*Acta Orthop. Belg.*, 2009, **75**, 239-244

*ORIGINAL STUDY*

# Does image guidance improve accuracy of core needle biopsy in diagnosis of soft tissue tumours ?

Amir Ali NARVANI, Elefterios TSIRIDIS, Asif SAIFUDDIN, Timothy BRIGGS, Stephen CANNON

*From the Royal National Orthopaedic Hospital NHS Trust, Stanmore, England*

**The aim of this study was to compare accuracy of an image guided percutaneous core needle biopsy (PCNB), using ultrasound or computed tomography, to PCNB without image guidance in the diagnosis of palpable soft tissue tumours.**

**One hundred forty patients with a suspected soft tissue sarcoma underwent a percutaneous core needle biopsy with or without image guidance. One hundred eleven patients had subsequent surgical excision. The accuracy of guided PCNB and blind PCNB was calculated by comparing the histological results of the needle biopsy to the surgical specimen.**

**The diagnostic accuracy of blind percutaneous core needle biopsy was 78% (36 of 46 biopsies) and was significantly lower ($p \leq 0.025$) in comparison to image guided percutaneous core needle biopsy, which was 95% (62 of 65 biopsies).**

**We suggest that image guidance improves the diagnostic accuracy of PCNB especially for small-size deep sited suspected soft tissue tumours.**

**Keywords** : soft tissue tumours ; diagnosis ; biopsy ; image guidance.

## INTRODUCTION

In recent years, the management of malignant soft tissue tumours has evolved from radical procedures to less extensive resections that control disease while preserving limb function (*1,9,10,13*). Optimal management of soft tissue tumours however depends on accurate biopsies, and avoiding diagnostic errors prevents inappropriate treatment, unnecessary amputation, and even death (*1,3,9,10,4*). In a multicenter study involving 597 patients with musculoskeletal tumours, Mankin *et al* reported a biopsy complication rate of 15.9% (*10*). Out of the 597 biopsies, 29 were performed by radiologists who used CT guided biopsies. They reported that 19.6% of patients needed an alteration in treatment because of a problem with diagnosis (*10*). In 16.6% of patients with soft tissue tumours the outcome was thought to have worsened as a result of poorly performed biopsy (*10*).

Techniques used for biopsy of soft tissue tumours include fine needle aspiration (FNAC), percutaneous core needle biopsy (PCNB), incisional biopsy, and surgical excisional biopsy (*1,15,16*). Although

■ Amir Ali Narvani, MSc, FRCS (Orth & Trauma), Knee & shoulder fellow.

■ Elefterios Tsiridis, PhD, FRCS, Consultant orthopaedic surgeon.

■ Asif Saifuddin, FRCR, Consultant radiologist.

■ Timothy Briggs, FRCS, Consultant orthopaedic surgeon.

■ Stephen Cannon, FRCS, Consultant orthopaedic surgeon.

*Tumour Unit, Royal National Orthopaedic Hospital NHS Trust, Stanmore, England.*

Correspondence : Amir Ali Narvani, 27 Farm Avenue, London NW2 2BJ, England. E-mail : alinarvani@hotmail.com



*No benefits or funds were received in support of this study*

FNAC is cost effective and relatively easy to perform, there is some difficulty in obtaining a histological grade and categorizing the tumours into subtypes (*8*). Surgical incisional and excisional biopsies provide large amounts of tissue and can have a high accuracy rate (76 to 97%), but they are also associated with high complication rates including tumour spillage, haemorrhage, and wound breakdown and infection (*3,9,10,11,16*). In Mankin's study of 1996, over 20% of those who underwent incisional or excisional biopsies needed an alteration in treatment because of problems in biopsy, as compared to less than 10% of those who underwent needle biopsy. Furthermore, in over 11% of those with open and incisional biopsies, the outcome was altered as a result of problems with the biopsy (only in 2.4% of those with needle biopsy was the outcome altered) (*10*). Percutaneous core needle biopsy (PCNB) has gained popularity recently as it is cost effective, relatively easy to perform, associated with less wound problems, can be undertaken as an outpatient procedure and also can be performed with image guidance, using ultrasound (US) or computed tomography (CT) (*2,8,17,19*). Studies have reported the accuracy of percutaneous core needle biopsy without image guidance (B-PCNB) in the management of soft tissue tumours to range from 70 to 94% (*5,6,8,10,17*). Other studies which have investigated the accuracy of Image Guided PCNB (G-PCNB), have shown its accuracy to range from 74 to 98%, most however involve small patient numbers (*2,4,7,9,12,18*). Despite the widespread use of the two approaches, we have found no studies comparing the accuracy of the two techniques in the English speaking literature.

