A Low-Cost Gelatin Phantom for Learning Sonographically Guided Interventional Breast Radiology Techniques

Gale A. Sisney[1,2] and Karen A. Hunt[1,3]

Sonography can be used for a variety of interventional procedures including cyst aspiration, needle core biopsy, fine-needle aspiration, preoperative needle localization, and abscess drainage [1, 2]. At the University of Colorado Health Sciences Center, residents and fellows are taught freehand sonography techniques using a gelatin phantom. The phantom facilitates learning hand–eye coordination skills needed for successful interventional techniques. Additionally, the clear gelatin phantom allows visual confirmation of the needle position relative to the target.

Materials and Methods

The gelatin phantom is prepared using common household goods with materials that cost less than $20. Materials needed include a 4-qt (3.8-l) microwave-safe container, Knox gelatin (Nabisco, Hanover, NJ), and target objects. We use capers or peas for solid targets and bath oil beads coated with nail polish for cystic targets. For a 4-qt (3.8-l) volume, 8 oz (248.8 g) of gelatin is combined with 16 cups (3.8 l) of water. The mixture is stirred thoroughly and allowed to sit for 2 min at room temperature. The mixture is then microwaved at high setting for 10 min, gently stirred, and refrigerated. When the gelatin is firm to the touch, a small amount of water is added to its surface. Multiple oblique tracts are made in the surface by inserting a straw 3–7 cm deep. Individual targets are then pushed down the tracts with a straw (Fig. 1A). The gelatin phantom is microwaved again for 30 sec and refrigerated to reseal the tracts. The completed phantom is then removed from its container and inverted (Fig. 1B). The targets will be seen at varying depths at the uninterrupted gelatin surface. The gelatin phantom can be stored up to 1 week if refrigerated. A soft phantom may result from too much water, excessive microwaving, inadequate refrigeration, or poor mixing.

Equipment needed to practice interventional techniques includes an electronically focused high-resolution 7- to 10-MHz linear array sonogram transducer to maximize needle visualization. A variety of needles can be used including an 18-gauge needle with a syringe for cyst aspiration, a 25-gauge needle with a syringe for fine-needle aspiration, a needle core biopsy apparatus, and a needle localization set. Proper sonography equipment settings optimize target visualization. The power gain setting should maximize the number of gray zones. The time gain curve is set to the right for the gelatin phantom because of the decreased echogenicity of the gelatin. The focal zones are adjusted to the depth of the target.

Several maneuvers of the transducer are used to ensure accurate sampling, including sliding, rocking, and rotating the transducer. Sliding is accomplished by moving the transducer along a plane parallel to either its short or its long axis. During transducer rocking, the transducer face is angled relative to the gelatin phantom's surface. Transducer rocking maximizes the reflective properties of the needle shaft because the central ultrasound beam is moved into a perpendicular orientation. Rotation involves moving the transducer clockwise or counterclockwise around the target's central axis.

Manipulations of the needle also increase sampling accuracy. Three common manipulations include advancing, depressing, and rotating. Advancement of the needle is always parallel to the long axis of the transducer with the needle at the midpoint of the short axis, which maximizes imaging of the needle shaft and bevel. Depressing the needle hub aligns the needle shaft parallel to the transducer face, further maximizing needle imaging. Rotation of the needle occurs around the target's central axis. When performed simultaneously with transducer rotation, needle rotation allows optimal repositioning of the needle relative to the center of the target.

One artifact should be recognized while performing sonographically guided procedures. Oblique needle crosscut occurs when the needle traverses the ultrasound beam obliquely and only a portion of the needle shaft is imaged (Fig. 2). The needle bevel is often not imaged and may lie in a precarious position. To avoid this artifact, visually inspect your hand alignment. The needle should always be held parallel to the long axis of the transducer and should be advanced only when the entire needle shaft and bevel are imaged.

Discussion

The gelatin phantom can be used to improve performance and increase confidence

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[1]Department of Radiology, University of Colorado Health Sciences Center, 4200 E. Ninth Ave., Denver, CO 80262. Address correspondence to G. A. Sisney.

[2]Present address: Fairfax Radiological Consultants, P.C., 3300 Gallows Rd., Falls Church, VA 22046.

[3]Present address: Department of Radiology, Henry Ford Hospital, 2799 W. Grand Blvd., Detroit, MI 48202.

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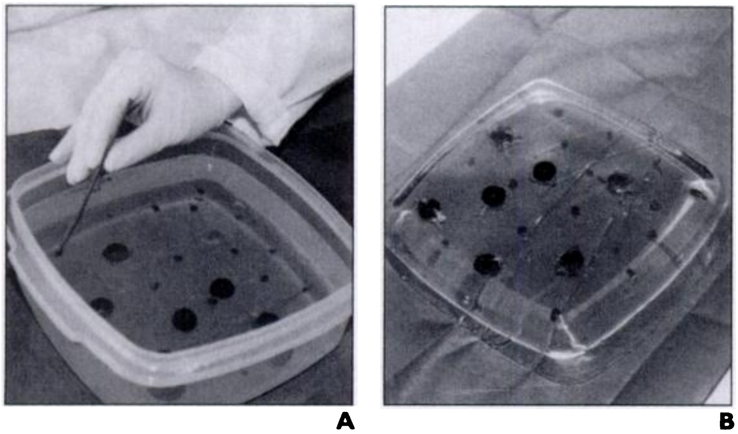

Fig. 1.—Photographs show gelatin phantom for learning sonographically guided interventional techniques.
A, Targets are pushed through straw tracts into gelatin phantom.
B, Inverted phantom with targets inserted.

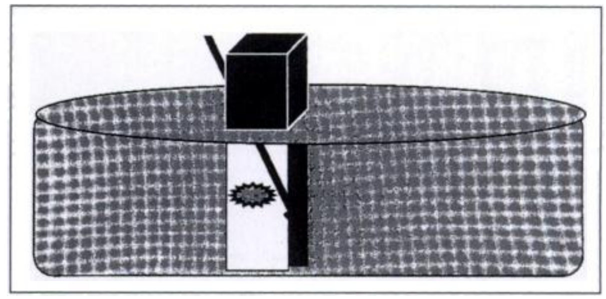

Fig. 2.—Drawing shows actual positioning of needle oblique to ultrasound beam in artifactual oblique needle crosscut.

for learning sonographically guided interventional techniques. The clear gelatin helps identify sampling errors and artifacts. One disadvantage is the limited ability to reposition along the needle tract because of the disruption of the gelatin after repeated attempts to sample a selected target. Inserting multiple targets into the gelatin phantom and approaching a single target from multiple angles minimizes this disadvantage. Injecting water through a syringe attached to a sampling needle after taking an aberrant path partially conceals unwanted tracts. The advantages of using a gelatin phantom for teaching sonographically guided interventional techniques include its visual assessment of needle-to-target position, its easy preparation, and its low cost.

References

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