A Tissue Phantom Model for Training Residents in Ultrasound-guided Liver Biopsy

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Rationale and Objectives: The apprenticeship model for training of percutaneous liver biopsy has limitations, and costs of commercially available simulation models can be prohibitive. We created an inexpensive tissue phantom for liver biopsy simulation and evaluated the utility of this model for training radiology residents.

Materials and Methods: A bovine–porcine tissue phantom was devised as a simulation model and consisted of bovine liver with a porcine rib layer and inserted pimento olives simulating target lesions. Training sessions (a 20-minute didactic lecture and a 90-minute practice session) were offered to all residents in a diagnostic radiology residency. Effect of training was assessed by questionnaire before and after training. Level of knowledge of topics covered in the didactic session, confidence in technical skills, and anxiety level were evaluated on a five-point scale (1, poor to 5, excellent).

Results: Thirty-five of 38 residents received training on the models (~$40). Mean reported value score for training was 4.88/5. Improvement was greatest for knowledge of technique (2.3–4.1/5, $P < .001$) and knowledge of postprocedure care (2.2–4.1/5, $P < .001$). Technical confidence increased (2.4–3.8/5, $P < .001$) and anxiety related to performing liver biopsy improved (2.7–3.7/5, $P < .001$). Residents with no prior experience in liver biopsy ($n = 21$) had significantly greater increases in all categories than residents with prior experience ($n = 14$), except for knowledge about obtaining informed consent and anxiety levels.

Conclusions: Utilization of an inexpensively created bovine/porcine liver biopsy simulation model was well perceived by radiology residents and can be used as an educational tool during residency.

Key Words: Liver biopsy; resident education; ultrasound; simulation training.

Ultrasound guidance for procedures is a skill used in many radiology subspecialty areas, such as body imaging, interventional radiology, mammography, and musculoskeletal radiology. Proficiency with ultrasound-guided (US-guided) procedures should be a part of a radiology residency core curriculum.

Percutaneous liver biopsy is a commonly performed procedure for staging of diffuse liver disease and diagnosis of hepatic lesions; however, it does carry the risk of hemorrhage, biliary leak, injury to adjacent structures, and even death (1–3). Ultrasound guidance for nontargeted liver biopsy can significantly decrease complication rate from 2.1% for blinded liver biopsy to 0.53% for those with ultrasound guidance (4). Learning to perform liver biopsies under ultrasound guidance also provides a solid foundation for percutaneous interventions on other solid organs and is a necessary step before performing targeted liver biopsies.

Resident training in both percutaneous liver biopsy and US-guided procedures, however, is variable between various institutions and even within a residency cohort (5). Reduced resident work hours, increasing diagnostic imaging volume, increased utilization of physician extenders, and increasing fellowship opportunities in body and interventional radiology may limit residents' experience with percutaneous procedures. Further drawbacks of a purely apprenticeship model include inconsistency of instruction and inability to familiarize oneself with equipment and technique prior to a patient encounter.

Simulation training has been shown to improve procedural competency, allowing residents to become familiar with equipment and to learn safe and effective technique in a standardized setting (6–9). However, there are few commercially available phantoms suitable for percutaneous biopsy, and their costs can be prohibitive.

Therefore, we sought to create an inexpensive tissue-based simulation model for practicing percutaneous US-guided liver biopsy and to evaluate the utility of this model in a standardized training curriculum for radiology residents.

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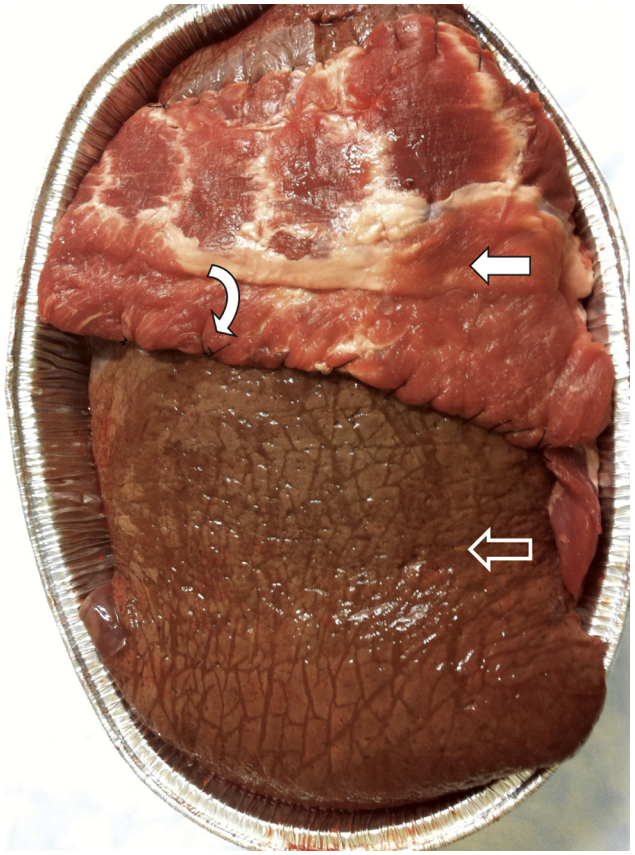

