The Journal of Emergency Medicine, Vol. 45, No. 2, pp. 240–243, 2013

Printed in the USA
0736-4679/$ - see front matter

ELSEVIER

http://dx.doi.org/10.1016/j.jemermed.2012.11.022

Ultrasound in Emergency Medicine

ULTRASOUND PHANTOMS MADE OF GELATIN COVERED WITH HYDROCOLLOID SKIN DRESSING

Shao-Lun Chao, MD,* Kuo-Chih Chen, MD,* Li-Wei Lin, MD,* Tzong-Luen Wang, MD, PHD,*† and Chee-Fah Chong, MSC, MD*†

*Emergency Department, Shin Kong Wu Ho-Su Memorial Hospital, Taipei, Taiwan, ROC and †School of Medicine, Fu-Jen Catholic University, New Taipei City, Taiwan, ROC

Reprint Address: Chee-Fah Chong, MSC, MD, School of Medicine, Fu Jen Catholic University, No.510 Chung-Cheng Road, Hsin-Chuang, New Taipei City 24205, Taiwan, ROC

□ **Abstract—Background: Ultrasound-guided invasive procedures, such as central venous catheter insertion, soft-tissue abscess drainage, and foreign-body removal are essential competencies for Emergency Physicians. Such competencies can be trained using ultrasound phantoms. Objective: Our aim is to describe ultrasound phantoms that are easily made, inexpensive, reusable, and can withstand multiple punctures. Methods: Previously recommended gelatin-only ultrasound phantoms have inadequate surface tension resulting in surface disruption, and cannot tolerate multiple punctures when simulating cyst drainage. Results: By covering the gelatin phantom with a hydrocolloid skin dressing, we are able to minimize physical surface disruption (by transducer or needles) and might reduce biological breakdown due to bacterial propagation. Conclusions: The elements required to construct homemade reusable ultrasound phantoms are inexpensive and can be easily obtained.** © 2013 Published by Elsevier Inc.

□ **Keywords—ultrasound; Emergency Medicine**

INTRODUCTION

Many invasive procedures like the insertion of central venous catheters (CVCs), soft-tissue abscess drainage, and foreign-body removal are essential competencies for Emergency Physicians. The use of ultrasound-guided approaches when performing these procedures is useful when difficulties are encountered using blind methods. Practicing with a simulator model has been shown to accelerate the acquisition of various skills of ultrasound-guided procedures (1).

However, commonly recommended ultrasound phantoms have inadequate surface tension resulting in surface disruption, and cannot tolerate multiple punctures (2–4). We describe an alternative model that is easily made, inexpensive, reusable, and can withstand multiple punctures.

METHODS

The materials required to construct the model include two shallow rectangular polyvinyl chloride (PVC) containers, one Latex rubber tube, and two patches of hydrocolloid skin dressings (DuoDERMR CGF® dressings; ConvaTec, Skillman, NJ) that are large enough to cover the surface of the phantom, pipette bulb, kitchen clip, gelatin powder, and sugar-free psyllium fiber (Metamucil Sugar Free; P&G, Cincinnati, OH; Figure 1).

After securing the phantoms in the PVC container and sealing gaps in the sides of the container, pour and mix 250 mL of boiling water, 40 g of unflavored gelatin, and 20 g of sugar-free psyllium fiber in the container to realistically simulate human tissue under ultrasound.

RECEIVED: 1 March 2012; FINAL SUBMISSION RECEIVED: 26 June 2012;
ACCEPTED: 5 November 2012

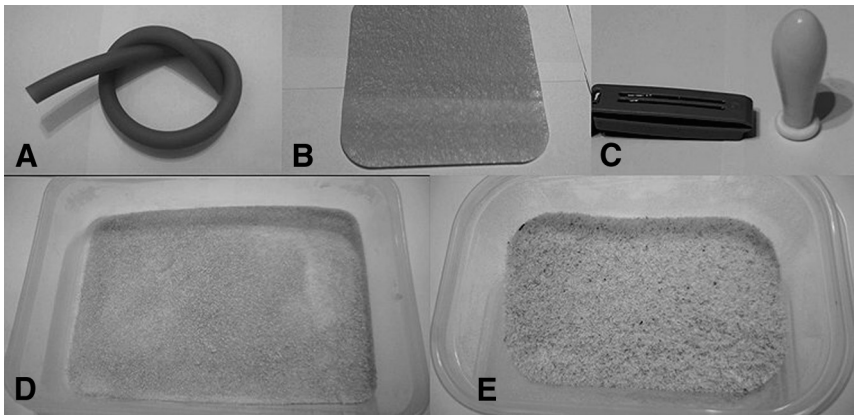

Figure 1. The Latex tube (A). The hydrocolloid skin dressing (B). The kitchen clip and the pipette bulb (C). The gelatin powder (D). The sugar-free psyllium fiber (E).

DISCUSSION

The CVC Insertion Model

In the CVC insertion model, first drill two holes, each on the opposite side of the PVC container, then embed the Latex rubber tube in the sides of the container and seal the gaps before filling the container with the gelatin mixture (Figure 2A). Trim the Latex rubber tube that protrudes out of the PVC container then seal the gap between the container and the tube with a silicone rubber compound (Figure 2B).

