

The role and histological classification of needle core biopsy in comparison with fine needle aspiration cytology in the preoperative assessment of impalpable breast lesions

A E K Ibrahim, A C Bateman, J M Theaker, J L Low, B Addis, P Tidbury, C Rubin, M Briley, G T Royle

Abstract

Aims—To investigate the role of needle core biopsy (NCB) in the preoperative assessment of impalpable breast lesions, mainly derived from the NHS Breast Screening Programme (NHSBSP) and to assess our own modifications to a suggested system for the classification of breast NCBs.

Methods—The NCB, fine needle aspiration cytology (FNAC), and radiology scores from 298 women with non-palpable breast lesions presenting between January 1997 and December 1998, together with the open biopsy results (where available) were collated and analysed.

Results—The mean follow up period was 15.8 months (range, 5–28). The 298 NCB specimens were categorised as follows: unsatisfactory/non-representative (B1; n = 61; 20.5%), benign but uncertain whether representative (B2r; n = 52; 17.4%), benign (B2; n = 103; 34.6%), lesions possibly associated with malignancy but essentially benign (B3a; n = 9; 3.0%), atypical epithelial proliferations (B3b; n = 10; 3.4%), suspicious of malignancy (B4; n = 7; 2.3%), and malignant (B5; n = 56; 18.7%). Excision biopsy was performed in 43 cases within the B1 (n = 19), B2r (n = 8), B2 (n = 8), and the B3a (n = 8; data unavailable in one case) categories, revealing malignancy in 18 (42.8%) cases and in 65 cases within the B3b, B4, and B5 categories, revealing malignancy in 64 cases (98.5%). The sensitivity of NCB for malignancy was 87.7%, with a specificity and positive predictive value of 99.3% and 98.5%, respectively. FNAC had an inadequacy rate of 58.7%, a complete sensitivity of 34.5% and a specificity of 47.6%.

Conclusions—This study confirms the value of NCB in the preoperative assessment of impalpable breast lesions. Two new categories are suggested for the NCB classification; category B2r for benign breast tissue where representativeness is uncertain, and the subdivision of category B3 into B3a for benign lesions potentially associated with malignancy (for example, radial scars and intraduct papillomas) and B3b for more worrisome atypical epithelial proliferations. These will aid the accurate audit of NCB and identify more

clearly the intellectual pathway leading to a particular assessment.

(*J Clin Pathol* 2001;54:121–125)

Keywords: needle core biopsy; impalpable breast lesions; fine needle aspiration cytology; NHS Breast Screening Programme

Since Bolmgren *et al* introduced stereotactic needle biopsy of the breast in the late seventies,¹ needle core biopsy (NCB) of the breast has become an increasingly important diagnostic tool in the assessment of both palpable and non-palpable breast lesions.^{2,3} Although there are well established scoring systems for both the radiological and cytological assessment of breast lesions, there is no such established system for reporting breast NCB specimens.^{4,5}

There is controversy in the literature about the role of combining fine needle aspiration cytology (FNAC) and NCB in the assessment of breast lesions. Some studies favour FNAC over NCB as a less expensive, faster, and more sensitive test.^{6,7} Others criticise the use of FNAC as the only pathological diagnostic test, particularly in the assessment of non-homogenous microcalcification containing breast lesions,⁸ as well as the inability of FNAC to distinguish invasive from in situ malignancy.^{9,10} Some authors recommend combining the two techniques in selected cases.¹¹

In our study, we assessed the combined role of NCB and FNAC in the preoperative assessment of impalpable breast lesions, most of which presented via the National Health Service Breast Screening Programme (NHSBSP). We have also evaluated our own modification of a suggested scoring system for breast NCB.

Patients and methods

Two hundred and ninety five women presenting mainly via the Southampton and Salisbury NHSBSP service between January 1997 and December 1998 with impalpable mammographic abnormalities, and assessed in the Southampton University Hospitals NHS Trust Breast Unit, were included in our study. The techniques used for NCB and FNAC are described below.

