Overview of Conventional Imaging-based Intervention in Clinical Practice

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KEYWORDS

• Image guided • Interventions • Biopsy • Ablation • Tumor • CT • Ultrasonography

KEY POINTS

- With better availability and improving technology, image-guided interventions are increasingly being performed.
- Ultrasonography-guided and/or computed tomography (CT)–guided biopsy and tumor ablations are the most commonly performed oncologic procedures using imaging guidance.
- Radiologists performing the procedures should not only be aware of risks associated with the interventions but also the various maneuvers to minimize those risks.
- PET-CT imaging can help identify the areas of metabolically active tumor (in the presence of necrosis, or in patients with history of prior treatment), which can then be specifically targeted for the purpose of biopsy under imaging guidance.

INTRODUCTION

In this evolving era of individualized oncologic medicine, image-guided interventions are increasing in popularity and frequency for several reasons, including (1) technical improvements that have led to increased efficacy and safety; (2) preference for minimally invasive techniques rather than surgical options; and (3) an increase in the number of situations in which tissue diagnosis is required, such as for clinical trials or biological/molecular tumor profiling for targeted therapy.[1–8] The most common imaging-guided interventions are biopsy and tumor ablation, which are commonly performed across the nation and have become key tools in the armamentarium of oncologic practices for the diagnosis and treatment of disease.[1–8]

This article discusses the indications, contraindications, techniques, and various considerations for some of the most commonly performed image-guided interventions, namely conventional imaging-guided biopsies and tumor ablation. It also briefly addresses the role of PET imaging and future imaging techniques in the context of these biopsies, which are addressed in other articles in this issue.

GENERAL CONSIDERATIONS

The Importance of Guidance

One of the primary advantages of image guidance is a decrease in both the nondiagnostic rate and in the number of complications. For example, in a study by Maya and colleagues[9] of random native kidney biopsies, none of the image-guided biopsies were nondiagnostic compared with 16% in the nonguided group. In addition, the rate of significant hemorrhage was significantly reduced,

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with none of the image-guided cohort requiring transfusion, compared with 11% of the nonguided group.

Choosing the Imaging Modality

Invariably, ultrasonography is the mainstay tool for image guidance of biopsies.[7,10] The mantra "If it can be seen it can be done" applies to ultrasonography as a guiding modality in most scenarios. Ultrasonography machines are portable and readily available in most radiology centers. In addition, the ultrasonography probes are easy to handle and allow real-time visualization of the needle and the target lesion. Color Doppler imaging also plays an important role during interventions to evaluate for vascular structures in the path of the needle and to assess the vascularity of the target lesion. Other advantages include the lack of ionizing radiation and real-time evaluation for potential postbiopsy complications such as arteriovenous fistulas and hemorrhage. Complications such as hemorrhage (if detected on postbiopsy scan) can usually be managed effectively with pressure application, while the patient is still on the biopsy table.

Despite its advantages, there are situations in which visualization of the target lesion may be suboptimal by ultrasonography, either because of patient-related factors, such as high body mass index, small sonographic windows caused by bowel gas, or because of small size and/or deep location of the target lesion. In these situations, computed tomography (CT) guidance may be preferred.[11]

Magnetic resonance (MR) imaging is a newer entrant to imaging guidance, and has been primarily used in breast and prostate biopsies.[12,13] It is yet not widely available, and is an expensive modality compared with ultrasonography and CT examinations. However, techniques such as MR imaging/transrectal ultrasonography fusion for prostate biopsies are becoming increasing popular because they combine the excellent tissue contrast of MR imaging with the real-time guidance capability of ultrasonography.[14]

Instrumentation and Technique

Image-guided biopsies are performed with a variety of different sized needles, which tend to be smaller (25–20 G) for fine-needle aspiration biopsies (FNABs), and larger (20–11 G) for core biopsies (**Table 1**). Core biopsies have the advantage of providing a greater amount of cellular material for analysis, and also allow the cellular architecture of the tumor to be examined, which may be critical in the diagnosis of lymphoma and certain sarcomas.[15–17] In addition, the greater amount of material obtained by core biopsy permits additional molecular testing, as may be necessary in both clinical and research settings.[15,16] In core biopsies, although larger needles have the theoretic advantage of higher diagnostic yield, this is countered by the higher potential risk of bleeding and organ injury. Radiologists performing the procedure, while collaborating with the pathologist and the requesting physician, should judiciously weigh the risk against the benefit of one technique compared with another.

Table 1
Commonly used needle sizes and their use in imaging-guided biopsies

Needle Size	Common Indications/Comments
27 G FNAB	Thyroid nodules, lidocaine injection
25 G FNAB	Soft tissue masses/lymph nodes
22 G FNAB	Deeper soft tissue masses/lymph nodes, solid organs
20 G FNAB	Deeper soft tissue masses/lymph nodes, solid organs (needle more visible through subcutaneous fat on ultrasound)
20 G core	Used occasionally in high-risk patients
18 G core	Most commonly used core biopsy needle
16 G core	Random organ biopsies, soft tissue sarcoma (16 G preferred)

Fine-needle aspiration biopsy

FNABs are often used in the following situations: (1) suspected metastatic deposit in a patient with known primary malignancy, when only a limited number of cells are required to establish a diagnosis; (2) small lesions, for which core biopsy may be risky or difficult (eg, thyroid nodules); and (3) to confirm areas of viable tumor in the setting of complex cystic or necrotic lesions (before core biopsy). In FNAB, a thin needle is introduced into the lesion under imaging guidance, and is moved in a to-and-fro manner, resulting in collection of cells via a capillary-action mechanism (**Fig. 1**). At our institution, cytopathologists are available on site to assess a portion of the specimen for adequacy and to determine whether a core biopsy is necessary. Any portion of the specimen that is not examined on site is submitted to the cytopathology department in solution for additional analysis or flow cytometry as required.[18]