The Cyst Drainage Model

In the cyst drainage model, fill the pipette bulbs with tap water then seal with kitchen clips. We place the "faux cyst" on the bottom of the container then fill the container only once with the gelatin mixture (Figure 3).

Surface Dressing

Both models are chilled for 24 h until the surface is firm enough to support the hydrocolloid dressing. Trace the shape of the PVC container on the hydrocolloid and cut it out and apply it to the surface of the models. Finally, seal the gap between the container and the dressing with a silicone rubber compound (Figure 4).

Comparison with Previous Models

Based on our previous experience, the hydrocolloid phantom had the advantage of being able to be used repeatedly, as compared to the gelatin-only phantom. Hydrocolloid dressings are medical bandages that are used to dry out and protect certain types of wounds. They are sonolucent and tightly adhere to the surface of the gelatin matrix, allowing the transducer to move over the phantom without causing disruption to the surface (2,4). In addition, the hydrocolloid dressing

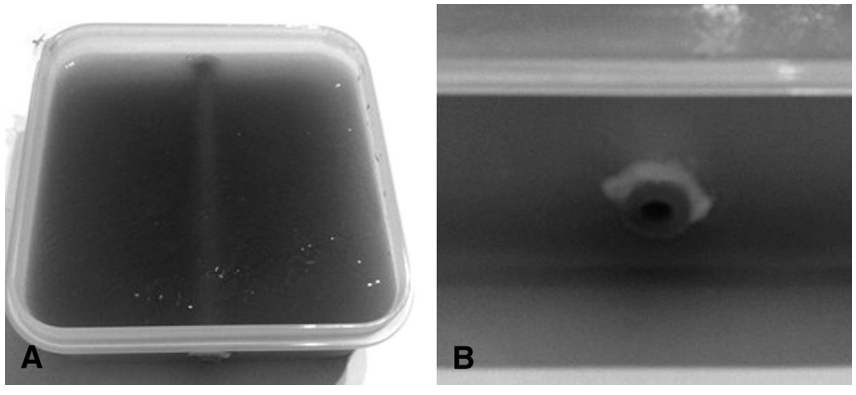

Figure 2. Embed the Latex rubber tube in the polyvinyl chloride container then fill the container with gelatin mixture (A) and trim the protruding tube and seal the gap between the container and tube (B).

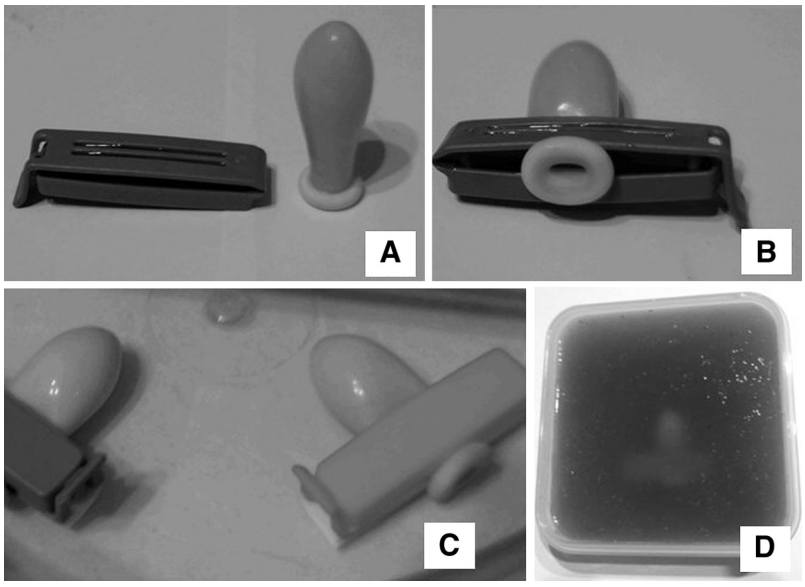

Figure 3. The kitchen clip for sealing the pipette bulbs (A). The pipette bulbs filled with tap water and seal by the clip (B). The faux cyst was placed on the bottom of the container (C). Place the faux cyst on the bottom of the container then fill the container only once with gelatin mixture (D).

might reduce the risk of bacterial propagation via direct contact with the gelatin, a potential culture medium for bacteria. The hydrocolloid-dressed models can be punctured repeatedly, as many as 20 times, and can be stored in regular refrigerators for as long as a month.

