Biopsy refers to tissue sampling for histological examination, diagnosis, classification, and grading of a tumor. The goal of biopsy is to obtain a diagnostic tissue sample without complications, tumor spread, and compromise of future treatments. As a rule, all lesions should be biopsied as if they were malignant, and all soft tissue masses 3 cm or larger in diameter or growing lesions should be biopsied. Biopsy for musculoskeletal tumors can be closed (percutaneous) or open (incisional or excisional). Closed biopsy can be performed with a fine needle (fine-needle aspiration biopsy) or a core needle, and can be imaging guided or not. This editorial discusses the techniques, principles, and errors of biopsies for musculoskeletal tumors from radiologists’ and orthopedic surgeons’ perspectives.

**The Radiologist’s Perspective**

Currently, imaging-guided closed biopsy with ultrasonography (Figure 1) or computed tomography (CT) (Figure 2) is the gold standard for musculoskeletal tumors because of low cost, low risk of tumor spread and contamination, and minimal invasiveness for the patient. Imaging-guided closed biopsy increases the accuracy and reduces the risk of complications of the biopsy, especially for deep-seated tumors. The radiologist performs the biopsy under the guidance and at the request of the orthopedic oncology surgeon. A poorly performed biopsy may jeopardize future treatments or alter the treatment approach. Therefore, the case should always be evaluated by a team of interventional radiologists experienced in musculoskeletal biopsies. The radiologist may have to discuss the necessity of the biopsy with the patient and the treating orthopedic surgeon. The biopsy may be omitted only in the case of clinically and radiologically unambiguous benign bone tumors such as chondroma, osteochondroma, osteoid osteoma, simple bone cyst, fibrous dysplasia, and histiocytic fibroma; benign soft tissue tumors such as lipoma, hemangioma, and neurofibroma; and pseudotumors such as ganglions and popliteal cysts, myositis ossificans, and pigmented villonodular synovitis. Yet in many cases, orthopedic surgeons ask for a biopsy of such lesions for medicolegal reasons.

Imaging findings that should be examined are the location, size, and morphological features (lytic, sclerotic, or mixed) of the lesion. These findings are important for choosing the optimal biopsy tract and trocar. The shortest distance to the lesion is not necessarily the optimal route. The biopsy tract should be carefully planned according to the site of the definitive surgery so that it will be included and removed en bloc with the resection specimen to avoid local recurrence. The biopsy tract should be considered contaminated with tumor, must not tra-
verse more than 1 anatomical compartment, and should be away from neurovascular bundles. Biopsy tracts should be clearly marked by means of a small incision or ink tattoo to ensure that the location can be recognized at the time of the definitive procedure.

The authors consider the size of the biopsy trocar the pearl for a successful biopsy. One size does not fit all; each case is unique, and each clinical situation deserves thoughtful consideration. The rate of false-negative results is high with fine-needle aspiration biopsy; tissue architecture cannot be evaluated, and cytology samples may not be adequate for ancillary, cytogenetic, molecular, or immunohistochemical studies. Therefore, fine-needle aspiration biopsy is only recommended for documentation of metastases and local or distant tumor recurrence where the cytology findings can be compared with the prior histology specimens. Core-needle biopsy is associated with a higher diagnostic rate; the architecture of tissue is preserved, so grading and immunohistochemical or molecular analysis of the tumor can be performed. There is no difference in accuracy between core-needle and open biopsy.

If the lesion is considered malignant (primary or secondary), even a small-diameter trocar (14 gauge) is usually sufficient for diagnosis. The biopsy should aim at the extraosseous soft tissue because it is as representative of the tumor as is the bony component. Violating the cortex of the bone predisposes the patient to a pathologic fracture and is recommended only if there is no extraosseous extension of the tumor. Tissue samples should be taken from the periphery of the tumor due to the frequent presence of central necrosis. Post-chemotherapy lesions (primary or secondary) that do not enhance on positron emission tomography-CT scans are probably void of pathological tissue.

In deep-seated tumors, the authors recommend aiming the lesion with a guidewire. Alternatively, coaxial biopsy kits that include a sleeve, guidewire, and biopsy trocar can be used, if available. Coaxial biopsy kits are not necessary for accessible tumors such as sacral, iliac spine, femoral condyles, tibial plateau, and diaphysis tumors. In the cervical spine, regardless of the approach, imaging of the cervical vessels with CT with contrast medium is recommended before the biopsy; if an anterior approach is to be used, a nasogastric catheter is necessary to identify and preserve the esophagus; and a left anterior approach should be performed to the C5-C7 levels to avoid the recurrent laryngeal nerve. Additional appropriate biopsy specimens can be taken from suspicious sites, as the exact staging of the disease has an impact on treatment and outcome. If an infection is suspected, antibiotics should be discontinued at least 48 hours, ideally 2 to 3 weeks, before biopsy, and tissue samples should also be sent for microbiological culture. The accuracy of percutaneous disk biopsy for suspected spondylodiscitis is less than 47%; in this setting, both disk and adjacent subchondral bone should be included in the specimen. After a closed biopsy, 5 to 10 minutes of gentle pressure should be applied to the site for hemostasis.

