# Prospective Durability Testing of a Vascular Access Phantom

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*Supervising Section Editor*: J Christian Fox, MD
Submission history: Submitted July 26, 2009; Revision Received January 24, 2010; Accepted February 22, 2010
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**Introduction:** We assessed the acoustic transmission, image quality, and vessel integrity of the Blue Phantom™ 2 Vessel Original Ultrasound Training Model with repeated use.

**Methods:** The study consisted of two phases. During the first phase, a portion of the Blue Phantom™ rubber matrix (without a simulated vessel) was placed over a two-tiered echogenic structure and was repeatedly punctured with a hollow bore 18-gauge needle in a 1 $cm^2$ area. During the second phase, a portion of the matrix with a simulated vessel was repeatedly punctured with another hollow bore 18-gauge needle. During both phases we obtained an ultrasound image using a high-frequency linear probe after every 100 needle punctures to assess the effect of repeated needle punctures on image quality, acoustic transmission, and simulated vessel integrity.

**Results:** Testing on the rubber matrix alone (first phase) without a vessel demonstrated a gradual decrease in image quality and visualization of the proximal and distal portions of the target structure, but they remained visible after 1,000 needle punctures. The second phase demonstrated excellent acoustic transmission and image quality on both transverse and longitudinal images of the rubber matrix and simulated vessel after 1,000 needle punctures. The anterior and posterior vessel walls and needle tip were well visualized without any signs of vessel leakage on still images or with compression and power Doppler.

**Conclusion:** The Blue Phantom™ 2 Vessel Original Ultrasound Training Model demonstrated excellent durability after 1,000 needle punctures in a 1- $cm^2$ area. Based on the length of simulated vessel in each model, it should support over 25,000 simulated attempts at vascular access. [West J Emerg Med. 2010; 11(4):302-305.]

## INTRODUCTION

A large body of medical research advocates the use of ultrasound guidance when obtaining central and peripheral vascular access.[1-18] In addition, major governmental organizations have recommended using ultrasound guidance when obtaining central venous access.[19,20]

The increasing use of ultrasound guidance for vascular access has created an educational need. Vascular access phantoms that mimic human soft tissue and vascular structures allow for ultrasound-guided vascular access training without exposing patients to painful, risky procedures. While private corporations have begun producing these vascular access phantoms, they are often expensive and have not been subject to independent testing to ensure durability with repeated use.

The Blue Phantom™ (Kirkland, WA) 2 Vessel Original Ultrasound Training Model is commonly used to teach ultrasound-guided peripheral vascular access and therefore was selected for durability testing. It consists of a rubber matrix and fluid-filled tubes simulating human soft tissue and peripheral vascular structures, respectively. We conducted independent durability testing to assess its acoustic transmission, image quality, and vessel integrity with repeated use.

## METHODS

The study, approved by the local institutional review committee consisted of two phases. During the first phase a

