Computed Tomography-Guided Core Needle Biopsy for Bone and Soft Tissue Tumors

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Abstract

Background: Imaging-guided core needle biopsy is a well-established technique for the diagnosis of bone and soft tissue tumors and tumor-like lesions in specialized orthopedic oncology centers.

Objective: To present our results of computed tomography-guided core needle biopsy with assessment of the accuracy of the technique.

Methods: Between July 1998 and October 2000, 215 CT-guided core needle biopies were performed and histologically examined in the Unit of Bone and Soft Tissue Pathology, Tel Aviv Sourasky Medical Center. There were 80 soft tissue and 135 bony lesions. All biopsies were performed by the same radiologist and the histologic examination by the same pathologist. To assess the accuracy of the procedure, we compared the diagnosis at biopsy with the diagnosis after definitive surgery (when available).

Results: Bone core needle biopsy (n = 135) showed malignancy in 89 cases (primary or recurrent bone sarcoma, lymphoma, myeloma, metastatic carcinoma or melanoma). There were 29 benign lesions. In 17 cases the result was inconclusive and an open incisional biopsy was performed. Of the 80 soft tissue biopsies, 35 were malignant (25 soft tissue sarcomas, 6 lymphomas, 4 metastatic carcinomas); 40 were benign (myositis ossificans, neurofibroma, desmoid tumor, schwannoma, hematoma and others), and 5 were inconclusive and followed by an open incisional biopsy. The core needle biopsy histologic diagnosis was compared with that of the definitive surgery and the diagnostic accuracy was 90%. Only three samples initially diagnosed as benign turned out to be malignant. No significant complications occurred during the procedures.

Conclusions: CT-guided CNB of musculoskeletal lesions is a safe and effective procedure that assures sufficient and proper material for histologic examination. The accuracy of this method in our center was 90%. Tumor sampling is extremely important, especially in soft tissue sarcomas, and cores should be taken in different directions, including areas of necrosis. The processing is quick, especially for bone CNB, and diagnosis can be achieved within 24 hours. The material undergoes excellent fixation and the immunostains are reliable.

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Open incisional biopsy was traditionally the method of choice for diagnosing tumors and tumor-like lesions of the musculoskeletal system [1]. It usually requires hospitalization of 48–72 hours, an operating room (time and crew) and general anesthesia [1,2]. While OIB is still considered the gold standard because of its accuracy (close to 100%), it is associated with several drawbacks, including morbidity and surgical complications, the risk of tumor contamination of surrounding normal soft tissues (an important issue for future limb-sparing surgery), and high cost [1,3]. The development of imaging-guided biopsies for musculoskeletal lesions (computed tomography, ultrasound, and fluoroscopy) has mostly overcome these disadvantages. It is especially suitable for sites that are deep or difficult to reach such as the spine, and it avoids major vessels or nerves [4–6].

CNB = core needle biopsy
OIB = open incisional biopsy

Materials and Methods

Between July 1998 and October 2000, 215 CT-guided core needle biopsies of 135 bone and 80 soft tissue lesions were performed and histologically examined in the Unit of Bone and Soft Tissue Pathology at our center. The same radiologist (G.F.) performed all the biopsies and the same pathologist (J.I.) interpreted the samples. The age range of the patients was 14–86 years and the male/female ratio 131/84. Almost all the patients were ambulatory, except for those whose general condition necessitated hospitalization and/or some kind of anesthesia. All patients underwent CNB after protocol staging studies, which included plain X-ray films, CT and/or magnetic resonance imaging of the affected area, and bone scan.

All available imaging studies are reviewed prior to the biopsy. A surgeon from the orthopedic-oncology team is frequently present during the procedure. The site of biopsy and the needle course are discussed to avoid possible contamination of future operative fields, which complicates future surgery.

Technique

For soft tissue and lytic bone lesions (where cortex is destroyed) we used a 14-18 gauge Tru-cut spring loaded biopsy needle (Finecore, Tokyo, Japan), and for bone or heavily calcified lesions, a 11-14Ga Jamshidi type bone needle (Manan, USA). A coaxial technique may be applied when a lytic lesion is located beneath intact cortex, using a bone needle to traverse the cortex, followed by a tru-cut needle. Several cores of tissue were taken, preferably from different sites within the lesion to ensure adequate sampling (3–6 bone cores, 5–10 soft tissue cores). The material was sent in formalin to the pathology laboratory. In some cases (in the presence of suspected inflammatory process, effusions or cystic lesions, or suspected sarcoma), material for cytologic, cytogenetic and

Table 1. Location of bone lesions (n = 135)

Pelvis	40
Femur	17
Spine	16
Tibia	12
Sacrum	12
Humerus	8
Radius	4
Ribs/clavicle	4
Scapula	3
Hand/foot	2
Patella	1
Other	16

Table 2. Location of soft tissue lesions (n = 80)

Lower extremity	29
Pelvic region	16
Upper extremity	9
Other	26

Table 3. Diagnosis of bone lesions

Metastasis	43
Lymphoma	16
Myeloma	11
Sarcoma, recurrent	7
Metastatic melanoma	5
Sarcoma	4
Chordoma	3
Giant cell tumor	3
Paget	3
Osteomyelitis	3
Fibrous dysplasia	2
Hemangioma	2
Enchondroma	1
Adamantinoma	1
Inconclusive	17
Other	14

Table 4. Diagnosis of soft tissue lesions

Sarcoma	25
Desmoid	6
Lymphoma	6
Schwannoma/neurofibroma	5
Metastasis	4
Pigmented villonodular synovitis	2
Myositis ossificans	2
Nodular fasciitis	2
Elastofibroma	2
Hemangioma	2
Other diagnosis	19
Insufficient	5

microbiologic studies was also taken. After the biopsy, patients were monitored hemodynamically for about an hour, and discharged with instructions regarding possible pain and complications. The total procedure time was 30–40 minutes.