The hypothesis of the current study is that PCNB can be improved by an ultrasound or a computed tomography guided technique. The aim of the current study was to investigate and compare the accuracy of B-PCNB and G-PCNB in the diagnosis of soft tissue tumours.

## METHODS

This study consisted of 140 consecutive patients referred to our musculoskeletal tumour unit with a palpable soft tissue mass, over a period of one calendar year. All 140 patients had magnetic resonance imaging (MRI), followed by PCNB (G-PCNB or B-PCNB) for the suspected soft tissue tumour. Patients with relatively large, palpable and superficially sited tumours underwent B-PCNB , while those with deep sited and smaller in size tumours were referred for G-PCNB. All 140 PCNB results were recorded in a computerized data base. The mean size of the masses was 3.9 cm (range, 1.8-6.3). One hundred and eleven (111) patients out of the latter 140 had subsequently surgical excision and biopsy (SEB) of the lesion according to clinical, radiological and histological indications and were included in the study. Histological examination of the excised specimen provided the definitive diagnosis. In the rest twenty nine (29) patients, the lesion was either diagnosed as lymphoma or as an inoperable malignant tumour (for systemic or local reasons or both) and subsequently managed with radiotherapy only, or it was considered benign, small in size and not threatening vital anatomical nearby structures by a multidisciplinary clinical consortium (surgeons, radiologists and histopathologists with special interest in soft tissue tumours), and therefore patients did not have a surgical excision. Therefore, all the latter 29 patients were excluded from the study. Sixty five (65) out of the 111 patients that were included in the study, had G-PCNB and 46 patients had B-PCNB prior to SEB. G-PCNB and B-PCNB histological results were compared for their accuracy to the SEB histological results.

All B-PCNBs were performed in the outpatient setting by a consultant orthopaedic oncologist surgeon. Following the appropriate antiseptic skin preparation, local anaesthetic (3-5 mL of 1% lidocaine) was applied to the skin and the subcutaneous tissues. Two to five passes were then made through the lesion using an automated 14-gauge biopsy needle (Temno Biopsy Device, Cardinal Health, Dublin, Ohio, USA).

All G-PCNBs were performed in the radiology department by consultant musculoskeletal radiologists with special interest in oncology. The specimens were obtained following a similar technique as the above described for the B-PCNB, but with the assistance of ultrasound or computed tomography (CT) guidance. The differential decision to use ultrasound or CT G-PCNB was based on the ease of access to the lesion by the operator consultant radiologist. Biopsies of superficial and as such easily accessible lesions were performed using ultrasound, and biopsies of deeper less accessible lesions were performed with CT guidance.

All PCNB specimens were examined by the same consultant histopathologist with special interest in musculoskeletal oncology.

PCNB histological results were classified into three categories according to their quality as previously reported (*18*). In Category 1, a definitive diagnosis could be made out of the biopsy specimen using various immunohistochemical techniques as required. In Category 2, a narrow differential diagnosis could be suggested that still allowed correct surgical management. In Category 3, the material obtained was insufficient to allow histological evaluation (*18*).

### Statistics

When PCNB was compared to the SEB we used the following definitions to evaluate diagnostic accuracy : 1) a true-positive result in which the PCNB provided lesional tissue and a correct diagnosis ; 2) a true-negative result in which the PCNB produced no lesional tissue and no tumour was present ; 3) a false-positive result was when the PCNB provided lesional tissue which was diagnosed as a tumour when no tumour was present ; and 4) a false-negative result in which the PCNB produced no lesional tissue, but tumour was present ; or there was a mismatch in diagnosis between PCNB and the surgical histology.

Chi square test was used for the statistical analysis and $p < 0.05$ was considered significant.

## RESULTS

In the G-PCNB group there were 37 male and 28 female patients with a median age of 56 years (range : 15-76 years). In the B-PCNB group, there were 27 male and 19 female patients with a median age of 58 years (range : 14-81). There were no significance differences in patients demographic between the two biopsy groups. Patients with relatively large, palpable and superficially sited tumours (diameter 3 cm or greater or extending to subcutaneous tissue) underwent B-PCNB, while those with deep sited and smaller in size tumours (diameter less than 3 cm or those deeper and without extension to subcutaneous tissue) were referred for G-PCNB.The anatomical location of the tumours per biopsy group is presented in table I. Overall for the 111 patients who underwent both PCNB (B-PCNB or G-PCNB) and SEB we found 73 malignant and 38 benign tumours (table II).

