Percutaneous Biopsy For Diagnosis Of Spine Infections

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ABSTRACT

Magnetic resonance imaging is the imaging modality for the diagnosis of spinal infections. The diagnosis is often made by a combination of clinical symptoms and radiologic abnormalities, as well as evidence of infection from histopathologic findings and/or identification of pathogens from biopsy specimens or blood cultures. Percutaneous biopsy has gained wide popularity, with the advances in cytopathologic techniques with the guidance of computed tomography (CT) and sonography, and the safety of needle biopsy.

KEY WORDS: Biopsy, infection, spine

INTRODUCTION

Magnetic resonance imaging of the spine often establishes the diagnosis of spinal infections and is associated with a high sensitivity and specificity (7,21). Occasionally, the diagnosis is difficult since the imaging features may be delayed or represent a noninfectious etiology (8,13,21). Infectious spondylitis accounts for 2% to 4% of cases of skeletal infection (13,21,22). However, there is evidence that the incidence is raising due to longer life expectancy for patients with chronic debilitating disease, immunosuppressive therapy, increasing use of indwelling devices, and spinal surgery (1,5,6,10,11,16).

Early and accurate diagnosis of spinal infections can prevent invasive surgical procedures for the patient (17, 23). Definitive microbiological and histopathologic diagnosis is often required for optimal management, unless blood cultures guide the treatment in hematogenous infections. Open biopsy and cultures remain the reference gold standard for diagnosis (3,9,17). The diagnosis is often made by a combination of clinical symptoms and radiologic abnormalities, as well as evidence of osteomyelitis/discitis from histopathologic findings and/or identification of pathogens from biopsy specimens or blood cultures. Percutaneous biopsy has gained wide popularity, with the advances in cytopathologic techniques, the ability to precisely guide needles to various locations with the guidance of computed tomography (CT) and sonography, and the safety of needle biopsy. Robertson and Ball introduced percutaneous needle biopsy of the spine in 1935 (10,20). It can be used to establish the identity of superficial or deep infections of the spine and paraspinal tissues (4,10,12,14,15,18,19).

Depending on the study, the diagnostic microbiological yields of percutaneous image-guided needle aspiration biopsy have been reported to vary from 36% to 91% (1,10,16). The wide range of success rates depend on the organism and multiple factors, such as prior use of antimicrobial therapy, biopsy techniques, and advances in imaging studies. Image-guided percutaneous needle aspiration biopsy has a high specificity and, therefore, is quite useful when positive. However, it has low sensitivity and can miss a substantial proportion of patients.
PATIENT PREPARATION

The vast majority of image-guided biopsies can be performed on an outpatient basis. Partial thromboplastin time (PTT), prothrombin time (PT), and platelet levels should be checked in all patients undergoing biopsy of any deep-seated lesion. If the lesion to be biopsied is superficial, coagulation studies are not required, since direct pressure will achieve hemostasis in case of bleeding. If the patient is receiving an antithrombotic drug such as aspirin, either defer the procedure for 10 days or, depending on the location of the lesion, perform a fine-needle biopsy, because the likelihood of bleeding as a result of aspirin alone is very low. In patients with drug-eluting stents or who had stents very recent, stopping therapy with clopidogrel or prasugrel would risk stent thrombosis. In these more difficult situations, the need for biopsy must be carefully evaluated against the risk of bleeding. Fine-gauge needles should be used and minimize the number of passes made. Most biopsies can be performed with the patient under local anesthesia without the use of sedation and analgesia. Exceptions include biopsies in pediatric patients and biopsies of deep lesions. Monitoring of patients with a pulse oximeter and for blood pressure measurements is necessary. A nurse should monitor the patient during the procedure so that the operator can concentrate solely on the biopsy (6,11).

Needle Choice

In the early years of image-guided percutaneous biopsy, most biopsies were obtained with thin needles (20-22 gauge). These needles obtain a cytologic aspirate that is sufficient to confirm or refute a diagnosis of infection. More recently, there has been a tendency to use core biopsy needles. The advantage of these needles is that cores of tissues retain the organization of the lesion, often allowing precise histologic diagnosis (6,11).

Fine-needle biopsies are obtained with 20- to 25-gauge needles. There are a wide variety of needle types and needle tip designs on the market. Broadly, fine-gauge needles can be divided into those with a sharp beveled tip or those with a modified, tissue-cutting tip. The advantage of using a needle with a cutting tip is that a core of tissue may be obtainable with this needle type. Large-gauge needle biopsies (14- to 19-gauge) are almost universally performed with a spring-activated, modified Tru-Cut system. Many such systems of variable gauge, throw length, and design are available. Most of these needles are disposable systems.

In recent years, this distinction between large-gauge biopsy and fine-needle biopsy has become blurred because of the development of 20-gauge automated Tru-Cut needles (6,11).

Image Guidance

Computed tomography and sonography are the two main image guidance modalities used for biopsy procedures. Although magnetic resonance interventional systems are used and gained increasing recognition in clinical practice, their role in performing routine biopsies is limited because of its high cost and lack of widespread availability. It has been used as an alternative to CT for lesions not visible on CT and other conventional modalities. For the vertebral body lesions, fluoroscopic guidance can be used as well (2,6,10,11). The choice between CT and sonography is largely guided by clinician preference and the nature, size, location, and site of the lesion. The relative advantages and disadvantages of CT and sonography are listed in Table 1 (Modified from 6,11).