Figure 1. Bovine–porcine tissue phantom. Porcine rib layer simulating the chest wall and allowing for practice targeting the liver between ribs (*white arrow*), whole or halved cow liver (*open arrow*), sutures to keep the porcine rib/chest wall layer in place (*curved arrow*).

METHODS

Study Design

This study was performed with institutional review board (IRB) exemption. The study group included all radiology residents ($n = 38$) in all 4 years of training at an academic medical center. A prospective study was performed in which all residents were offered participation in a liver biopsy training session. The teaching session included a 20-minute didactic lecture followed by a 90-minute practical teaching session. Participants completed surveys before receiving training and after training. At the beginning of the didactic session, per IRB exemption requirements, participants were informed about the voluntary nature of this session and anonymity of survey results.

Creation of a Bovine–Porcine Tissue Phantom

The tissue phantom consisted of bovine liver (whole or halved) with an overlying porcine rib layer sutured to its surface to simulate the challenges of rib shadowing and the intercostal approach (Fig 1). Inserted pimento olives resulted in a target appearance on ultrasound, simulating focal hepatic lesions (Fig 2). All materials were readily available at a local supermarket on being specifically requested and the total cost of each model was ~$40. A total of four models were created, two for each training session. The models were prepared as follows: the bovine livers were thawed and rinsed with tap water, the liver was sectioned into halves (after initial sessions demonstrated sufficiency with 1/2 liver volume), small incisions were made along the ventral surface of the liver and pimento olives were inserted into the liver parenchyma, a porcine rib layer was then placed over the dorsal surface of the liver, and the edges were sutured using 0 silk. Preparation was straightforward and took ~45 minutes per model. The model was wrapped in a biohazard bag to contain fluids and allow removal of ultrasound gel between biopsy procedures. Models used over a 2-day period were stored overnight in an ice bath. The models can last up to 3–4 days, potentially longer if frozen.

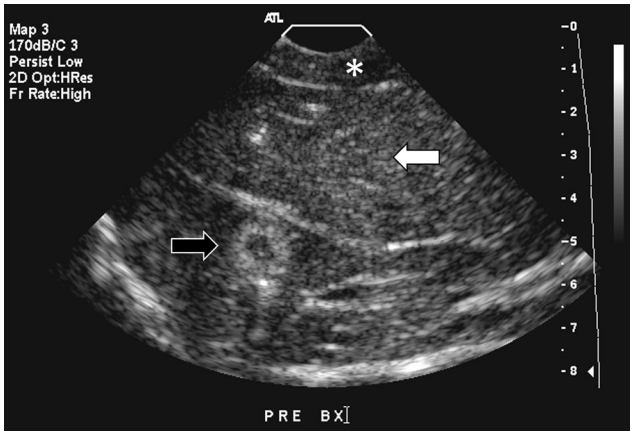

Figure 2. Ultrasound images of the model. Excellent visualization of the porcine chest wall (*), hepatic parenchyma (*white arrow*) and pimento olive target lesions (*black arrow*) was obtained.

Selection of Participants

Liver biopsy training sessions were offered to all radiology residents ($n = 38$) in all 4 years of training at an academic medical center.

Training Sessions

Each session consisted of a 20-minute didactic lecture (Table 1) given by an abdominal imaging fellow, followed by a 90-minute hands-on practice session. The trainees completed a pretraining survey to assess their prior experience and subjective degree of knowledge and confidence on a number of variables related to the performance of US-guided liver biopsy (Appendix 1).

The 90-minute hands-on sessions were held in a conference room setting. During each session, two small groups of 3–5 residents were trained, with each group supervised by an abdominal interventionalist (XX, with 2 years of experience, XX, with 6 years of experience). Equipment used