Published in final edited form as:

J Surg Oncol. 2015 September ; 112(4): 449–451. doi:10.1002/jso.23984.

A Low Cost Training Phantom Model for Radio-guided Localization Techniques in Occult Breast Lesions

Fatih Aydogan, MD^{1,2} [Associate Professor], Melissa Anne Mallory, MD¹, Mustafa Tukenmez, MD^{1,3}, Yasuaki Sagara, MD¹, Erkan Ozturk, MD⁴ [Associate Professor], Yavuz Ince⁵, Varol Celik, MD² [Professor], Tamer Akca, MD⁶ [Professor], and Mehra Golshan, MD¹ [Associate Professor]

¹Women's Cancer Center, Dana-Farber/Brigham and Women's Hospital, Harvard Medical School, Boston, MA

²Breast Division, Department of Surgery, Cerrahpasa Medical School, Istanbul University, Istanbul, Turkey

³Department of Surgery, Istanbul Medical School, Istanbul University, Istanbul, Turkey

⁴Department of Surgery Gulhane Military Medical Academy and Medical School, Ankara, Turkey

⁵Koc Medical School, Istanbul, Turkey

⁶Department of General Surgery, Mersin University Medical Faculty, Mersin, Turkey

Abstract

Radio-guided localization (RGL) for identifying occult breast lesions has been widely accepted as an alternative technique to other localization methods, including those using wire-guidance. An appropriate phantom model would be an invaluable tool for practitioners interested in learning the technique of RGL prior to clinical application. The aim of this study was to devise an inexpensive and reproducible training phantom model for RGL. We developed a simple RGL phantom model imitating an occult breast lesion from inexpensive supplies including a pimento olive, a green pea and a turkey breast. The phantom was constructed for a total cost of less than \$20 and prepared in approximately 10 minutes. After the first model's construction, we constructed approximately 25 additional models and demonstrated that the model design was easily reproducible. The RGL phantom is a time- and cost-effective model that accurately simulates the RGL technique for non-palpable breast lesions. Future studies are warranted to further validate this model as an effective teaching tool.

Corresponding Author: Fatih Aydogan MD, faydoganmd@gmail.com, fatih_aydogan@dfci.harvard.edu, Address: 450 Brookline Avenue, Yawkey 1441, Boston, MA, Telephone: 857-2308167.

This is the peer reviewed version of the following article: [Aydogan, F., Mallory, M. A., Tukenmez, M., Sagara, Y., Ozturk, E., Ince, Y., Celik, V., Akca, T. and Golshan, M. (2015), A low cost training phantom model for radio-guided localization techniques in occult breast lesions. *J.Surg. Oncol*. doi: 10.1002/jso.23984], which has been published in final form at [<http://onlinelibrary.wiley.com/doi/10.1002/jso.23984/full>]. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Self-Archiving.

Keywords

breast; radio-guided localization; training; phantom model

Introduction

Radio-guided localization methods are among a variety of localization techniques that have been developed to assist with the management of occult breast lesions. Radio-guided localization (RGL) techniques, which have been widely accepted by practitioners, provide excellent alternatives to wire-guided localization (WGL) methods for non-palpable breast lesions and lymph nodes (1–7). Two techniques that utilize the RGL approach include radio-guided occult localization (ROLL) and radioactive seed localization (RSL). In the ROLL technique, a liquid radioactive tracer (most commonly Tc99m-Human Serum Albumin Makroaggregate) is injected into the lesion under stereotactic, ultrasound (US), or magnetic resonance imaging (MRI) guidance up to 24 before surgery. In the RSL technique, a radio-opaque titanium seed containing Iodine-125 (I-125) is inserted in the center of the lesion under imaging guidance. The I-125 seed has a half-life of 60 days, which allows preoperative localization to be performed up to several days prior to the scheduled surgery. ROLL and RSL techniques both allow surgeons to use a hand-held gamma probe intraoperatively to identify and excise target lesions.

Phantom models are generally used in medicine to provide simulated learning experiences for practitioners seeking to practice techniques and improve skills prior to clinical application. Computer-based models and training simulators for the sentinel node biopsy procedure have been previously described; however these models do not currently accommodate the ROLL or RSL techniques (8–10). The aim of our project was to describe an inexpensive, time-efficient, and reproducible training phantom model that would allow practitioners to learn and practice the skills necessary for RGL of occult breast lesions.