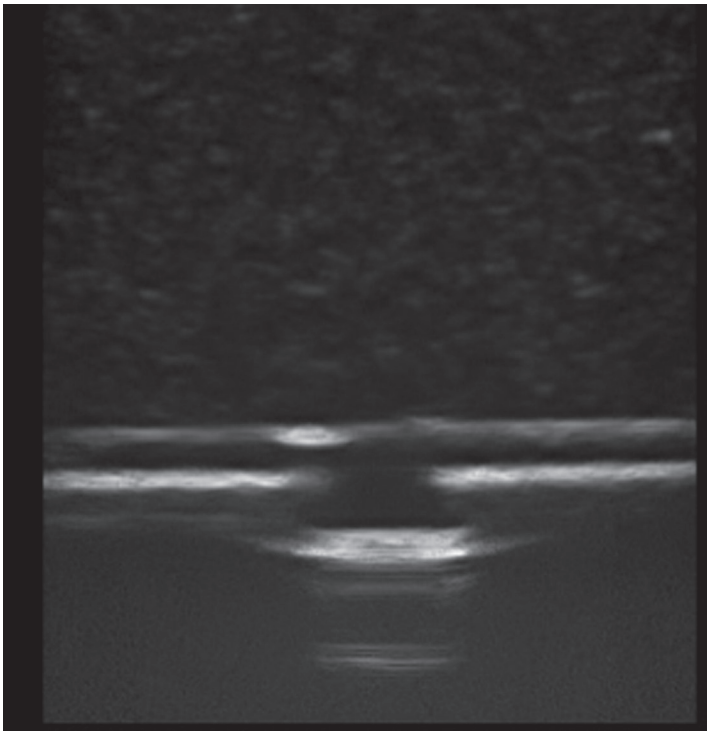

**Figure 1.** Image of the Blue Phantom™ rubber matrix placed over a two-tiered echogenic structure prior to any needle punctures.

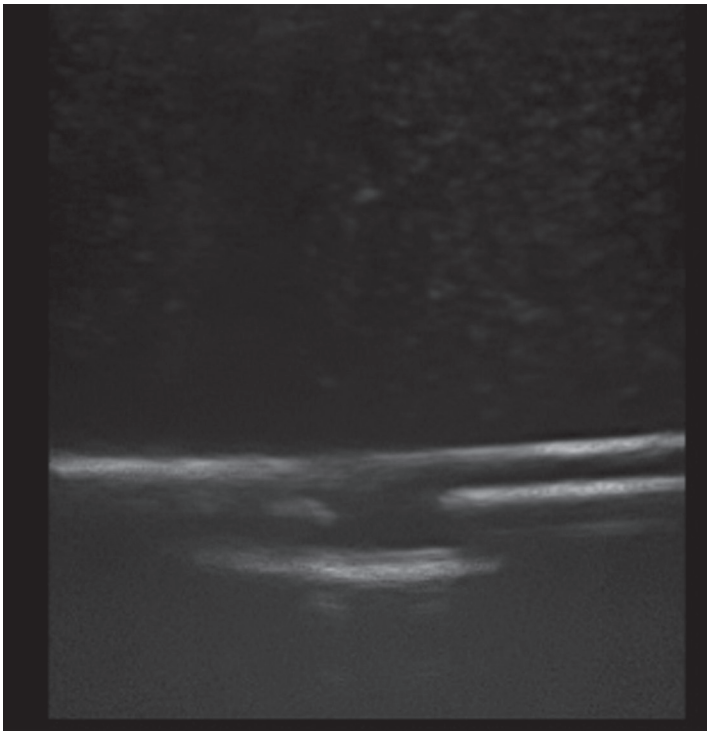

**Figure 2.** Image of the Blue Phantom™ rubber matrix placed over a two-tiered echogenic structure after 1,000 needle punctures in a 1 $cm^2$ area.

portion of the Blue Phantom™ rubber matrix (without a simulated vessel) was placed over an echogenic structure, in a water bath, and repeatedly punctured with a hollow bore 18-gauge needle in a 1 $cm^2$ area. We did this to test the acoustic transmission of the rubber matrix and visibility of the echogenic structure with repeated punctures. During the second phase we repeatedly punctured a portion of the matrix with a simulated vessel with another hollow bore 18-gauge needle in a 1 $cm^2$ area at a 45° angle. The simulated vessel was assessed for fluid leakage with active compression and power Doppler.

During both phases we obtained an ultrasound image using a Sonosite™ (Bothell, WA) M-Turbo ultrasound machine with a 25mm, 6-13 MHz linear probe after every 100 needle punctures to assess the effect of repeated needle punctures on image quality, acoustic transmission, and simulated vessel integrity. All settings (depth, gain, frequency, etc.) were unchanged during the acquisition of images. All images were obtained and later assessed qualitatively in digital format in an unblinded fashion by four board certified/eligible emergency physicians who were in an emergency ultrasound fellowship or had completed a fellowship. Both phases of the study were concluded after a total of 1,000 needle punctures.