The diagnostic accuracy of imaging-guided closed biopsy ranges up to 77.3%. The factors that influence the diagnostic accuracy include the trocar used, site, size, nature, and histology of the tumor, imaging guidance, and the institution where the biopsy is performed. The success rate is higher with core needles, in malignant tumors, and at specialized tumor centers and lower with fine needles and in benign, pseudotumoral, systemic, and inflammatory lesions, especially if chronic. Diagnostic difficulty is usually associated with myxoid and round cell neoplasms and spinal tumor location, especially in the cervical spine. If closed biopsy is not diagnostic, or the histological diagnosis is in doubt or inconsistent with the suspected clinical and/or imaging diagnosis, biopsy should be repeated. Repeat imaging-guided biopsy may yield diagnostic results in up to 94% of cases.

The Orthopedic Surgeon’s Perspective

The orthopedic oncology surgeon follows and treats the patient, requests the biopsy, and outlines the approach to the lesion. Traditionally, open biopsy has been the biopsy technique of choice for musculoskeletal tumors, providing adequate material for histological and immunohistochemical studies, resulting in a higher rate of accuracy compared with closed biopsy.
Currently, the authors only perform an open biopsy when (1) a repeat closed biopsy is not diagnostic or is inconclusive, (2) an adequate tissue sample cannot be obtained with closed biopsy, (3) the result of closed biopsy does not correlate with the clinical presentation and imaging findings, and (4) accurate histological diagnosis and grading is required to determine whether preoperative chemotherapy or radiation therapy will be administered.¹⁵

In an open biopsy, longitudinal incisions are preferable because they can easily be resected during the definite surgery. If a tourniquet is used, the limb should be elevated before inflation for 5 to 10 minutes and not exsanguinated by compression. Biopsy should be performed through only 1 compartment; as little tissue as possible should be exposed, as all exposed tissue is considered contaminated. Adequate samples of representative areas must be obtained for histology.⁵¹⁰⁻¹⁶ For intraosseous bone lesions, the optimal shape of the cortical window to avoid a pathological fracture should be oblong with rounded ends.¹⁶

Open biopsy can be combined with frozen-section histological analysis to ensure that diagnostic material has been obtained, and if the diagnosis of a benign lesion is made, complete curettage of the tumor can be performed.³ Biopsy tissue samples should be sent for microbiological culture for a potential differential diagnosis. If a suction drain is placed, it should be in proximity to the biopsy incision. The channels through which suction drains have been placed should also be excised at the time of definitive resection. Hemostasis is of paramount importance. Intraoperatively, electrocauterization should be used, and postoperatively, patients should be advised to rest the affected limb for several days to reduce the risk of a cancer cell-laden hematoma.⁵¹⁴

**The Errors**

Major errors may occur in up to 13.5% of biopsies, and complication rates range from 1% to 15.9%.⁵¹⁰⁻¹⁶ The main complications are bleeding, neurapraxia, and infection. Closed biopsy techniques have been associated with a lower risk of complications compared with open biopsy (0% to 10% vs up to 16%).³ Complications may compromise the treatment strategy and patient outcome. Amputation as a sequel of a complicated biopsy may occur in 3% of patients.²¹ Success is greater and complications are fewer when the biopsy of a suspected sarcoma is conducted at a reference tumor center and performed or supervised by a physician experienced with limb salvage for musculoskeletal sarcomas, ideally the surgeon who will perform the definitive tumor resection or a radiologist member of the team.⁵¹⁰⁻¹³,¹⁴,¹⁶,²¹ Biopsy tissue samples must be interpreted by an experienced pathologist. The request form should contain sufficient details regarding the tumor site and the patient.

**CONCLUSION**

The principles of biopsy for musculoskeletal tumors are independent of the technique. A poorly performed biopsy can spread tumor cells locally and increase the risk of local recurrence, jeopardizing future treatments, or alter the treatment approach. If, after biopsy, the histological diagnosis is in doubt or inconsistent with the suspected clinical and/or imaging diagnosis, biopsy should be repeated. Repeat biopsy should be guided by imaging.

**REFERENCES**