Results

Bone lesions

The skeletal location of the bone lesions is shown in Table 1. The bone CNB showed malignancy in 89 cases, namely primary or recurrent bone sarcoma, lymphoma, myeloma and metastatic carcinoma or melanoma (Table 2). The benign lesions turned out to be chronic osteomyelitis, fibrous dysplasia, chondroblastoma, osteoid osteoma, and others.

The pathology results of 17 of the 135 bone biopsies were inconclusive or insufficient, giving a success rate of 87.4%. Biopsies were considered inconclusive or insufficient when neoplastic cells were lacking and where neoplastic tissue was present, but the pathologist could not reach a definitive diagnosis. For biopsies that were inconclusive or insufficient an OIB was recommended. The rate of insufficient or inconclusive biopsies was relatively high during the first 6 months of performing the procedures, after which it decreased as the radiologist gained more experience.

The repeated biopsy, almost always an OIB, of some of the inconclusive material revealed one case of fibrous dysplasia, one case of simple bone cyst, and two with post-irradiation osteosarcoma. In one case the CNB revealed evidence of a small, blue, round cell tumor, but as the material was insufficient for a definitive diagnosis an OIB was performed and an adamantinoma was diagnosed. In another case the diagnosis on CNB was suggestive for osteoblastoma, but the OIB showed an osteosarcoma. The other cases were followed clinically.

Soft tissue lesions

The location of soft tissue lesions is shown in Table 3 and their diagnoses in Table 4. The success rate for soft tissue lesions was 93.8%. The benign lesions were neurofibroma, myositis ossificans, desmoid, schwannoma, hematoma, etc. Thirty-five of the soft tissue lesions were malignant (25 sarcomas, 6 lymphomas, and 4 were metastatic carcinoma).

Of the five inconclusive or insufficient soft tissue biopsies, three were cystic or vascular benign lesions (hemangioma or cyst) and two were non-diagnostic (the OIB showed a myxofibrosarcoma and an epithelioid sarcoma).

Repeat biopsies

Some patients underwent repeat biopsies with either CT guidance or OIB. One case appeared more aggressive on follow-up and the repeated CT-guided biopsy and subsequent OIB showed an epithelioid hemangioendothelioma instead of epithelioid hemangioma. A lesion diagnosed as neurofibroma on CNB was found to be a malignant peripheral nerve sheath tumor on open excision, and another case initially diagnosed as MPNST versus melanoma on CNB was changed to anaplastic lymphoma (S100 positive). The complication rate was very low. Three patients had a local hematoma that resolved spontaneously.

Discussion

Percutaneous CT-guided core needle biopsy of bone and soft tissue lesions has become the method of choice for obtaining tissue for diagnosis in musculoskeletal tumors and tumor-like lesions. It is a reliable, accurate and economic method with low morbidity and few complications. The reported accuracy rate is variable, ranging between 61 and 96% according to different series [6–9].

The reason for an unsuccessful CNB is small sample size, failure to reach the exact lesion site, and sampling error. Our overall success rate of 90% accuracy is comparable to other quoted series [6–9]. Diagnostic accuracy in this context means the percent of correlation between the diagnosis on CNB and the definitive specimen.

One of the questions that invariably arises with an unsuccessful biopsy is: when should a repeat biopsy be performed? Whenever the pathologist's answer is inconclusive or insufficient – which means a discrepancy between the clinical-radiologic impression and the histologic picture – a repeat biopsy should be done.

MPNST = malignant peripheral nerve sheath tumor

The referring physician should be consulted whether to perform an OIB or a repeat CT-guided biopsy.

The advantages of CT-guided CNB are cost-effectiveness, low complication rate and low morbidity [1,3]. From a pathologic point of view CNB is recommended because it provides adequate tissue for diagnosis, enables a quick and excellent fixation of the material, the processing is quick (less than 24 hours), the immunostain results are excellent, and even the polymerase chain reaction technique can be used in cases with lymphoma. The main drawbacks are a non-diagnostic biopsy, sampling error, and potential error in diagnosis and sarcoma grading. Since sarcomas are usually heterogeneous, sampling error may occur. For this reason obtaining multiple cores from different areas in the lesion is essential. When dealing with tumors containing necrotic areas, care should be taken to sample a solid portion of the tumor where viable tissue is present. Cystic lesions usually yield fluid only, while vascular ones yield blood, both of which are non-specific. It may be difficult to sample enough material from the lesion wall to ensure correct diagnosis. Some of our inconclusive results were of material taken from such lesions (cysts or lesions of vascular origin).

Cartilaginous lesions may also pose a diagnostic difficulty. Pathologic differentiation between benign enchondroma and well-differentiated chondrosarcoma is often difficult, even in OIB. Thus enchondroma, when diagnosed, should be followed closely and an OIB considered. Another disadvantage of the CNB is that the material may be insufficient for other examinations such as electron microscopy, cytogenetics and tissue banking.

Some types of tumors are under-represented in our series. Tumors that appeared benign radiologically and clinically, such as aneurysmal bone cyst, giant cell tumor and osteochondroma, were usually excised completely without prior biopsy. Primary malignant bone tumors, such as osteosarcoma and Ewing's sarcoma, occur primarily in young children, thus general anesthesia is essential, and biopsy is usually performed in the operating room in our institute.

Conclusion

CT-guided biopsy of bone and soft tissue lesions is currently the procedure of choice in specialized orthopedic oncology centers. There is a low complication rate, low cost, and reasonably high accuracy. Team work, including an experienced radiologist, consultation with the referring orthopedic-oncologist and skilled pathologist able to handle the relatively small samples, are essential for creating a successful system.

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