FINE NEEDLE ASPIRATION CYTOLOGY (FNAC)

A breast FNAC was performed by one of two radiologists involved with the study (CR and MB) under ultrasonographic or conventional

Departments of
Histopathology and
Cytopathology,
Southampton
University Hospitals
NHS Trust, Tremona
Road, Southampton,
SO16 6YO, UK
A E K Ibrahim
A C Bateman
J M Theaker
B Addis
P Tidbury

Department of
Medical Statistics and
Computing,
Southampton
University Hospitals
NHS Trust
J L Low

Department of
Radiology,
Southampton
University Hospitals
NHS Trust
C Rubin
M Briley

Department of
Surgery, Southampton
University Hospitals
NHS Trust
G T Royle

Correspondence to:
Dr Bateman, Department of
Histopathology, Level E,
South Block, Southampton
General Hospital, Tremona
Road, Southampton
SO16 6YD, UK
adrian.bateman@suht.swest.
nhs.uk

Accepted for publication
25 May 2000

Table 1 Classification system for the categorisation of breast needle core biopsy (NCB)

Biopsy category	Description of NCB
B1	Unsatisfactory or normal tissue†
B2r*	Benign but uncertain whether representative
B2	Benign representative lesion
B3a*	Essentially benign lesions that may be associated with malignancy—for example, radial scar/complex sclerosing lesion, intraduct papilloma
B3b*	Lesions showing atypical features and strongly associated with malignancy, such as atypical ductal hyperplasia (ADH)
B4	Malignant, but diagnosis cannot be categorically made owing to a technical artefact or the small size of the biopsy
B5	Malignant, either in situ or invasive

*Our modifications to the suggested classification system from St Bartholomew's Hospital. The B2r (benign but requires clinical/radiological review) category is an additional category and the B3 category has been subdivided into B3a and B3b.

†We included biopsies showing normal/benign tissue within the B1 category if the biopsy was performed because of microcalcifications but no microcalcifications were identified within the biopsy material.

stereotactic guidance. The FNAC was obtained by an ultrasonographic guided 21 gauge 1.5 inch needle or a conventional stereotactic guided 22 gauge spinal needle without aspiration. When performing FNAC before NCB the needle was used to localise the lesion and a single FNAC was obtained opportunistically and not repeated to obtain an adequate sample. The cytology smears were classified by the cytologist into five categories according to the NHSBSP guidelines for cytology.⁵

NEEDLE CORE BIOPSY (NCB)

All core biopsies were performed by the two radiologists involved with our study using ultrasonographic and conventional stereotactic guidance. Fourteen gauge needles were used (18 gauge needles were used initially). The NCB was performed by first cleaning the skin overlying the lesion with alcohol; this was followed by skin and subcutaneous infiltration with approximately 1–2 ml of 1% lignocaine. Utilising a sterile technique, the needle was inserted into the lesion. Usually two or more biopsies were taken from each solid lesion with, towards the end of our study, six cores being taken from microcalcifications. The specimen was then x rayed and calcifications were identified within the tissue sample. The specimen was then transferred into formaldehyde and processed in the histopathology department.

All of the biopsies were reported by one of two consultant histopathologists with a special interest in breast pathology (ACB and JMT), who placed them into one of several categories, using a classification system based on that kindly provided by Dr C Wells at St Bartholomew's Hospital, London (table 1). We introduced two modifications to the original classification system, namely the B2r category (benign but uncertain whether the tissue was representative of the mammographic lesion) and the subdivision of the B3 category into B3a (benign lesions that might be associated with

malignancy, such as radial scar/complex sclerosing lesion, intraduct papilloma) and B3b (atypical epithelial proliferations, such as atypical ductal hyperplasia).

The breast NCB results were discussed at one or both of two weekly meetings attended by the breast radiologists, the histopathologists, the cytopathologists, and the surgeons. Surgical excision biopsy was performed, where indicated, in a proportion of the cases.

DATA ANALYSIS

The data were entered into a Microsoft Excel[®] V5.0/95 database and analysed using the SPSS[®] V6 statistical program and Stata[®] V 6.0.

To calculate the sensitivity and specificity of breast NCB, the individual cases were categorised into positive and negative groups. Positive breast NCBs were defined as those within the B3b, B4, and B5 categories. The true positive cases were those confirmed as malignant on subsequent open biopsy. Negative breast NCBs were defined as those within the B2r, B2, and B3a categories; false negative breast NCBs were defined as those cases within the B2r, B2, and B3a categories in which malignancy was identified on subsequent excision biopsy.