## RESULTS

The first phase of testing on the rubber matrix alone without a vessel demonstrated a gradual decrease in image quality and visualization of the proximal and distal portions of the target structure, but they remained visible after 1,000 needle punctures. (Figures 1-2)

The second phase of the study demonstrated excellent acoustic transmission and image quality on both short- and long-axis images of the rubber matrix and simulated vessel after 1,000 needle punctures. The anterior and posterior vessel walls and needle tip were well visualized without any signs of vessel leakage on still images or with compression and power Doppler. (Figures 3-6)

## DISCUSSION

The Blue Phantom™ 2 Vessel Original Ultrasound Training Model demonstrated excellent durability after 1,000 needle punctures in a 1 $cm^2$ area. The rubber matrix demonstrated a gradual decrease in acoustic transmission, but this did not affect the ability to visualize the anterior and posterior walls of the simulated vessel or the needle tip. The integrity of the simulated vessel was well preserved without any signs of vessel leakage.

## LIMITATIONS

This study tested only one of the many different commercially available vascular access phantoms; therefore, the results may not be applicable to other products on the market. In addition, because we only punctured the simulated vessel and rubber matrix with an 18-gauge needle, these results may not be reproduced if a different needle size or a catheter/needle combination is used. Despite the

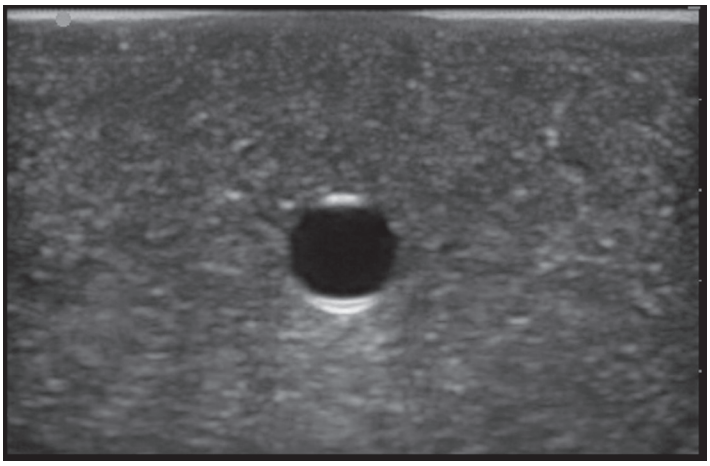

**Figure 3.** Short-axis image of the Blue Phantom™ rubber matrix and simulated vessel prior to any needle punctures.

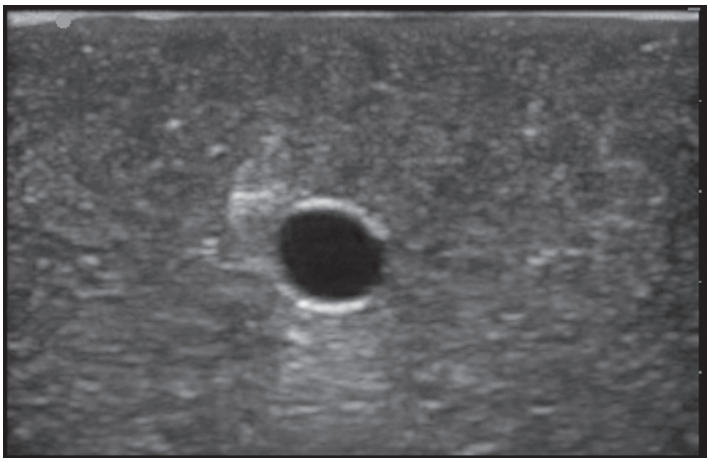

**Figure 4.** Short-axis image of the Blue Phantom™ rubber matrix and simulated vessel after 1,000 needle punctures in a 1 $cm^2$ area.

manufacturer's recommendation against this, some users who access the simulated vessel aspirate and then re-inject the fluid into the vessel, which often leads to air deposits in the phantom material. This practice and the air deposited can lead to more rapid image degradation than was seen in our study. Further research could address these variables.

## CONCLUSION

If the full length of simulated vessel contained in this vascular access phantom is used (excluding the vessel on the ends of the phantom), each model should support over 25,000 simulated attempts at vascular access without significant degradation in the integrity of the simulated vessel or the ultrasound image produced.

