Ultrasound-guided needle biopsy of primary bone tumours
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Needle biopsy is an established technique for the histological diagnosis of bone tumours, usually guided by fluoroscopy or CT. Surface lesions and aggressive tumours which have extended through the cortex are also amenable to imaging with ultrasound (US). We have assessed the diagnostic accuracy of US-guided Trucut needle biopsy in a consecutive series of patients referred to a Bone Tumour Unit with suspected primary bone tumours. Of 144 patients (83 men, 61 women; mean age 34.7 years) referred over a period of two years, 63 were considered suitable for US-guided biopsy. This was based on the presence of a relatively large extraosseous component, seen typically in osteosarcoma and malignant round-cell tumours. The results of needle biopsy were compared with those of surgical biopsy. The diagnostic accuracy was 98.4%, with only a single failed biopsy.

Thus, in a selected group of patients, US is a very reliable technique of guidance for percutaneous needle biopsy of bone tumours.

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Patients and Methods

Between November 1995 and November 1997, a record was kept of all patients who had needle biopsies after referral by the surgeons of the London Bone and Soft-tissue Tumour Unit. There were 144 patients (83 men, 61 women) with a mean age of 34.7 years (2 to 81 years) and all had a suspected primary bone tumour of the appendicular skeleton, pelvis or sacrum. Before biopsy, they had plain radiography and MRI of the lesion (Fig. 1). Based on these results a decision was made by the radiologist to biopsy the lesion using either fluoroscopic, CT or US guidance (Fig. 2). Those lesions which showed a relatively large extraosseous component (>2.0 cm in depth) were biopsied under US guidance using either a 14G Trucut needle (Baxter Healthcare Co, Deerfield, Illinois) or a 14G Temno needle (Allegiance Healthcare Co, McGaw Park, Illinois). Those which were purely intramedullary or demonstrated a relatively small extraosseous component were biopsied using fluoroscopic guidance with a 14G Jamshidi needle (Baxter Healthcare Co). CT with either a Trucut or a Jamshidi needle was used for those which could not be easily localised using fluoroscopy or in which the major extraosseous component was in a difficult site for US guidance. Since the aim of the study was to determine when US could appropriately replace fluoroscopy as a guidance technique, the 29 patients biopsied using CT were not considered further. All biopsies were made through a small stab incision. This left a scar which allowed identification of the site for excision of the biopsy track at the time of definitive surgery.

Patients over the age of 16 years had local anaesthesia (3 to 5 ml 1% lignocaine) to the skin and subcutaneous tissues. All adults were treated as outpatients, unless they had been admitted for other reasons. The 35 patients aged under 16 years were admitted as day cases and biopsied under general anaesthesia. Between two and four passes were made depending on the quality of the specimens obtained.
This allowed sufficient tissue for any special techniques required by the pathologist. All biopsies were carried out by one of two consultant radiologists (AS and RM) or, in a few patients, by a radiology trainee under direct supervision of the consultant.

The unfixed samples were taken direct to the Department of Histopathology for imprint cytology. This has several advantages in that it gives a rapid assessment of the presence of sufficient viable tissue, and in most cases, can immediately distinguish between benign and malignant lesions. With the latter it can differentiate between primary tumours, metastases and myeloma. The use of an alkaline phosphatase stain allows a diagnosis of osteosarcoma to be made when little or no tumour osteoid is present in the sample. Stored imprints can be used for more sophisticated techniques including cytogenetics.

The results were divided into three categories. In category 1 a definitive diagnosis could be made using various immunohistochemical techniques as required. In category 2 a narrow differential diagnosis could be suggested which still allowed correct surgical management as in a benign osteoclast-containing lesion in which the differential diagnosis is between a benign fibrous histiocytoma, a solid aneurysmal bone cyst or a giant-cell tumour. Such lesions could be adequately managed by curettage with or without bone grafting or the insertion of cement into the surgical defect. In category 3 insufficient material was obtained to allow a histological diagnosis. The results of needle biopsy from patients who had been treated by surgery were...
compared with the final histological findings from tissue obtained at operation.

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

Results

Based on the features seen on imaging, 63 lesions were considered suitable for US-guided biopsy and 81 for biopsy under fluoroscopic guidance. Table I lists the sites of the lesions. Table II gives the histological diagnoses based on needle biopsy and Table III shows the breakdown of the histological findings into the different diagnostic categories as differentiated by the guidance technique. Table IV summarises the diagnostic errors for those results of needle biopsy which were compared with the surgical histological findings. In seven cases, no diagnosis could be made on specimens from needle biopsy (category 3). Four of these proved to be cysts (2 aneurysmal bone cysts, 1 simple bone cyst and 1 subchondral cyst associated with osteoarthritis). Giant-cell tumour and osteoblastoma accounted for two other cases while one patient with ‘failed’ US-guided needle biopsy of a lytic lesion in the femur went on to have CT-guided needle biopsy. This also showed no diagnostic tissue and open biopsy was then undertaken which did not demonstrate tumour. The lesion was thought to represent a renal metastasis which had undergone spontaneous necrosis. All biopsy diagnoses in category 2 were confirmed on examination of the surgical specimens. In no case did needle biopsy diagnose a benign lesion which proved to be malignant. In two cases, a low-grade malignant tumour was diagnosed on needle biopsy, but examination of the surgical specimen revealed a benign lesion. The diagnostic accuracy of needle biopsy is presented in Table V.