The complete sensitivity of breast FNAC was defined as the number of cases scored as C3, C4, or C5 expressed as a percentage of the total number of cases subsequently confirmed as malignant on NCB and/or excision biopsy. The specificity of FNAC was defined as the number of correctly identified benign cases (that is, scored as C2) expressed as a percentage of the total number of benign lesions aspirated.

Sensitivity, specificity, and complete sensitivity are all presented together with their respective 95% confidence intervals (CI). Spearman rank correlation coefficients were obtained to assess the strength of the linear association between the breast NCB score and the radiology and cytology scores, respectively.

Results

The results from 298 consecutive breast NCBs from 295 women (mean age, 56 years; range, 46–80) were analysed along with the corresponding FNAC, radiological, and excision biopsy data. The mammographic indications for NCB, listed by NCB result category, are shown in table 2. The mean follow up period was 15.8 months (range, 5–28).

The breast NCB specimens were categorised as follows: unsatisfactory/non-representative (B1; n = 61; 20.5%), benign but uncertain whether representative (B2r; n = 52; 17.4%), benign (B2; n = 103; 34.6%), benign lesions that might be associated with malignancy (B3a; n = 9; 3.0%), atypical epithelial proliferations (B3b; n = 10; 3.4%), suspicious of malignancy (B4; n = 7; 2.3%), and malignant (B5; n = 56; 18.7%).

Excision biopsy was performed in 43 cases within the B1–B3a categories (B1, n = 19; B2r, n = 8; B2, n = 8; B3a, n = 8 (data unavailable in one case)) because of radiological or cytological concerns, revealing malignancy in 18 cases (table 3). Of these 18 cases, the radio-

Table 2 Mammographic indications for breast needle core biopsy by category

	B1	B2r	B2	B3a	B3b	B4	B5	Total
Microcalcification	49	34	89	3	10	7	42	234 (78.5%)
Asymmetrical density	5	10	7	3	0	0	9	34 (11.4%)
Calcified opacity	1	4	4	1	0	0	3	13 (4.4%)
Stellate lesions	2	1	1	1	0	0	1	6 (2.0%)
Others	4	3	2	1	0	0	1	11 (3.7%)
Total	61	52	103	9	10	7	56	298 (100%)

Table 3 Cases in which a negative breast needle core biopsy was followed by the identification of malignancy on excision biopsy

Case	Indication	Age	Radiology	Cytology	NCB category	Description of NCB	Excision biopsy histology
1	Microcalcifications	63	3	2	B1	Inadequate tissue	IDC
2	Microcalcifications	61	4	1	B1	Non-representative (no microcalcifications)	DCIS
3	Microcalcifications	58	5	2	B1	Normal breast tissue	DCIS
4	Microcalcifications	55	3	3	B1	Non-representative (no microcalcifications)	DCIS
5	Stromal density	51	5	5	B1	Non-representative (no microcalcifications)	IDC
6	Microcalcifications	58	4	1	B1	Non-representative (no microcalcifications)	DCIS
7	Unknown	52	5	1	B1	Non-representative (no microcalcifications)	DCIS
8	Microcalcifications	51	5	1	B1	Inadequate tissue	DCIS
9	History of DCIS	55	3	1	B1	Inadequate tissue	DCIS
10	Microcalcifications	57	4	5	B2r	Microcalcifications in benign lesion, uncertain whether representative	DCIS
11	Microcalcifications	60	4	1	B2r	Microcalcifications in benign lesion, uncertain whether representative	IDC
12	Distortion	54	4	1	B2r	Dense hyaline stroma	IDC
13	Microcalcifications	54	5	1	B2r	Coarse stromal calcifications	DCIS
14	Asymmetrical density	52	3	3	B2	Fibrocystic change	IDC
15	Microcalcifications	54	5	1	B2	Microcalcifications in benign lesion	IDC and DCIS
16	Microcalcifications	58	5	1	B2	Benign changes only	IDC
17	Microcalcifications	52	4	1	B2	Microcalcifications in benign lesion	IDC with microcalcifications in adjacent benign lesion
18	Asymmetrical density	50	5	1	B3a	Complex sclerosing lesion	IDC and IMC