## SUPPORT DISCLOSURE

The Blue Phantom™ 2 Vessel Original Ultrasound Training Model was provided by the manufacturer for testing. They had no input into the study design or analysis of the results.

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*Conflicts of Interest:* By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources, and financial or management relationships that could be perceived as potential sources of bias. The authors disclosed none.



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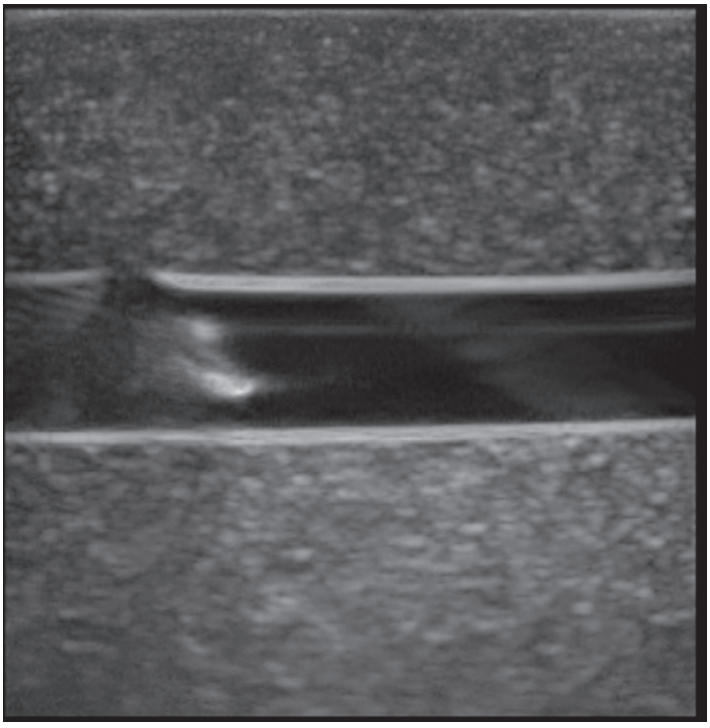

**Figure 5.** Long-axis image of the Blue Phantom™ rubber matrix, simulated vessel, and needle tip after the initial needle puncture.

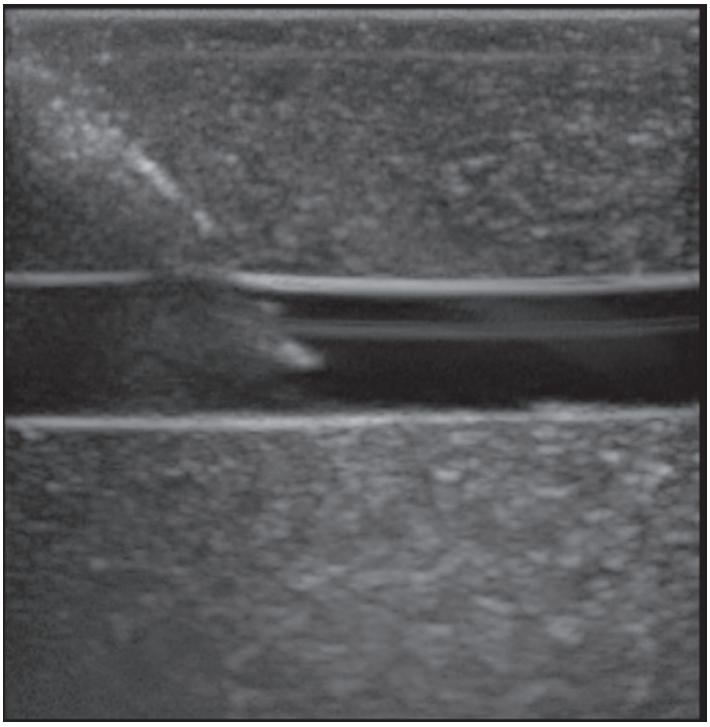

**Figure 6.** Long-axis image of the Blue Phantom™rubber matrix, simulated vessel, and needle tip after 1,000 needle punctures in a 1 $cm^2$ area at a 45° angle.


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