Discussion

Biopsy is an essential investigation for all suspected primary bone tumours after local staging. It may be carried out either as an open operation or as a closed percutaneous procedure by an orthopaedic surgeon or a radiologist. It must, however, be undertaken in the centre where the definitive management of the patient will take place. A biopsy which has been inadequately obtained remains the commonest reason for inability to perform limb-salvage surgery. The major advantage of open biopsy is that a large amount of tissue can be obtained. Without radiological...
guidance, however, it is possible that this tissue may be either mainly necrotic or from a low-grade area of a lesion which has undergone dedifferentiation. Other disadvantages of open biopsy include the need for general anaesthesia and increased cost compared with needle biopsy which is carried out as an outpatient procedure under local anaesthesia. It is also associated with a higher rate of complications. Percutaneous needle biopsy has been criticised because of the small amounts of tissue obtained, which, it is suggested, may result in sampling errors. The combination, however, of a needle biopsy and sections of good quality, reliable immunohistochemistry and pathologists experienced in making diagnoses from specimens of needle biopsy can result in a diagnostic accuracy as high as 97%. Proper placement of the biopsy allows the track to be excised at the time of surgery. Needle biopsy also preserves the periosteum and is made through a small stab incision which leaves a scar visible to the surgeon at the time of surgery. This allows identification of the biopsy site.

Previous studies of percutaneous needle biopsy of primary and metastatic bone tumours have emphasised the value of fluoroscopy and CT as guidance techniques. Skrzynski et al obtained a diagnostic accuracy of 84% in outpatients with soft-tissue lesions or bone tumours with a palpable extraosseous mass. Trucut needle biopsy was guided by palpation alone. Possible reasons considered for a failed biopsy included a sampling error, necrosis of the central tumour and a geographical miss. The value of US guidance for Trucut biopsy of certain types of primary soft-tissue tumour has been well recorded, and the extension of this technique to primary bone tumours with a relatively large extraosseous tumour mass, is logical. Most primary bone tumours arise adjacent to a major joint and any extraosseous component will be separated from the skin by periosteum, muscle and subcutaneous fat. This distance is usually between 1 and 2 cm allowing most malignant tumours to be imaged well with US. The areas of tumour necrosis are clearly visualised and the additional use of colour Doppler will identify regions of neovascularity in the tumour, which are areas of viable tissue as opposed to those of solid necrosis. In the case of relatively hypovascular tumours, such as malignant round-cell tumours and the cartilage cap of peripheral chondrosarcomas, biopsy from the margin of the lesion will increase the likelihood of obtaining a diagnostic sample. With such a technique, infiltration of adjacent skeletal muscle can also be identified. A major advantage of US is the lack of risk from ionising radiation to both the patient and staff. It is also quick and relatively cheap.

Our study has shown that most aggressive malignant bone tumours, particularly osteosarcoma and malignant round-cell tumours, can easily be biopsied using US guidance since they are typically associated with a relatively large extraosseous mass at the time of presentation. All needle biopsies from these two groups of tumours gave a correct diagnosis. Only two US-guided biopsies were classified as category 3, and as mentioned earlier, one of these was a true-negative result for the presence of viable tumour. The other was a giant-cell tumour with a relatively small extraosseous component. Biopsy of this region revealed only inflammatory tissue. US guidance was associated with a diagnostic accuracy of over 98%.

Comparison of the results of needle biopsy with surgical histology showed a diagnostic mismatch in six cases. These were all fluoroscopically-guided biopsies, the details of which are shown in Table IV. Although classed as false-negative results, only one of the misdiagnoses resulted in incorrect surgical management. Four of the biopsies which revealed no diagnostic tissue were from cysts. The difficulty in biopsy of such lesions has been previously documented. A single fluoroscopically-guided biopsy was classed as a false-positive result. This lesion arose in the scapula and needle biopsy revealed a large number of atypical lymphocytes raising the possibility of non-Hodgkin lymphoma. Special stains did not support this diagnosis and the patient was referred for open biopsy. Based on this, a diagnosis of chronic necrotising granuloma was made. Thus the needle biopsy result was not associated with an incorrect management decision.
Our experience indicates that in carefully selected cases, US is a highly reliable alternative to fluoroscopy as a guidance technique for percutaneous needle biopsy of suspected bone tumours arising outside the spine. The lack of risk of ionising radiation is a major advantage to both patients and staff.

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References