DCIS, ductal carcinoma in situ; IDC, invasive ductal carcinoma; IMC, invasive mucinous carcinoma.

logical assessment was equivocal (R3) in four cases, suspicious (R4) in six cases, and malignant (R5) in eight cases. The cytological assessment was equivocal (C3) in two cases (both assessed radiologically as R3) and malignant (C5) in two further cases (assessed radiologically as R4 and R5, respectively). Excision biopsy was performed in 65 of the 73 cases in the B3b, B4, and B5 categories (data unavailable in seven cases and one case of a lymphoma not requiring open biopsy), revealing malignancy in 64 cases (in situ carcinoma, n = 36, 56.3%; invasive carcinoma, n = 28, 43.7%) and a single benign lesion.

The sensitivity of breast NCB for malignancy in this series was 87.7% (CI, 77.9% to 94.2%), with a specificity of 99.4% (CI, 96.4% to 100.0%) and a positive predictive value of 98.5% (CI, 91.7% to 100.0%), based on the prevalence within the study population of 31.9%. The complete sensitivity of FNAC for

malignancy was 34.5% (CI, 24.6% to 45.4%), with a specificity of 47.6% (CI, 37.8% to 57.6%) and an inadequacy rate of 58.7%.

Tables 4 and 5 show the association between the breast NCB score and the radiology and cytology, respectively; table 6 shows the association between the radiology and cytology scores. Ignoring all cases in which the NCB score was inadequate (B1 cases), the correlation between the NCB and radiology scores was $r = 0.49$ (n = 237; $p < 0.0005$). Similarly, ignoring cases with inadequate biopsy or cytology, the correlation between the breast NCB and cytology scores was $r = 0.59$ (n = 102; $p < 0.0005$). These correlation coefficients demonstrate that there is a moderate association between the breast NCB score and each of the radiology and cytology scores. Ignoring cases with inadequate cytology, the correlation between the cytology and radiology scores was $r = 0.52$ (n = 123; $p < 0.0005$). This indicates that when an adequate cytology specimen was available, there was a moderate correlation between the cytology and radiology scores.

Discussion

We have found the five category classification system for breast NCB to be very useful but have encountered two main drawbacks. First, a considerable proportion of breast NCB specimens show benign changes but the histopathologist cannot be certain whether the tissue is representative of the mammographic lesion. This occurred most frequently in our study when NCBs were performed for microcalcifications but only occasional microcalcifications were identified. However, we also encountered this problem when NCBs were performed for mammographic lesions other than microcalcifications. These NCB specimens could be classified as either B1 (normal/inadequate) or B2 (benign), but we feel that such cases should be highlighted to ensure that the breast team reviews them. Therefore, we have introduced the B2r category for this situation, indicating that benign breast tissue is present but that review is particularly important. Breast NCBs are often obtained in our

Table 4 Cross tabulation of breast needle core biopsy score with the radiology score

	B1	B2r	B2	B3a	B3b	B4	B5	Total
R2	27	21	58	0	2	3	2	113 (37.9%)
R3	24	25	35	6	3	2	12	107 (35.9%)
R4	6	5	8	1	5	1	21	47 (15.8)
R5	4	1	2	2	0	1	21	31 (10.4%)
Total	61	52	103	9	10	7	56	298 (100%)

Table 5 Cross tabulation of breast needle core biopsy score with the cytology score

	B1	B2r	B2	B3a	B3b	B4	B5	Total
C1	40	40	62	4	4	6	19	175 (58.7%)
C2	12	7	31	1	4	1	5	61 (20.5%)
C3	5	4	10	3	1	0	6	29 (9.7%)
C4	2	0	0	1	0	0	8	11 (3.7%)
C5	2	1	0	0	1	0	18	22 (7.4%)
Total	61	52	103	9	10	7	56	298 (100%)

Table 6 Cross tabulation of breast FNAC score with the radiology score

	C1	C2	C3	C4	C5	Total
R2	75	27	8	2	1	113 (37.9%)
R3	65	27	12	1	2	107 (35.9%)
R4	20	4	5	4	14	47 (15.8)
R5	15	3	4	4	5	31 (10.4%)
Total	175 (58.7%)	61 (20.5%)	29 (9.7%)	11 (3.7%)	22 (7.4%)	298 (100%)

FNAC, fine needle aspiration cytology.

group using a stereotactic method,¹² and therefore one can be relatively confident in such cases that the tissue is truly representative of the mammographic lesion.