Methods

We designed a phantom model to teach the technique of RGL of occult breast lesions for surgical trainees and surgical faculty not yet familiar with the technique. In order to create this model, we obtained the supplies listed in Table 1. Model preparation requires three steps. The first step is to inject a volume of 0.1 ml of liquid radioactive tracer (Tc-Human Serum Albumin Makroaggregate-MAA) into a small green pea (Figure 1). The second step is to manually insert the pea into the pimento olive (Figure 2). The third and final step is to insert the pimento olive into the back-side of the turkey breast using the assistance of a scalpel to create the hole (Figure 3). The final model mimics an occult breast lesion with the turkey breast representing the breast and the olive representing the occult lesion. After the model is completed, a handheld gamma probe can then be used to localize the olive, as it will locate the area of maximum radioactivity. The appropriate incision can then be made over the area of maximal radioactivity, and with standard dissection techniques the olive can be removed. After removing the olive (representing removal of the cancerous lesion), the resection cavity can be checked for residual activity using the gamma probe (Figure 4). The

phantom model was constructed for a total cost of less than \$20 and prepared in approximately 10 minutes (this cost reflects the estimated US dollar equivalent of the price of materials obtained from a regular grocery store during initial model development in 2012). After the first model's construction, we constructed approximately 25 additional models and demonstrated that the model design was easily reproducible. In order to further evaluate this model among practicing surgeons, a breast surgery workshop focused on RGL was held in May 2012 during which 22 surgeons participated in RGL phantom training. Before the simulation training, all participating surgeons were given a three-hour introductory lecture on breast RGL by a multidisciplinary team of clinician faculty including physicians from nuclear medicine, breast radiology, and surgery. Following the lecture, the attendees were allowed to practice on the RGL phantom models.

Discussion

Standard surgical training under the supervision of a trained surgeon is time-consuming, costly, and of variable effectiveness (11). Simulation-based training has become an increasingly accepted part of modern medical education (12). A number of surgical simulators have been described, including computer-based models, synthetic models, cadavers, animals and animal organs (8,13–16). An ideal training model should be of low cost, widely available, and of similar consistency to the target organ (16). There are numerous advantages of our proposed RGL phantom model. It is made with easily available and inexpensive materials including a pea, olive, and a turkey breast, and the entire model costs under \$20. Additionally, the model is easily prepared and time-efficient, taking only approximately 10 minutes to construct. Compared to other available options for the model, the turkey breast is the optimal choice because turkey meat provides the most realistic simulation of breast tissue (17). Our breast turkey phantom model offers a realistic and safe learning model to practice breast procedures without posing a risk to patients or to learners. Excision of non-palpable breast cancer is a commonly performed surgical procedure given that occult lesions are frequently found during common breast-screening techniques. RGL is being increasingly used as an alternative to WGL for the management of non-palpable breast lesions. Practitioners interested in utilizing this advantageous technique are faced with the task of learning and perfecting the appropriate skills, thus making a phantom model a desirable tool to allow practice prior to clinical application. Performance tends to improve with experience as practitioners overcome the learning curve associated with new skills, further adding to the need for the development of an appropriate RGL simulation model.

The results of Murphy et al., which found that RGL was associated with longer median operative times than WGL during a 6-month period (55 vs. 48 min, $p < 0.0001$), may have been a reflection of the learning curve phenomena, especially given that numerous other trials have shown reduced operative times for breast surgeries using RGL compared to standard WGL techniques (18). Experience and training using a phantom model such as the one we have presented here for RGL could help practitioners overcome the learning-curve effect in a simulation based environment and allow them to improve their operative performance when applying their newly learned skills in the clinical environment.

Our study has a few limitations. First, our phantom model requires radiopharmaceutical for its construction, which often requires participation of the Nuclear Medicine department. The cost of both the radiopharmaceutical and the gamma probe, as well as the cost of surgical instruments, are not accounted for within the estimated model cost. Although the surgical instruments could be obtained relatively cheaply depending on quality desired, the radiopharmaceutical material and probe would most likely require access and permission from a Nuclear Medicine department and this may limit the feasible reproduction of our model. However given the small volume (0.1ml and 3–5 MBq per model) of radioactive tracer that is used, learners are not required to take special radiation protection measures, which makes the model easily used once it is created (19). Second, because our model has not yet been validated in an appropriate trial, further studies are warranted. Finally, the model is likely of most benefit to clinicians with limited experience using the gamma probe. However, even clinicians who routinely use the gamma probe for other techniques (such as sentinel node biopsy) may benefit from this model as it can offer them the opportunity not only to refine their gamma probe localization skills, but it can also introduce them to a new technique that they may find useful and begin using in clinical practice.

Conclusion

Our RGL phantom model provides an accurate simulation experience for the excision of non-palpable breast lesions, and it is both time- and cost-efficient to construct. The availability of the RGL training phantom will allow surgeons to obtain competence in a simulation-based environment prior to application of this technique in clinical practice, and will ideally improve their surgical performance when using RGL for surgical excision of non-palpable breast lesions.

Acknowledgments

This project was funded in part by the the NIH grant R25CA089017 (MAM) and Turkish Anti-Cancer Foundation (FA).

