Advanced Low-Cost Ultrasound-Guided Vascular Access Simulation
The Chicken Breast Model

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Abstract: There is a growing body of literature that supports the use of ultrasound for vascular access. Advanced simulation has become a widely applied technique for training medical staff in vascular access. Nevertheless, advanced simulators are expensive and of limited usage. We describe both a step-wise systematic approach and an experimental cadaveric model of vascular access using a simple piece of chicken that can be easily used for trainees.

Key Words: ultrasound, teaching, animal model, simulation, vascular access

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There is a growing body of scientific evidence that supports the use of ultrasound (US) for vascular access.[1–3] However, the success of the technique requires additional training, and there is still lack of consensus on the number of procedures required to achieve this efficiency into the clinical practice.

Training in the use of US for vascular access is challenging. Emergency departments and intensive care units must satisfy very specific needs.[4] The use of advanced medical simulation is becoming a key component of training in vascular access. Nevertheless, advanced simulators for vascular access are expensive and of limited usage. There are limited data about the use of "homemade" simulation models as an alternative to the expensive existing models.[5,6]

The objective of this study was to describe an experimental cadaveric model of vascular access on the basis of using a simple piece of chicken breast and to describe a systematic approach for US-guided vascular access.

METHODS

Animal Cadaveric Model

A good-sized boneless and skinless piece of chicken breast bought at a local supermarket was used. The breast was kept in a standard freezer until 15 minutes before use. The chicken breast was then decontaminated for 5 seconds in a container with 10 mL of bleach diluted in 1 L of tap water. A 10-cm Penrose drain was used. A 3-way stop-cock was inserted in Penrose and secured with a 2-0 silk suture in one of the ends of the drain and the other end was directly tied with a 2-0 silk suture. A tunnel was made with tweezers in the chicken breast and the 10-cm Penrose was inserted (Fig. 1). Tap water was used to fill the drain.

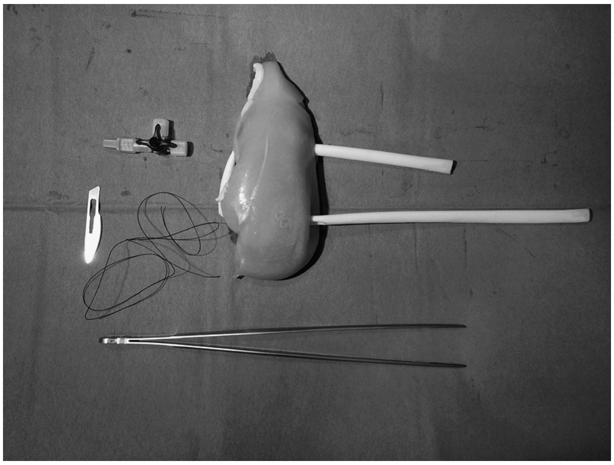

FIGURE 1. Model preparation. A Penrose drain is used. A 3-way stop-cock is inserted and secured with a 2-0 silk suture in one of the ends of the drain and the other end is directly tied with a 2-0 silk suture. A tunnel is made with tweezers in the chicken breast and the Penrose is inserted.

Procedure

A point-of-care US machine with a 12L-R linear probe was used for image acquisition. A 10-step systematic approach was designed to access the fake vessel on the basis of previous existing guidelines[1,2] (Table 1). A sterile cover kit was used. The probe

TABLE 1. Systematic Approach for US-Vascular Access

1. Ensure the use of sterile measures: plastic cover kit and sterile gel.
2. Appropriate probe positioning.
3. Ensure model/screen concordance: structures right sided to the examinee should be identified on the right side of the screen.
4. Appropriate depth adjustment.
5. Appropriate gain adjustment.
6. Structure identification and vessel recognition (cross-sectional view).
7. Depth measurement from skin to the center of the vessel (Fig. 3).
8. Initial approach (cross-sectional view), needle insertion.
9. Final approach (longitudinal sectional view), vessel cannulation.
10. Wire confirmation.