The second problem that we encountered was that the B3 group includes a heterogeneous group of breast diseases, some of which are essentially benign, although possibly associated with an increased frequency of malignancy (for example, radial scar and intraduct papilloma). However, also included in the B3 category are atypical epithelial proliferations, which are strongly associated with the presence of malignancy on excision biopsy. This would include the presence on NCB of single ducts containing an atypical epithelial proliferation, but in which a firm diagnosis of either atypical ductal hyperplasia or ductal carcinoma in situ was not possible because the extent of the abnormal proliferation could not be assessed from the NCB alone. A review of the literature found 66 cases of "atypical ductal hyperplasia" identified on breast NCBs, which on subsequent excision were diagnosed as ductal carcinoma in situ in 27 cases and invasive ductal carcinoma in seven cases.¹³ Other studies have reported the identification of malignancy at open biopsy in 33–88% of cases in which atypia was identified on breast NCBs.^{13–16} Of the 10 breast NCBs showing atypical epithelial proliferation in our study, open biopsy revealed carcinoma in situ in six cases, invasive ductal carcinoma in three cases, and one case of fibrocystic change with an incidental focus of atypical lobular hyperplasia. Because of the wide variation in the prognostic relevance of the breast diseases comprising the B3 category, these cases could not be included within either the positive or negative groups for the calculation of sensitivity and specificity, and previous studies have excluded them from statistical analysis.¹⁷ We believe that separation of these groups of conditions is also important for departmental and national audit programmes, which may otherwise produce apparently conflicting results when different centres are compared. We have subdivided the B3 group into essentially benign conditions such as intraduct papillomas and radial scars/complex sclerosing lesions (category B3a), which can then, as in our study, be considered as negative cases for statistical and audit purposes, and atypical epithelial proliferations (category B3b), which can be considered as positive cases for analysis.

The specificity of breast NCB for malignancy in our series (99.3%; CI, 96.4% to 100.0%) compares well with published reports of specificity ranging from 85% to 100%.^{14–21} However, our sensitivity for NCB in diagnosing malignancy (87.7%; CI, 77.9% to 94.2) was less than the reported range of 93–100% in similar studies.^{14–21} This might be because of the inclusion of different types of case within the "negative" and "positive" groups. For example, we included within the negative group those breast NCBs showing benign changes, but in which we could not be entirely certain from histological examination alone whether they were derived from the mammographic lesion (category B2r). We also included

within the negative group breast NCB specimens showing lesions that were benign in themselves, but which might be associated with malignancy, such as radial scars (category B3a; excision biopsy was always performed in such cases). When we calculate sensitivity using only NCB specimens showing benign changes that were thought to be definitely representative of the mammographic lesions (category B2) the sensitivity rises to 97.0% (CI, 89.5% to 99.7%), well within the previously reported ranges.

Our series contained a high inadequacy rate for breast FNAC (58.7%), with a specificity of 47.6% (CI, 37.8% to 57.6%) and a complete sensitivity for malignancy of 34.4% (CI, 24.6% to 45.4%). In a similar study, Lifrange *et al* reported a 22% inadequacy rate, 96% specificity, and 57% sensitivity.²² However, we believe that multiple attempts to obtain an adequate FNAC are not usually justified if an adequate breast NCB has already been obtained, and therefore FNAC was done as a sighting shot with samples taken opportunistically, and was not often repeated even if the first aspirate produced little material. Furthermore, unlike our study, Lifrange *et al* calculated the sensitivity and the specificity of their series after excluding the inadequate cases.²² If we were to combine the data gained from the radiological assessment, breast FNAC, and NCB in our calculation of the sensitivity and the specificity, there would be no "false negative" cases and both the sensitivity and the specificity of preoperative assessment would rise to 100%. This is because when the breast NCB revealed benign tissue in the 18 cases where malignancy was subsequently identified on excision biopsy, the radiological assessment was always at least equivocal (R3 or above) and the FNAC score was at least equivocal in four cases (C3 or above) (table 3). This illustrates the requirement for good clinicopathological liaison and for regular multidisciplinary meetings before further treatment is planned. We cannot of course be certain that all cases in which a negative breast NCB specimen was obtained were definitely benign, because only 18 such cases proceeded to excision biopsy. However, we have followed the patients for a median of 15.8 months and during this period no further cases of malignancy have been identified within this patient group.