Looking at the diagnostic categories between the two groups we found no statistically significant

Table I. — Lesion sites

| Site | Blind | Image |
|---|---|---|
| Chest wall & Axilla | 2 | 1 |
| Shoulder & Upper arm | 8 | 13 |
| Elbow & Forearm | 3 | 4 |
| Hand | 0 | 1 |
| Thigh, groin, gluteal region | 23 | 31 |
| Knee & lower leg | 4 | 12 |
| Foot & ankle | 5 | 3 |
| Low back | 1 | 0 |
| Total | 46 | 65 |

Table II. — Final diagnoses

| Final Diagnosis | Blind | Image |
|---|---|---|
| Malignant | | |
| Myxofibrosarcoma | 1 | 1 |
| MFH | 6 | 8 |
| Leiomyosarcoma | 4 | 4 |
| Liposarcoma | 10 | 10 |
| Synovial sarcoma | 4 | 7 |
| High grade sarcoma | 6 | 3 |
| Rhabdomyosarcoma | 1 | 0 |
| Clear cell sarcoma | 1 | 0 |
| Spindle cell sarcoma | 1 | 3 |
| Round cell sarcoma | 1 | 0 |
| Alveolar soft part sarcoma | 0 | 1 |
| Non-Hodgkin lymphoma | 1 | 0 |
| Total | 36 | 37 |
| Benign | | |
| Fibromatosis | 1 | 5 |
| Lipoma | 4 | 5 |
| Haemangioma | 1 | 6 |
| Schwannoma | 1 | 2 |
| PVNS | 1 | 1 |
| Myxoma | 0 | 1 |
| Elastofibroma | 0 | 1 |
| Neurofibroma | 1 | 5 |
| Gossypiboma | 0 | 1 |
| TB (cold abscess) | 0 | 1 |
| Hibernoma | 1 | 0 |
| Total | 10 | 28 |

MFH = Malignant Fibrous Histiocytoma
PVNS = Pigmented Villonodular Synovitis
TB = Tuberculosis.

Table III. — Diagnostic categories

| Type of biopsy | Diagnostic category | | | |
|---|---|---|---|---|
| | 1<br>Definitive diagnosis could be made | 2<br>A narrow differential diagnosis could be suggested | 3<br>Insufficient material was obtained to allow a histological diagnosis | Total |
| Blind PCNB<br>Guided PCNB | 31 (67%)<br>53 (81%) | 9 (19%)<br>12 (19%) | 6 (14%)*<br>0 (0%)* | 46<br>65 |
| Total | 84 | 21 | 6 | 111 |

PCNB = percutaneous core needle biopsy

* $p < 0.01$ ; significant difference between the two groups in category 3.

Table IV. — Details of the six category 3 patients with blind PCNB

| Mass Site | Blind PCNB Report | Final Surgical Diagnosis |
|---|---|---|
| Calf | Inconclusive | Haemangioma |
| Groin | Inconclusive because of necrosis | High grade pleomorphic sarcoma |
| Groin | Insufficient material | Non-Hodgkin B cell lymphoma |
| Thigh | Inconclusive | Liposarcoma |
| Thigh | Fatty tissue and inconclusive | Liposarcoma |
| Forearm | Insufficient material | Lipoma |

PCNB = percutaneous core needle biopsy.

Table V. — Diagnostic accuracy of blind PCNB versus guided PCNB

| Type of Biopsy | Diagnostic Accuracy | | | | | |
|---|---|---|---|---|---|---|
| | True-positive | True-negative | False-positive | False-negative | Total | Diagnostic accuracy (percent) |
| Blind<br>Guided | 36<br>62 | 0<br>0 | 2<br>0 | 8<br>3 | 46<br>65 | 78.26<br>95.38 |
| Total | 98 | 0 | 2 | 11 | 111 | 88.29 |

PCNB = percutaneous core needle biopsy.

difference between G-PCNB and B-PCNB for category 1 ($p \leq 0.1$, df = 1) and 2 ($p \leq 1$, df = 1), difference however was found in category 3 ($p \leq 0.01$, df = 1) (table III). In category 3, 14% (6 out of 46 patients) of the B-PCNB group failed to provide adequate material for histological diagnosis (table III). Four (4) out of the later 6 patients had a malignant lesion eventually diagnosed by the SEB (table IV). No G-PCNB (0%) was classified as category 3 (table III).