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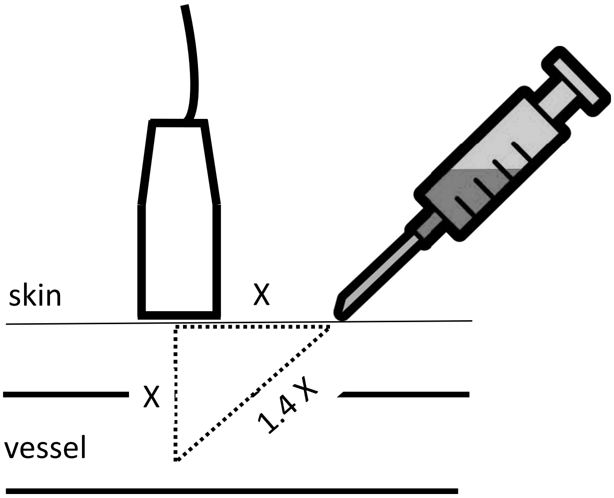

FIGURE 2. Pythagorean Theorem and US-guided vascular access. On a cross-sectional view, locate the vessel at the center of the screen. Measure the depth between the skin margin and the center of the fake vessel (x). Apply the same measured distance (X to the surface of the skin away from the US probe). The distance between the insertion point and the center of the vessel would then be calculated on the basis of the Pythagorean Theorem (1.4 × X). The hypotenuse of this triangle will be the distance that the needle would need to be advanced with an angle of 45° to end up with the tip at the center of the vessel.

was positioned with the dot to the left and concordance between the chicken position, operator and screen was ensured. A cross-sectional axis view was then obtained for structure visualization and vessel recognition. Vessel internal diameter was then measured. With the vessel in the center of the screen, the depth between the skin margin and the center of the fake vessel (x) was calculated. The same distance apply to the surface of the skin away from the US probe was used to locate the insertion point. The distance between the insertion point and the center of the vessel would then be calculated on the basis of the Pythagorean Theorem (in any right triangle, the hypotenuse is 1.4 times the length of the equilateral sides). The hypotenuse of this triangle will be the distance that the needle would need to be advanced with an angle of 45° to end up with the tip at the center of the vessel (Fig. 2).

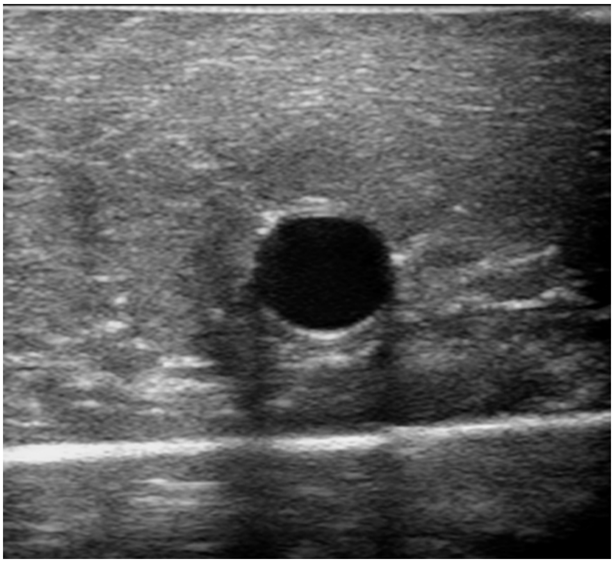

FIGURE 3. Cross-sectional view.

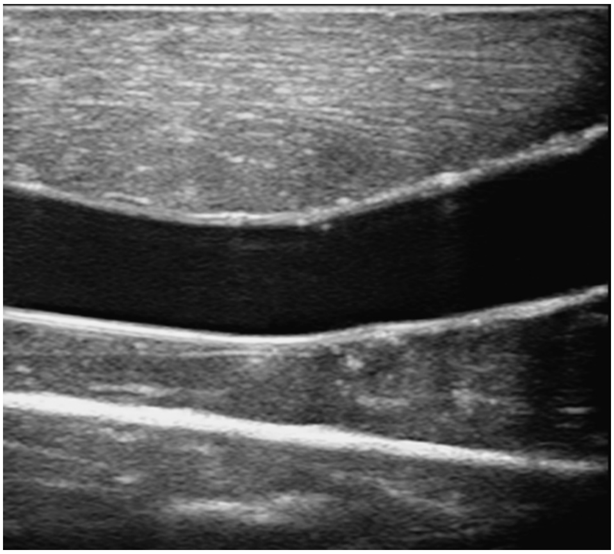

FIGURE 4. Longitudinal view.