Although the relatively high inadequacy rate of breast FNAC in our series precludes a definitive assessment of its role alongside breast NCB in the preoperative assessment of impalpable breast lesions, we suggest that there are advantages to combining the two methods. When performed in a "one stop" setting, breast FNAC allows immediate definitive diagnosis in a proportion of patients, within the outpatients' department. Furthermore, FNAC may sample a larger or slightly different area of breast tissue than NCB, resulting in a smaller number of false negative cases when the two techniques are combined, as was evident in our study and other studies (table 3).²³ On the other hand, the advantages of breast NCB over FNAC include a definitive histological diagnosis adding

important prognostic factors, essential for planning future treatment.^{23 24} Other studies have suggested that combining the two techniques is particularly important in certain situations—for example, cases of microcalcifications where multiple sampling is paramount¹¹ and cases in which the differential diagnosis lies between phyllodes tumour and fibroadenoma, because FNAC is unable to distinguish phyllodes tumours from fibroadenoma.^{25 26} However, we believe that phyllodes tumours at the benign end of the spectrum cannot be reliably distinguished from cellular fibroadenomas using breast FNAC or NCB, and therefore recommend excision biopsy in this situation.

In conclusion, our study highlights the importance of a multidisciplinary approach in the preoperative assessment of impalpable breast lesions. We have also suggested two modifications to an otherwise very useful classification system for breast NCBs. We fully accept that the clinical decision facilitated by breast NCB in these patients relates solely to their further management and, in particular, to whether a mammographic abnormality requires surgical excision. However, we believe that it is essential that the intellectual pathway leading to patient management decisions is clearly identifiable, particularly for audit purposes, and hope that our refinements to the classification system will enable this to be achieved with greater accuracy.

We are very grateful to Dr C Wells for supplying the breast NCB classification system upon which much of this study was based.