The overall diagnostic accuracy of G-PCNB (95%) was significantly greater in comparison to that of B-PCNB (78%) ($p \leq 0.025$, df = 2) as it was also for the true positive ($p \leq 0.01$, df = 1) and the false negative ($p \leq 0.05$, df = 1) results. Contrary, for the false positive results the difference between the two groups was not significant ($p \leq 0.1$, df = 1) (table V). In all three false negative patients who had G-PCNB, there was a mismatch between G-PCNB and SEB diagnosis. It is important to note however that G-PCNB provided the diagnosis of malignant tumour, but the tumour histology was different in the SEB (table VI). These results illustrate an improved accuracy with image guidance

Table VI. — Details of the three false-negative patients with guided PCNB

| Mass Site | Guided PCNB Report | Final Surgical Diagnosis |
|---|---|---|
| Thigh | Low grade MFH | Intramuscular fibrosarcoma |
| Groin | Spindle cell sarcoma | MFH |
| Shoulder | Liposarcoma | Synovial sarcoma |

PCNB = percutaneous core needle biopsy ; MFH = malignant fibrous histiocytoma.

even though the lesions were more likely to be deeper and therefore technically more difficult to biopsy.

## DISCUSSION

The aim of this study was to investigate whether image guidance improves the accuracy of PCNB for the histological diagnosis of soft tissue tumours. G-PCNB provided significantly ($p \leq 0.025$) greater diagnostic accuracy in comparison to B-PCNB. Furthermore no G-PCNB failed to provide adequate material for histological diagnosis (category 3) (table III) and in the 3 false negative diagnostic cases with G-PCNB, there was a failure to provide the accurate histology of the lesion however the correct diagnosis of malignant disease was provided (table VI). On the other hand B-PCNB not only failed to provide with adequate material for histological diagnosis (category 3) in the 14% of the cases (table III) but also in one patient with liposarcoma, provided the wrong diagnosis of lipoma (case 5 table IV). In addition B-PCNB provided with 8 false negative results

Our results are in agreement with the current published literature. Our accuracy for blind PCNB was comparable to previous studies (*5,6,8,10,17*). Skrzynski *et al* reported a diagnostic accuracy of 78% for unguided core needle biopsy in 45 patients with soft tissue tumours (*17*). Heslin *et al* studied 60 patients with soft tissue masses and reported an accuracy of 70%, and Madhavan *et al* reported diagnostic accuracy of 94% in 24 patients with malignant soft tissue tumours (*5,8*). Hoeber *et al* also demonstrated that tumour subtype and grade could be accurately predicted in 80% of patients using PCNB (*6*). In Mankin *et al*'s multicenter survey the accuracy of PCNB was 69% (*10*). In studies of image guided PCNB the reported diagnostic accuracy was 74-98% (*2,4,7,8,12,15,19*). We found a 95% accuracy using guided PCNB. This is higher than many other studies, but our patient sample was also larger. Furthermore this study compares the two techniques in the same clinical setting as all biopsies, histological and radiological evaluations were provided by the same group of investigators. All operators were highly specialized in musculoskeletal oncology.

On the other hand one of the main limitations of this study is that it is a non-randomized case control study. As a result, one could argue that the difference in accuracy between the two techniques may not be as a result of an intrinsic problem with the blind technique but due to bias that may occur as result of not randomizing the patients. It is however, important to mention that allocation of patients in each group was based on location and size of the tumour. Patients with relatively large, palpable and superficially sited tumours underwent B-PCNB, while those with deep sited and smaller in size tumours were referred for G-PCNB. Patient allocation in the two study groups would consequently favor B-PCNB for diagnostic accuracy, as the latter biopsies would probably have been technically easier for the operator who had to perform a biopsy of large, superficially sited tumours. B-PCNB however proved to provide less accurate histological diagnosis in comparison to G-PCNB performed in less palpable and less sizeable, deeper sited lesions, allowing us to assume that bias introduced by the selection criteria did not influence the study outcome in a great extent. Furthermore bias may have also been introduced as biopsies were performed by different operators (B-PCNB by surgeons and G-PCNB by radiologists) having different level of experience. All operators however, were highly

specialized in musculoskeletal oncology, allowing little room for differential experience to be suspected.

Overall failure to obtain sufficient biopsy material for histological diagnosis (category 3) using B-PCNB may also been attributed to the operator's failure to avoid areas of tumour necrosis or areas of low grade tumour. Magnetic resonance imaging is essential before biopsy to identify the latter areas. These areas cannot be adequately identified by palpation during a B-PCNB. The latter observation reinforces the outcome of our study. An experienced musculoskeletal radiologist could selectively biopsy areas of high grade tumour, identified on MRI and subsequently viewed using ultrasound or CT scan guidance.

