Image-Guided Musculoskeletal Biopsy

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- Orthopedic imaging

Sampling of bone and marrow for analysis has been recognized for millennia;[1] however, image-guided bone biopsy is a relatively recent development. Since the description of percutaneous biopsy for diagnosis of skeletal lesions by Coley in 1931,[2,3] and fluoroscopic-guided procedures by Lalli in 1970,[3,4] image-guided bone biopsy has developed significantly, led by innovations in imaging and intervention. It has become an essential part of managing musculoskeletal lesions, including primary and secondary bone tumors[5,6] and infections.[7,8]

Although early reports dismissed minimally invasive bone biopsy only as a "simple, primary diagnostic procedure" with significant inconclusive or misleading results,[9,10] later reports increasingly recognized their low morbidity, lower cost (compared with open biopsy),[11] high accuracy, and repeatability in the event of an inconclusive result.[3,5,12–27] This has led to greater importance of image-guided bone biopsy, which has replaced open surgical biopsy in many instances. The advantages of the procedure even have translated to veterinary applications.[28,29] The accurate characterization based on the small tissue samples obtained is often challenging, however.[30–36]

Image guidance allows safe passage of needles, often into small and otherwise inaccessible lesions, and into the portions of the lesion most likely to yield useful samples, while avoiding damage to important structures. This article hopes to provide a useful guide to image-guided musculoskeletal biopsy for radiologists in practice and in training.

PREPARATION

Why Must One Perform This Biopsy?

The presence of a bony or soft tissue lesion does not automatically imply the need for histology. Clinical information, laboratory findings, and imaging features may be sufficient to provide high diagnostic confidence for certain lesions, allowing for a conservative management or therapeutic trial. In addition, a clearly benign lesion for which therapy is not indicated does not require biopsy. A range of benign bone lesions has been described in the literature and familiarity with these may help avoid an unnecessary biopsy.[37–41] The history, physical examination, and laboratory and imaging findings for each patient should be reviewed thoroughly and the case discussed with the referring clinicians. The indication and approach to image-guided biopsy must be tailored for each patient.

Indications and Contraindications

The recognized indications and contraindications for biopsies in general are outlined in **Box 1**.[42–44]

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Box 1
Indications and contraindications for musculoskeletal biopsy

Indications

Determination of the nature of a solitary bone or soft tissue lesion with nonspecific imaging findings

Confirm or exclude musculoskeletal metastasis in a patient who has a known primary tumor

Exclude malignancy in vertebral body compression, particularly metastases or myeloma.

Evaluation for tumor recurrence

To investigate and confirm diagnosis of musculoskeletal infection and to obtain sample of organism

To investigate cause of a pathologic fracture

Contraindications

Bleeding diathesis

Decreased platelet count

Suspected hypervascular lesion in the thoracic or cervical vertebra.

Infected soft tissues surrounding a bone lesion suspected to be noninfective in nature

Uncooperative patient

Inaccessible sites

These should be considered carefully in reference to each patient. The most common indications for bone biopsies are tumor and infection. For known primary tumors, biopsy may be indicated for solitary bone lesions if identification of the bone lesion will influence therapy. For example, in a patient who has known colon carcinoma and extensive liver and lung metastases, finding multiple new vertebral osteolytic lesions clearly does not need biopsy of these vertebral lesions, as it will not alter the patient's management. In contrast, a patient who has a known colon carcinoma with no solid organ metastases and a single vertebral osteolytic lesion may be considered for vertebral biopsy, because the outcome will affect the stage of tumor and subsequent management.

Patients with tumors in remission after treatment who subsequently present with a new bone lesion may need biopsy. For known, radiographically stable, bone metastases, biopsy may be needed to determine tumor viability, especially if scintigraphic studies (eg, fluorodeoxyglucose [FDG] positron emission tomography [PET]) are equivocal. Often, biopsy may be the only method of exclusion of sinister solitary bone lesions in the absence of classic benign features, especially when the history is suggestive.[41] Primary musculoskeletal tumors require identification, grading, and often cytogenetic analysis, for prognosis and treatment. Even in definite bone metastases, biopsy may be useful for identifying a primary lesion when this is not apparent. Tumor markers are recognized to be unhelpful in identifying an unknown primary lesion, except for possibly prostate-specific antigen (PSA).[45]

Early stages of spondylodiskitis may be difficult to differentiate from degenerative Modic 1 changes, inflammatory lesions (eg, seronegative spondiloarthropathy), amyloidosis, or crystal deposition disease[8,46] on MR imaging, and scintigraphy.[47] Hence, biopsy may be required to help to make a distinction.

Perhaps the only absolute contraindication to performing a biopsy is a lesion that can be diagnosed on imaging with a high degree of certainty and where no additional information will be obtained from the biopsy to aid in patient management. Examples include the classic benign lesion (the "do not touch lesion") and definite metastases from a known primary (eg, multiple bone metastases of prostate cancer).

Biopsy in certain sites increases the hazard, and alternative biopsy routes may be more appropriate. For example, C1 and odontoid biopsy may be conducted by means of a transpharyngeal route by the otorhinolaryngologic surgeon with a lower risk of complications than computed tomography (CT)-guided percutaneous biopsy if no other less hazardous site is apparent. Uncooperative or pediatric cases may require referral for general anesthesia. The risk–benefit ratio of percutaneous versus open biopsy should be reconsidered, if the patient ultimately will require general anesthesia. Severe coagulopathy or thrombocytopenia should be corrected before the procedure. For certain cases, a hematological consultation may be required to deal with coagulopathies that the radiologist may not have experience in correcting.

Percutaneous or Open Biopsy?

Percutaneous biopsy has several advantages over open biopsy. It is minimally invasive, allowing access to different parts of the lesion rather than just the surgically exposed area. The imaging modality often can direct the biopsy needle to the areas most likely to yield suitable specimens. The minimally invasive approach reduces recovery time and patient morbidity. The procedure has a high reported accuracy, which ranges from 68% to 97%.[14,15,17–20] There is also lower cost incurred for the patient.[11,48–50] For example, Ward

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