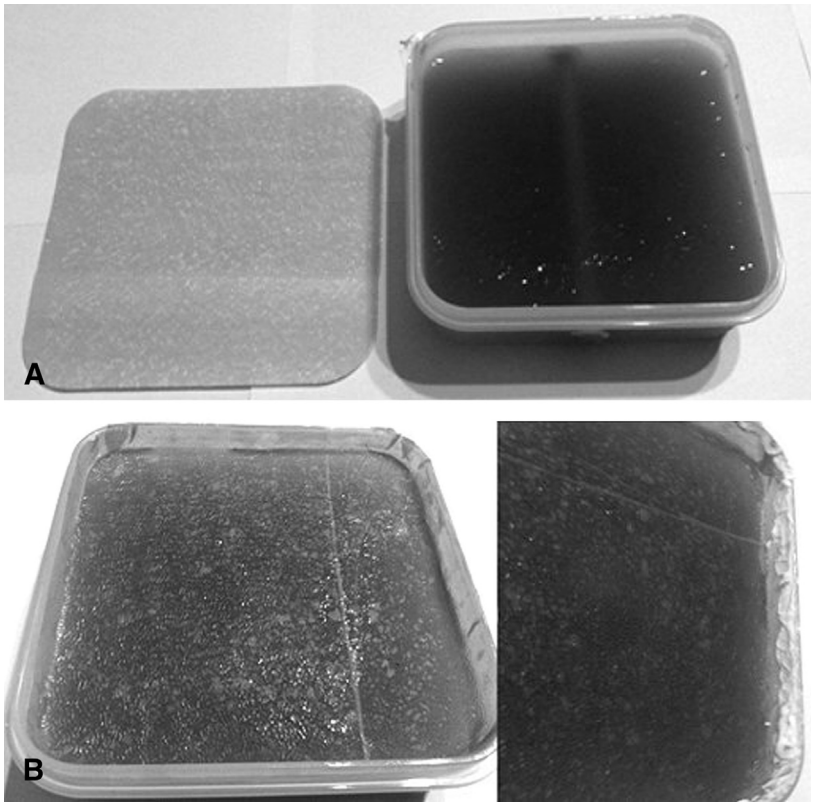

Figure 4. The hydrocolloid skin dressings (DuoDERM® CGF dressings), which is large enough to cover the surface of the phantom (A). Apply the dressing to the surface of the model and seal the gap between the container and the dressing with a silicone rubber compound (B).

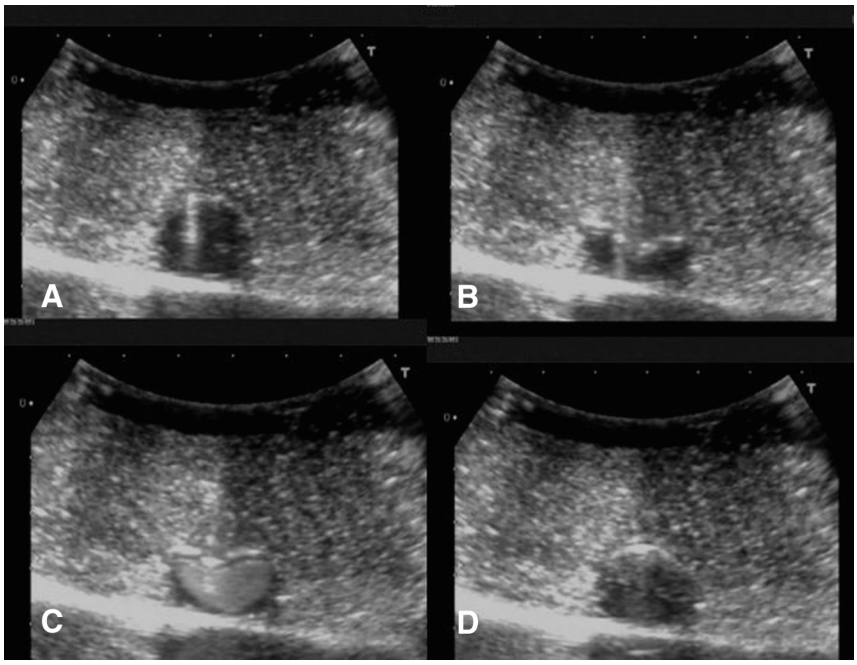

Figure 5. Sonographic view of the simulated cyst being punctured in the short axis plane (A). Cyst collapsed during drainage (B). Cyst showing turbid flow during refilling (C). Cyst returned to its original shape (D).

In the recommended CVC model, the tube protrudes out of both sides of the container to simulate the vessels, one side is connected to a syringe for refilling and the other side is clamped. The downside of this model is that the trainee can easily locate the embedded tube by visualizing an imaginary line between the protruding tubes, even though the phantom is covered by hydrocolloid dressing.

Previous models that attempted to simulate cyst or abscess drainage used balloons or Latex gloves filled with tap water, but they were not reusable and the models needed to be reconstructed each time the cyst was drained (2,4). In our model, we use pipette bulbs as faux cyst and place it on the bottom of the container then fill it only once. The pipette bulb is able to self-seal even after multiple needle punctures. It also tolerates drainage and refilling of fluid without losing integrity (Figure 5).

CONCLUSIONS

The elements required to construct these models are inexpensive and are easily obtainable. The hydrocolloid skin dressing, which costs $7−10 per patch, is also affordable because the models can be used repeatedly. The suggested ultrasound phantoms for CVC placement and cyst drainage are easily made, low-cost, reusable, and can withstand multiple punctures.

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