## CONCLUSIONS

We found that PCNB is an effective technique in the management of soft tissue tumours. However, its accuracy can be improved when performed with image guidance.

## REFERENCES


1. **Damron TA, Beauchamp CP, Rougraff BT, Ward WG.** Soft tissue lumps and bumps. *J Bone Joint Surg* 2003 ; 85-A : 1142-1155.
2. **Dupuy DE, Rosenberg AE, Punyaratabandhu T, Tan MH, Mankin HJ.** Accuracy of CT-guided needle biopsy of musculoskeletal neoplasms. *Am J Roentgenol* 1998 ; 171 : 759-762.
3. **Giuliano AE, Eilber FR.** The rationale for unplanned reoperation after unplanned total excision of soft tissue sarcomas. *J Clin Oncol* 1985 ; 3 :1344-1348.
4. **Hau A, Kim I, Kattapuram S, Hornicek FJ *et al.*** Accuracy of CT-guided biopsies in 359 patients with musculoskeletal lesions. *Skeletal Radiol* 2002 ; 31 : 349-353.
5. **Heslin MJ, Lewis JJ, Woodruff JM, Brennan MF.** Core needle biopsy for diagnosis of extremity soft tissue sarcoma. *Ann Surg Oncol* 1997 ; 4 : 425-431.
6. **Hoeber I, Spillane AJ, Fisher C, Thomas JM.** Accuracy of biopsy techniques for limb and limb girdle soft tissue tumours. *Ann Surg Oncol* 2001 ; 8 : 80-87.
7. **Issakov J, Flusser G, Kollender Y *et al.*** Computed tomography-guided core needle biopsy for bone and soft tissue tumours. *Isr Med Assoc J* 2003 ; 5 : 28-30.
8. **Madhavan VP, Robinson Smile S *et al.*** Value of core needle biopsy in the diagnosis of soft tissue tumours. *Indian J Pathol Microbiol* 2002 ; 45 : 165-168.
9. **Mankin HJ, Lange TA, Spanier SS.** The hazard of biopsy in patients with malignant primary bone and soft tissue tumours. *J Bone Joint Surg* 1982 ; 64-A : 1121-1127.
10. **Mankin HJ, Mankin JC, Simon MA.** The hazards of the biopsy revisited. *J Bone Joint Surg* 1996 ; 78-A : 656-663.
11. **Noria S, Davis A, Kandel R *et al.*** Residual disease following unplanned excision of a soft tissue sarcoma of an extremity. *J Bone Joint Surg* 1996 ; 78-A : 650-655.
12. **Parkkola RK, Mattila KT, Heikkila JT *et al.*** MR-guided core biopsies of soft tissue tumours on an open 0.23 T imager. *Acta Radiol* 2001 ; 42 : 302-305.
13. **Ray-Coquard I, Ranchere-Vince D, Thiesse P *et al.*** Evaluation of core needle biopsy as a substitute to open biopsy in the diagnosis of soft-tissue masses. *Eur J Cancer* 2003 ; 39 : 2021-2025.
14. **Saifuddin A, Mitchell R, Burnett SJD, Sandison A, Pringle JAS.** Ultrasound-guided needle biopsy of primary bone tumours. *J Bone Joint Surg* 2000 ; 82-B : 50-54.
15. **Serpell JW, Fish SH, Fisher C, Thomas JM.** The diagnosis of soft tissue tumours. *Ann R Coll Surg Engl* 1992 ; 74 : 277-280.
16. **Simon MA, Finn HA.** Diagnostic strategy for bone and soft tissue tumours. *J Bone Joint Surg* 1993 ; 75-A : 622-631.
17. **Skrzynski MC, Biermann JS, Montag A, Simon MA.** Diagnostic accuracy and charge-savings of outpatient core needle biopsy compared with open biopsy of musculoskeletal tumours. *J Bone Joint Surg* 1996 ; 78-A : 644-649.
18. **Torriani M, Etchebehere M, Amstaldon E.** Sonographically guided core needle biopsy of bone and soft tissue tumours. *J Ultrasound Med* 2002 ; 21 : 275-281.
19. **Yao L, Nelson SC, Seeger LL, Eckardt JJ, Eilber FR.** Primary musculoskeletal neoplasm : effectiveness core-needle biopsy. *Radiology* 1999 ; 21 : 682-686.