Table 1: Image Guidance

<table>
<thead>
<tr>
<th>Image guidance</th>
<th>CT</th>
<th>Ultrasonography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous needle monitoring</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Learning curve</td>
<td>Short</td>
<td>Long</td>
</tr>
<tr>
<td>Cost</td>
<td>Higher</td>
<td>Low</td>
</tr>
<tr>
<td>Portable</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Expediency</td>
<td>Slow</td>
<td>Fast</td>
</tr>
<tr>
<td>Ionizing radiation</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Sonography

Sonography should be used for image guidance because it provides continuous real-time visualization of the needle. In the widest technique (called free-hand technique), one of the operator’s hand holding the transducer while the other hand holding the needle. This technique provides flexibility of position of the needle.

The transducer can be covered with a sterile sheath or alternatively, the transducer can be sterilized by painting the surface with Betadine. The skin is cleansed with Betadine or other type of skin disinfectants and the lesion located in the center of the ultrasound beam. The shortest and safest path to the lesion is chosen. The needle is aligned with the
ultrasound beam and inserted through the anesthetized skin and subcutaneous tissues toward the lesion to be biopsied. With proper alignment of the needle within the plane of the ultrasound beam, the entire length of the needle shaft should be visualized at all times. When experience is gained with sonographically guided freehand biopsy methods, this becomes a very rapid and reliable method of guiding biopsy needles to the target lesion (6,11).

Sonographic guidance can be problematic in obese patients since the echogenic needle can be hard to visualize in the echogenic soft tissues and deep-seated lesions.

**Computed Tomography**

CT is the standard method of biopsy guidance for spinal infections. In 1981, Adapson et al described the use of a CT scan for percutaneous biopsy (10,20). The learning curve associated with CT-guided biopsies is generally shorter compared to sonography. Scans through the region of interest with a grid system or a homemade grid system placed on the patient's skin.

On the CT image that gives the best view of the lesion, a safe access route is chosen and the distance to the lesion marked on the image. The patient is then brought to the table position where the biopsy is to be performed and the skin site marked using the grid on the patient's skin and the centering laser light beam in the CT gantry. The needle is inserted to the predetermined depth and location. Scans are obtained at the level of the needle entry site to determine the location of the needle. A black streak artifact that occurs at the needle tip readily recognizes the tip of the needle. If the needle is not in an appropriate position, needle can be positioned again and scanned until an appropriate position within the lesion is obtained.

**Figure 1:** A) Sagittal STIR image shows increased vertebral body and disc signal with epidural extension of the infectious process. B,C) Axial and sagittal postcontrast MR images showing severe contrast enhancement of the vertebral bodies and the disc space with paravertebral extension.

**Figure 2:** A) Axial CT image of the same patient showing destruction of the vertebral body and paravertebral soft tissue swelling. B) Axial CT image of right paravertebral fine-needle aspiration biopsy in the same patient with spondylodiscitis where the tip of the needle is situated in the affected area on L3-4 level.
Compared to ultrasonography, the lack of real-time visualization with CT guidance is a limiting factor. The recent introduction of CT fluoroscopy with multislice CT scanners has attempted to readdress this balance. However, CT fluoroscopic units will undoubtedly make CT guidance a much more viable, it is more expensive and harm the operator because of radiation exposure (6,11).

Flat detector angiography systems may use like CT fluoroscopy for the biopsy guidance as well. These systems allow tracking the needle with the guidance of CT images like a stereotaxic system.

PERFORMING THE BIOPSY

Fine-Needle Aspiration Biopsy

A 10-mL syringe is applied to the hub of the needle that has been inserted into the lesion, and suction is applied. In general, 3-5 mL of suction is appropriate for most biopsies. The needle is moved quite firmly in a to-and-fro motion through the lesion during the suction for approximately 10-15 seconds or until blood appears in the hub of the needle. Suction is released while the needle is being removed to prevent aspiration of cells along the needle track that may confuse the cytologic interpretation of the sample. Ideally, a cytopathologist should be available to handle the specimen. If sufficient tissue is unavailable for interpretation, more samples are obtained. If necessary, a large-gauge core biopsy sample should be obtained instead of repeated fine needle biopsies (6,11).

Coaxial vs. Tandem Technique

Using the coaxial technique, a single needle is placed in the periphery of the lesion and a smaller, longer needle is placed through the initial needle to biopsy the lesion. The coaxial technique has several advantages in that only one puncture is made into the organ, reducing the propensity for hemorrhage or other complications. Multiple tissue samples can be obtained through the first needle. Lastly, precise needle placement is required only for the first needle.

Using the tandem technique, a 22-gauge needle is placed into the lesion and used as a reference needle. This reference needle then stays within the lesion until the end of the procedure. Further needles are inserted in tandem to the reference needle and are placed to the same depth and follow the same trajectory as the reference needle. This technique is useful for CT-guided biopsies wherein multiple fine-needle samples can be obtained without precisely localizing each subsequent needle that is passed.

In the main, the coaxial and tandem techniques are primarily used with CT guidance. Because of the flexibility of sonography and continuous real-time visualization, the tandem and coaxial techniques are rarely necessary. However, they are useful when using CT guidance so that further needle passes do not require precise CT monitoring, which is cumbersome and time consuming (6,11).

REFERENCES


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