- 1 Bolmgren J, Jacobson B, Nordenström B. Stereotaxic instrument for needle biopsy of the mamma. *Am J Roentgenol* 1997;129:121–5.
- 2 Pettine S, Place R, Babu S, et al. Stereotactic breast biopsy is accurate, minimally invasive, and cost effective. *Am J Surg* 1996;171:474–6.
- 3 Pijnappel RM, Van Dalen A, Borel Rinkes IHM, et al. The diagnostic accuracy of core biopsy palpable and nonpalpable breast lesions. *Eur J Radiol* 1997;24:120–3.
- 4 Breast imaging reporting and data system (BI-RADS). Proceedings of the American College of Radiology (ACR). Reston, VA: ACR Publications, 1993.
- 5 NHSBSP—*Guidelines for cytology procedures and reporting in breast cancer screening*. Sheffield: NHSBSP Publications, 1993.
- 6 Ballo MS, Sneige N. Can core needle biopsy replace fine needle aspiration cytology in the diagnosis of palpable breast carcinoma: a comparative study of 124 women. *Cancer* 1996;78:773–7.
- 7 Donegan WL. Evaluation of palpable breast mass. *N Engl J Med* 1992;327:937–42.
- 8 Oliver DJ, Frayne JR, Sterrett G. Stereotactic fine needle biopsy of the breast. *Aust N Z J Surg* 1992;62:463–7.
- 9 Kitchen PRB, Cawson JN. The evolving role of fine needle cytology and core biopsy in the diagnosis of breast cancer. *Aust N Z J Surg* 1996;66:577–9.
- 10 Frayne J, Sterrett GF, Harvey J, et al. Stereotactic 14 gauge core-biopsy of the breast: results from 101 patients. *Aust N Z J Surg* 1996;66:585–91.
- 11 Florentine BD, Cobb CJ, Frankel K, et al. Core needle biopsy: a useful adjunct to fine needle aspiration in selected patients with palpable breast lesions. *Cancer Cytopathology* 1997;81:33–9.
- 12 Hirst C, Davis N. Core biopsy for microcalcifications in the breast. *Aust N Z J Surg* 1997;67:320–4.
- 13 Moore MM, Hargett W, Hanks JB, et al. Association of breast cancer with the finding of atypical ductal hyperplasia at core breast biopsy. *Ann Surg* 1997;225:726–33.
- 14 Jackman RJ, Nowels KW, Shepard MJ, et al. Stereotaxic large-core needle biopsy of 450 nonpalpable breast lesions with surgical correlation in lesions with cancer or atypical hyperplasia. *Radiology* 1994;193:91–5.
- 15 Liberman L, Cohen MA, Dershaw DD, et al. Atypical ductal hyperplasia diagnosed at stereotactic core biopsy of breast lesions: an indication for surgical biopsy. *Am J Radiol* 1995;164:1111–13.
- 16 Dahlstrom JE, Sutton S, Jain S. Histological precision of stereotactic core biopsy in diagnosis of malignant and premalignant breast lesions. *Histopathology* 1996;28:537–41.
- 17 Parker SH, Burbank F, Jackman RJ, et al. Percutaneous large-core breast biopsy: a multi-institutional study. *Radiology* 1994;193:359–64.
- 18 Israel PZ, Fine RE. Stereotactic needle biopsy for occult breast lesions: a minimally invasive alternative. *Am Surg* 1995;61:87–91.
- 19 Nguyen M, McCombs MM, Ghandehari S, et al. An update on core needle biopsy for radiologically detected breast lesions. *Cancer* 1996;78:2340–5.
- 20 Iorianni P, La Grenade A, Barr H, et al. Correlation of stereotactic core breast biopsy with open biopsy: a study of 102 patients. *Surg Forum* 1995:628–9.
- 21 Doyle AJ, Murray KA, Nelson EW, et al. Selective use of image guided large-core needle biopsy of the breast: accuracy and cost-effectiveness. *Am J Radiol* 1995;165:281–4.
- 22 Lifrante E, Kridelka F, Colin C. Stereotaxic needle-core biopsy and fine-needle aspiration biopsy in the diagnosis of nonpalpable breast lesions: controversies and future prospects. *Eur J Radiol* 1997;24:39–47.
- 23 Clark GM, Dressler LG, Owens MA, et al. Prediction of relapse or survival in patients with node negative breast cancer by DNA flow cytometry. *N Engl J Med* 1989;320:627–33.
- 24 Lovin JD, Sinton EB, Burke BJ, et al. Stereotaxic core breast biopsy: value in providing tissue for flow cytometric analysis. *Am J Radiol* 1994;162:609–12.
- 25 Shimizu K, Masawa N, Yamada T, et al. Cytologic evaluation of phyllodes tumour as compared to fibroadenoma of the breast. *Acta Cytol* 1994;38:891–7.
- 26 Dusenbery D, Frable WJ. Fine needle aspiration cytology of phyllodes tumour: potential diagnostic pitfalls. *Acta Cytol* 1992;36:215–21.



The role and histological classification of needle core biopsy in comparison with fine needle aspiration cytology in the preoperative assessment of impalpable breast lesions

A E K Ibrahim, A C Bateman, J M Theaker, et al.

J Clin Pathol 2001 54: 121-125

doi: 10.1136/jcp.54.2.121

Updated information and services can be found at:

<http://jcp.bmj.com/content/54/2/121.full.html>

These include:

References

This article cites 22 articles, 5 of which can be accessed free at:

<http://jcp.bmj.com/content/54/2/121.full.html#ref-list-1>

Article cited in:

<http://jcp.bmj.com/content/54/2/121.full.html#related-urls>

Email alerting service

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic Collections

Articles on similar topics can be found in the following collections

[Clinical diagnostic tests](#) (637 articles)

Notes

To request permissions go to:

<http://group.bmj.com/group/rights-licensing/permissions>

To order reprints go to:

<http://journals.bmj.com/cgi/reprintform>

To subscribe to BMJ go to:

<http://group.bmj.com/subscribe/>