaler JA, Duke D, Monsees BS, Barton PT, Clark C, Dietz JR. Correlation between core biopsy and excisional biopsy in breast high-risk lesions. *Am J Surg* 2006; **192**(4): 534-537.

[6] Collins LC, Connolly JL, Page DL, Goulart RA, Pisano ED, Fajardo LL, et al. Diagnostic agreement in the evaluation of image-guided breast core needle biopsies: results from a randomized clinical trial. *J Surg Pathol* 2004; **28**(1): 126-131.

[7] Schoonjans JM, Brem RF. Fourteen-gauge ultrasonographically guided large-core needle biopsy of breast masses. *J Ultrasound Med* 2001; **20**(9): 967-972.

[8] Youk JH, Kim EK, Kim MJ, Oh KK. Sonographically guided 14-gauge core needle biopsy of breast masses: a review of 2,420 cases with long-term follow-up. *AJR Am J Roentgenol* 2008; **190**(1): 202-207.

[9] Vanel D. The American College of Radiology (ACR) breast imaging and reporting data system (BI-RADS™): a step towards a universal radiological language? *Eur J Radiol* 2007; **61**(2): 183.

[10] Youk JH, Kim EK, Kim MJ, Lee JY, Oh KK. Missed breast cancers at US-guided core needle biopsy: how to reduce them. *Radiographics* 2007; **27**: 79-94.

[11] Crystal P, Koretz M, Shcharynsky S, Makarov V, Strano S. Accuracy of sonographically guided 14-gauge core-needle biopsy: results of 715 consecutive breast biopsies with at least two-year follow-up of benign lesions. *J Clin Ultrasound* 2005; **33**: 47-52.

[12] Ernst MF, Roukema JA. Diagnosis of non-palpable breast cancer: a review. *Breast* 2002; **11**(1): 13-22.

[13] Jang M, Cho N, Moon WK, Park JS, Seong MH, Park IA. Underestimation of atypical ductal hyperplasia at sonographically guided core biopsy of the breast. *AJR Am J Roentgenol* 2008; **191**: 1347-1351.

[14] Sauer G, Deissler H, Strunz K, Helms G, Remmel E, Koretz K, et al. Ultrasound-guided large-core needle biopsies of breast lesions: analysis of 962 cases to determine the number of samples for reliable tumour classification. *Br J Cancer* 2005; **92**(2): 231-235.

[15] Comstock CE. US-guided interventional procedures. In: Feig SA. (ed.) *Syllabus: categorical course in diagnostic radiology-breast imaging*. Oak Brook: Radiological Society of North America; 2005, p. 155-168.

[16] Jackman RJ, Nowels KW, Rodriguez-Soto J, Marzoni FA, Finkelstein SI, Shepard MJ. Stereotactic, automated, large-core needle biopsy of nonpalpable breast lesions: false-negative and histologic underestimation rates after long-term follow-up. *Radiology* 1999; **210**: 799-805.

[17] Lee CH, Philpotts LE, Horvath LJ, Tocino I. Follow-up of breast lesions diagnosed as benign with stereotactic core-needle biopsy: frequency of mammographic change and false-negative rate. *Radiology* 1999; **212**: 189-194.

[18] Takayuki O, Naoya G, Toshihiko W, Toshiki Y, Wataru I, Zenro N, et al. Ultrasound-guided core needle biopsy for breast cancer: preliminary report. *Jpn J Clin Oncol* 2000; **30**(2): 65-67.

[19] Acheson MB, Patton RG, Howisey RL, Lane RF, Morgan A, Rowbotham RK. Three- to six-year follow-up for 379 benign image- guided large-core needle biopsies of nonpalpable abnormalities. *J Am Coll Surg* 2002; **195**: 462-466.

[20] Smith DN, Rosenfield Darling ML, Meyer JE, Denison CM, Rose DI, Lester S, et al. The utility of ultrasonographically guided large-core needle biopsy: results from 500 consecutive breast biopsies. *J Ultrasound Med* 2001; **20**(1): 43-49.