References

1. Aydogan F, Ozben V, Atasoy D, et al. Excision of axillary lymph node recurrences in breast cancer patients with axillary ROLL (A-ROLL). *J Surg Oncol*. 2010; 101:141–4. [PubMed: 19937993]
2. Aydogan F, Velidedeoglu M, Kilic F, Yilmaz H. Radio-guided localization of clinically occult breast lesions: current modalities and future directions. *Expert Rev Med Devices*. 2014; 11:53–63. [PubMed: 24308735]
3. Tükenmez M, Erbil Y, Barbaros U, et al. Radio-guided nonpalpable metastatic lymph node localization in patients with recurrent thyroid cancer. *J Surg Oncol*. 2007; 96:534–8. [PubMed: 17680637]
4. Ahmed M, Douek M. Radioactive seed localisation (RSL) in the treatment of non-palpable breast cancers: systematic review and meta-analysis. *Breast*. 2013; 22:383–8. [PubMed: 23673078]
5. Lovrics PJ, Cornacchi SD, Vora R, Goldsmith CH, Kahnani K. Systematic review of radioguided surgery for non-palpable breast cancer. *Eur J Surg Oncol*. 2011; 37:388–97. [PubMed: 21333482]
6. Sajid MS, Parampalli U, Haider Z, Bonomi R. Comparison of radioguided occult lesion localization (ROLL) and wire localization for non-palpable breast cancers: a meta-analysis. *J Surg Oncol*. 2012; 105:852–8. [PubMed: 22213057]

7. Zgajnar J, Hocevar M, Frkovic-Grazio S, et al. Radioguided occult lesion localization (ROLL) of the nonpalpable breast lesions. *Neoplasma*. 2004; 51:385–9. [PubMed: 15640944]
8. Britten A, Newey VR, Clarke R. A computerized gamma probe simulator to train surgeons in the localization of sentinel nodes. *Nucl Med Commun*. 2007; 28:225–9. [PubMed: 17264782]
9. Krynyckyi BR, Singh G, Colon D, et al. Training simulator for sentinel node biopsy (SLNB). *Eur J Surg Oncol*. 2005; 31:805–6. [PubMed: 15975758]
10. Keshtgar MR, Chicken DW, Waddington WA, Raven W, Ell PJ. A training simulator for sentinel node biopsy in breast cancer: a new standard. *Eur J Surg Oncol*. 2005; 31:134–40. [PubMed: 15698728]
11. Nagendran M, Gurusamy KS, Aggarwal R, Loizidou M, Davidson BR. Virtual reality training for surgical trainees in laparoscopic surgery. *Cochrane Database Syst Rev*. 2013 Aug 27.8:CD006575. [PubMed: 23980026]
12. Eppich W, Howard V, Vozenilek J, Curran I. Simulation-based team training in healthcare. *Simul Healthc*. 2011; 6:S14–9. [PubMed: 21817858]
13. Jackson A, Rajbhandari S. Developing a grapefruit model for assessment and training of diabetic foot ulcer debridement. *Simul Healthc*. 2014; 9:331–6. [PubMed: 25188487]
14. Martinek J, Suchanek S, Stefanova M, et al. Training on an ex vivo animal model improves endoscopic skills: a randomized, single-blind study. *Gastrointest Endosc*. 2011 Aug; 74(2):367–73. [PubMed: 21802589]
15. Kessler J, Moriggl B, Grau T. Ultrasound-guided regional anesthesia: learning with an optimized cadaver model. *Surg Radiol Anat*. 2014; 36:383–92. [PubMed: 23978870]
16. Sekhar A, Sun MR, Siewert B. A tissue phantom model for training residents in ultrasound-guided liver biopsy. *Acad Radiol*. 2014; 21:902–8. [PubMed: 24928159]
17. Fischmann A, Siegmann KC. Low-cost phantoms for training of stereotactic vacuum-assisted biopsy of the breast. *Clin Imaging*. 2010; 34:97–9. [PubMed: 20189071]
18. Murphy JO, Moo TA, King TA, et al. Radioactive seed localization compared to wire localization in breast-conserving surgery: initial 6-month experience. *Ann Surg Oncol*. 2013; 20:4121–7. [PubMed: 23943024]
19. Rampaul RS, Dudley NJ, Thompson JZ, et al. Radioisotope for occult lesion localisation (ROLL) of the breast does not require extra radiation protection procedures. *Breast*. 2003; 12:150–2. [PubMed: 14659345]

Figure 1.
Injection of the liquid radioactive tracer into the pea

Figure 2.
Insertion of the pea into the pimento olive

Figure 3.
The olive is embedded into the turkey breast via the back surface.

Figure 4.
The cavity is checked for residual activity by gamma-probe

Table 1

Materials Required for Construction of a RGL Phantom Model

1. One small pea2. One pimento olive3. One turkey breast4. Scalpel5. Forceps6. Gamma probe device7. Radioactive solution (0.1ml)8. One syringe9. Two sets of Latex gloves