Biopsy of Musculoskeletal Tumors

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Biopsy is a key step in the diagnosis of bone and soft-tissue tumors. When inadequate or improper, it may:

1. Fail to allow a proper diagnosis
2. Have a negative impact on survival
3. May necessitate an amputation to accomplish adequate margins of resection
• It should be well planned and executed
• The surgical approach to different anatomic locations that coincides with the tumor resection is emphasized
• In 1958, Jaffe stated that a biopsy should be regarded as the final diagnostic procedure, “not” as a mere short cut to diagnosis.
• **Careful clinical evaluation and analysis** of the imaging studies is a “**must**”

• Avoid a large incision that may cause contamination of the surrounding soft tissues with tumor cells, as was usually removed by the amputation

• This would not apply to limb sparing procedures
• **Limbsparing procedures** are performed in **90–95%** of patients with musculoskeletal tumors of the extremities

• The indications and surgical technique of musculoskeletal biopsy had to be changed to allow these procedures to be performed
Not all bone or soft-tissue lesions merit a biopsy.

A proper *medical history, thorough physical examination, laboratory data* when indicated, & appropriate *imaging studies & last biopsy* allows accurate diagnosis of most musculoskeletal lesions.
• A biopsy is indicated (Last) in:
  1. Benign aggressive
  2. Malignant
  3. Questionable lesions
• To confirm the clinical diagnosis and accurately classify the lesion before initiation of definitive treatment
Patients who have undergone poorly performed biopsies subsequently may require an amputation to achieve an adequate surgical resection.
In “1982”, Mankin et al. evaluated 329 patients who underwent biopsy for bone or soft-tissue sarcomas. The rate of major errors was 18.2%, and complications was 17.3%. Unnecessary amputations were performed in 4.5%.
• In 1996, Mankin et al. performed a second study on 597 patients.
• They documented major errors in diagnosis in 13.5%, & a complication rate of 15.9%.
• Unnecessary amputations in 3%.
Due to the common origin from the mesenchymal elements of the musculoskeletal system, bone and soft tissue sarcomas share certain unique biologic characteristics.

Sarcomas grow in a “centripetal fashion” with the most immature part of the tumor growing at the edge.
A **reactive zone** is formed between the tumor and the compressed surrounding normal tissues.

It is composed of induced proliferation of mesenchymal cells, neovasculature, and inflammatory process.
• The type of mesenchymal proliferation is determined by the anatomic location of the tumor:
  1. Soft tissue tumors stimulate a fibrous reaction
  2. Intraosseous lesions stimulate a bone-forming reaction
• Unlike sarcomas, carcinomas usually infiltrate, rather than push, the surrounding tissues and usually do not induce the formation of a reactive zone.
DIAGNOSTIC STUDIES AND BIOPSY CONSIDERATIONS
• Biopsy of a musculoskeletal lesion should be performed "only" at the conclusion of staging
• **Staging** helps determine the exact anatomic approach to the tumor and specifies the region of the tumor that represents the underlying disease.

Isosignal intensity relative to muscle of the tumor (red arrow) is appropriate for biopsy.
• A biopsy should also be deferred until staging is complete as it superimposes real and artificial radiologic changes at the biopsy site, and would alter the interpretation of the imaging studies.
Anatomic Location of the Biopsy Tract
• **Sarcomas** as a result of heterogeneity within the lesion, multiple samples are required to establish a diagnosis

• **Carcinomas**, by contrast, are commonly homogeneous and a single tissue core or aspirate is sufficient for diagnosis
A “sampling error” is a inconclusive diagnosis that occurs because the biopsy was not taken from a region that represents the underlying primary disease.

The clinical findings and imaging studies must be evaluated before biopsy by the surgeon and the radiologist, who must be familiar with the biologic and radiologic findings of musculoskeletal tumors.
• The questions that must be answered before biopsy are:
  1. What part of the lesion has to have a biopsy?
  2. What is the safest anatomic route to that location?
• A Computed tomography guided core needle biopsy of a lytic lesion of the distal humerus, suspected of being a metastatic malignant melanoma

• The biopsy tract was resected en-bloc and its pathological evaluation revealed a tumor deposit
• So one should assume that the biopsy tract is contaminated with tumor cells and, therefore, it should be resected with the same safety margins as the primary tumor (i.e., wide margins)
• Biopsy site over an osteosarcoma of the distal femur
• The definitive surgical incision is planned to include the biopsy skin incision and the biopsy tract
• The tumor is resected en-bloc with the biopsy tract and the biopsy skin incision
• Preferably, the surgeon performing the biopsy will be the same person who will perform the definitive procedure.
Guidelines used to decide biopsy location:

1. Decide, before biopsy, what part of the lesion is most representative of the underlying disease and will need to have a biopsy

• As a rule the *extraosseous component* of a malignant bone tumor is as representative of the tumor as is the bony component, and should have a biopsy, if present
• Violating the cortex of a bone that harbors a malignant tumor, predisposes the patient to a pathologic fracture, and is recommended only if there is no extraosseous extension of the tumor.
2. Position the point of entry along the planned incision of the definitive surgery.