Cross-sectional and longitudinal axis views were obtained (Figs. 3, 4). A 21-G needle was used. A US-guided vascular access cannulation was performed. With the probe in transverse position, a cross-sectional axis view was obtained for structure visualization. With the tip of the needle close to the superior wall of the vessel, a clockwise probe turn to longitudinal sectional plane was performed to identify the needle entering into the vessel. Once fluid return was obtained, a wire was introduced through the needle into the vessel and a confirmatory image was obtained (Fig. 5).

DISCUSSION

Our chicken breast model allows visualization of the US signs/images of vascular structures and made it possible to practice the systematic approach, wire introduction, and cannulation technique repeatedly.

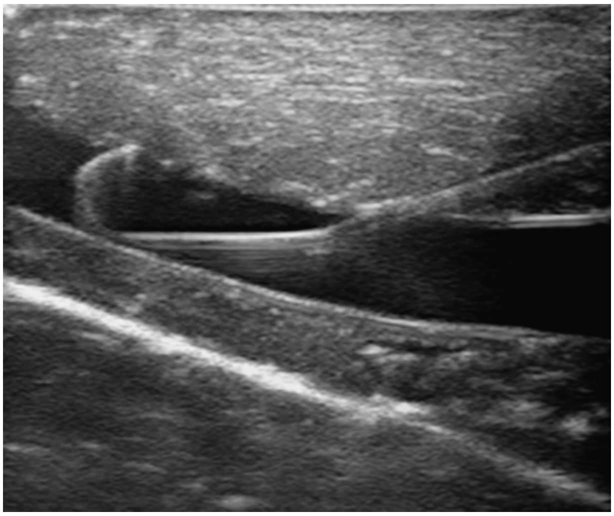

FIGURE 5. Wire confirmation.

The relatively low incidence of medical emergencies in pediatrics, together with other factors such as the increase in the number of medical residents in the emergency department and/or intensive care unit and timetable restrictions, makes the training on vascular access a challenge. A step-wise systematic approach along with the use of advance simulation is an essential component of the current training process in several institutions. In the last 10 years, advanced simulation has become a widely applied technique. Several models exist for US-vascular access but those are expensive and of limited use. Some groups have built simple homemade simulators using different materials such as silicone or meat with positive results.[5–7] In our case, the combination of a chicken breast model and a stepwise systematic approach helped us establish a model to train our staff in US-guided vascular access.

CONCLUSIONS

The use of cadaveric animal models can be integrated in the armamentarium of advance simulators in US-guided vascular access, resulting in a low economic cost of personnel training.

REFERENCES

1. Lamperti M, Bodenham AR, Blaivas M, et al. International evidence-based recommendations on ultrasound-guided vascular access. *Intensive Care Med*. 2012;38:1105–1117.
2. Troianos CA, Hartman GS, Glas KE, et al. Guidelines for performing ultrasound guided vascular cannulation: recommendations of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. *J Am Soc Echocardiogr*. 2011;24:1291–1318.
3. Schindler E, Schears GJ, Hall SR, et al. Ultrasound for vascular access in pediatric patients. *Paediatr Anaesth*. 2012;22:1002–1007.
4. Mencía S, López-Herce J, Botrán M, et al. Evaluation of advanced medical simulation courses for training of paediatric residents in emergency situations [in Spanish]. *An Pediatr (Barc)*. 2013;78:241–247.
5. Hocking G, Herbard S, Mitchell CH. A review of the benefits and pitfalls of phantoms in ultrasound-guided regional anesthesia. *Reg Anesth Pain Med*. 2011;36:162–170.
6. Kendall JL, Faragher JP. Ultrasound-guided central venous access: a homemade phantom for simulation. *CJEM*. 2007;9:371–373.
7. Baddoo H, Djagbletey R, Owoo C. A simple tissue model for practicing ultrasound guided vascular cannulation. *Ghana Med J*. 2014;48:47–49.