3. The biopsy tract must be the shortest way to the lesion; however, it must not violate more than one compartment and must be as remote as possible from the main neurovascular bundle of the extremity.
• Proximal Tibia

- Extensor hallucis longus
- Tibialis anterior
- Biopsy tract
Biopsy Technique
• A **closed biopsy** does not involve an incision
• The specimen is obtained after a skin puncture by a needle or trephine
• An **open biopsy** requires an incision
• It can either be by **incisional**, in which case only a representative specimen is removed from the lesion, or **excisional**, in which the lesion is excised en-bloc
Types of biopsy

- **FNA** (75% accuracy)
  - Relies on cytology
  - Need experienced pathologist
  - Used to confirm diagnosis

- **CORE** (85% accuracy)
  - CT guided or TRU-CUT

- **OPEN** (96% accuracy)
Fine Needle Biopsy
• Needle biopsy of mesenchymal tumors initially was criticized because the quantity of biopsy material was often insufficient for routine histopathologic evaluation and ancillary studies that require tissue.

• Fine-needle aspiration (FNA) using a 22-gauge needle, has been shown to be a reliable technique for the diagnosis of “soft-tissue tumors”
• Diagnostic accuracy of FNA is highest when the cell type of the tumor is homogeneous, as in the case of multiple myeloma or metastatic carcinomas

• BUT! Tissue architecture and matrix formation have a major significance in the histologic evaluation and diagnosis of “bone tumors”
• An important limitation of FNA stems from its inability to sample tissue matrix adequately and to show tumor structure.

• Because of these considerations, with the exception of few specialized centers, FNA is not commonly used to diagnose "primary bone tumors"
CORE NEEDLE BIOPSY
• **Core needle biopsy (CNB)**, using a 14-gauge needle that provides a core of tissue with a maximum length of 20 mm, is more than 90% accurate in differentiating malignant from benign lesions.

• In bone or soft-tissue sarcomas it is the biopsy performed before initiation of treatment.
• CNB is the first biopsy modality

• *Open biopsy* is performed when the pathologic diagnosis either is inconclusive or does not correlate with the clinical presentation and radiologic findings

• *Bone* biopsies, using a CNB, should be performed under *CT or fluoroscopy guidance*, & *multiple cores* should be obtained
• Biopsy of a deep seated or pelvic soft-tissue tumors is performed under CT guidance
Open incisional biopsy
Allows the pathologist to evaluate cellular morphologic features and tissue architecture from different sites of the lesion.
It allows ancillary studies:

1. Immunohistochemistry
2. Cytogenetics
3. Molecular genetics
4. Flow cytometry
5. Electron microscopy

These studies may help in the diagnosis & subclassification of bone & soft-tissue tumors
Guidelines to an Open Biopsy
• After adequate planning of the biopsy tract:

1. Use the **smallest longitudinal** incision that is compatible with obtaining an adequate specimen

• **Transverse incisions** are contraindicated because they require a wider soft-tissue resection at the time of definitive surgery
2. Avoid crushing or distorting the specimen’s texture

• When a purely intraosseous bone lesion is having a biopsy, make a cortical window and pay attention to its shape

• Clark et al. evaluated the impact of three types of hole shape (rectangular hole with square corners, rectangular hole with rounded corners, and oblong hole with rounded ends) on the breaking strength of human femora
An oblong hole with rounded ends afforded the greatest residual strength.

Increasing the width of the hole caused a significant reduction in strength, but increasing the length did not.
• A small circular hole should be made in bone so that only minimal stress-risers are created

• If a larger window is needed, an oblong window should be made
An oblong cortical window with rounded ends affords the greatest residual strength and is recommended for biopsy of purely intraosseous lesions.
3. Obtain enough tissue

• Always send a specimen for frozen section to verify the presence of representative tumor material in the specimen.

• For needle biopsies, cytopathologic evaluation has to confirm the presence of viable tumor cells.

• If pathologic evaluation is negative or questionable, repeat the biopsy.
4. “As a general rule, culture what you biopsy and biopsy what you culture”

5. Use meticulous hemostasis

• Any hematoma around a tumor should be considered contaminated

• Large hematoma may dissect the soft and subcutaneous tissues and contaminate the entire extremity, making limb-sparing surgery impossible
• A **tourniquet** is rarely indicated for an open biopsy, because bleeding vessels cannot be observed and adequate hemostasis is hard to achieve (*remove before closure*)

• If a tourniquet is used, the limb should not be exsanguinated by wrapping with an **Esmarch** bandage, because this may force tumor cells to the proximal aspect of the extremity and into the bloodstream
6. Use drains if necessary

- The port of entry has to be in proximity and continuation with the skin incision, not to its sides.
• The **drain path** is considered contaminated and has to be excised with the surgical specimen

• Guidelines regarding the excision of the draining tract therefore are similar to those that apply to the biopsy tract
TAKE HOME MESSAGE
Accurate diagnosis of a musculoskeletal tumor is based on:

1. Clinical presentation
2. Radiologic studies
3. Pathologic evaluation
• Careful planning and performance of a biopsy is a must as an error may have a negative impact on:
  1. Survival
  2. Impede a proper diagnosis
  3. Compromise the ability to perform limb-sparing surgery

• Core needle biopsies, performed under CT guidance when indicated, IS most recommended
THANK YOU