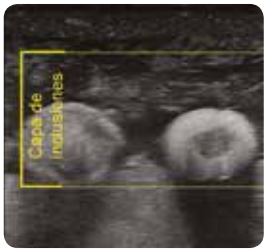

CONSTRUCTION, REPAIR AND MAINTENANCE OF ULTRASOUND PHANTOMS

Construcción, reparación y mantenimiento de simuladores de paciente (fantomas) de ecografía

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Summary

Ultrasound phantoms are useful for teaching ultrasound and particularly in the instruction of ultrasound guided techniques. They are commercially available, being expensive, or they can be inexpensively built using gelatin. We built gelatin phantoms for the instruction of ultrasound guided techniques and during the practice they deteriorated due to the apprentices lack of experience. We developed repair techniques for gross ruptures in the surface, for small dents resulting from multiple punctures and finally for the growth of microorganisms.

Resumen

El uso de simuladores "fantomas" o *fantoms* ha demostrado ser de utilidad para la enseñanza de ultrasonido y particularmente para la enseñanza de técnicas de intervencionismo guiado por ecografía. Los fantomas se pueden conseguir comercialmente, aunque son costosos, o se pueden construir utilizando gelatina, lo cual es más económico. Construimos fantomas de gelatina para la instrucción de técnicas de intervencionismo y, como es natural, estos se deterioraron ostensiblemente con el uso debido a la falta de experiencia de los estudiantes. Por lo tanto, desarrollamos técnicas de reparación para rupturas grandes de la superficie, para el deterioro por el uso de agujas en repetidas ocasiones y finalmente para el deterioro ocasionado por crecimiento de microorganismos.

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Introduction

Gelatine *phantoms* are useful elements for ultrasound instruction and particularly for the instruction of interventional techniques (1-7). It is economical to build phantoms with gelatine, which can be used to train different ultrasound guidance techniques for puncture, drainage and biopsy (7-9). People in training put excessive pressure on the phantom and can break it. Additionally there is deterioration by multiple punctures and growth of microorganisms when storage is prolonged.

Methods

Construction technic

The conventional technique of building phantoms with gelatine was used, following the four-step method described in the literature by Philippe Jeanty (thefetus.net) (10).

Base coat: 25 g of gelatine are added to 250 ml of boiling water. The most economical commercial presentation available is used, with artificial flavour and aroma and dark colour to hide inclusions. Add 10 g (one tablespoon) of psyllium hydrophilic muciloid fibre (trade name: Metamucil) to simulate tissue ecogenicity (Figure 1). It is shaken gently so that the ecogenic fibers produced by the psyllium are in suspension. A layer approximately 3 cm deep is added to a plastic container, avoiding the introduction of air bubbles at all costs. The gelatine is refrigerated at 6 °C for 12 hours until it has a firm consistency (Figure 2).

Layer of inclusions: The use of different inclusions allows different exercises to be performed. Fingers of latex gloves filled with water with dyes were used to make "cysts". The dyes do not alter the ecogenicity of the water but allow different drainage exercises to be developed. Some gloved fingers were filled with gelatin from the base layer with psyllium for "isoecogenic material" and some with triple psyllium for "ecogenic material". Some cigarette fragments (20 mm, 30 mm, 40 mm) are added and used to percutaneously "channel" them with needles. In addition, some fragments of wood, glass and metal are included to observe artifacts related to these materials. Finally, grapes, stuffed olives and capers are included for "percutaneous needle biopsy" exercises (Figure 3).

Because inclusions float, the technique of anchoring the inclusions to the proper depth within the phantom consisted of preparing a compound with 25 g of gelatin, 250 ml of boiling water, and 10 g (one tablespoon) of psyllium hydrophilic muciloid fiber. Apply a thin layer of gelatine of approximately 1 cm sufficient to cover 80% of the height of large inclusions and refrigerate at 6 °C for 12 hours. This step is repeated twice until the inclusions are covered (Figure 4).

Surface layer: To 200 ml of boiling water (less water is used to make this layer firmer and more resistant), add 25 g of gelatine and 10 g (one tablespoon) of hydrophilic muciloid fibre psyllium. A surface vinyl membrane (vinipel) is used over the surface layer to protect the surface. It is not recommended to de-mould it once finished and it is not necessary to add antiseptic to the gelatine. While it is not in use it should be kept refrigerated (figure 5).

Deterioration due to use

People in training put a lot of pressure on the transducer, which breaks the surface of the phantom (rupture). Additionally, after multiple punctures, the surface of the phantom is deteriorated and the vinyl membrane is broken. And with the passage of time, approximately 5 weeks, after prolonged storage fungi appear on the surface (Penicillum sp). The repair and maintenance techniques are described below.

Repairing ruptures: We did not find the technique of repairing ruptures described in the literature, so we developed our own technique. Initially we removed the vinyl membrane. With a hair dryer we "melt" the edges of the gelatin rupture until it is locally liquefied and repaired and left to cool.

Figure 1. Ingredients.

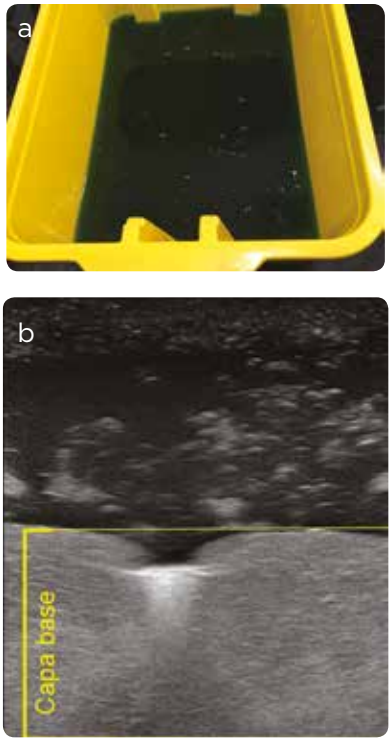

Figure 2. a) Base layer with few bubbles. b) Ultrasound image of the base layer.

Figure 3. Inclusions: elements of different ecogenicity and consistency for training in puncture, drainage and biopsy techniques.

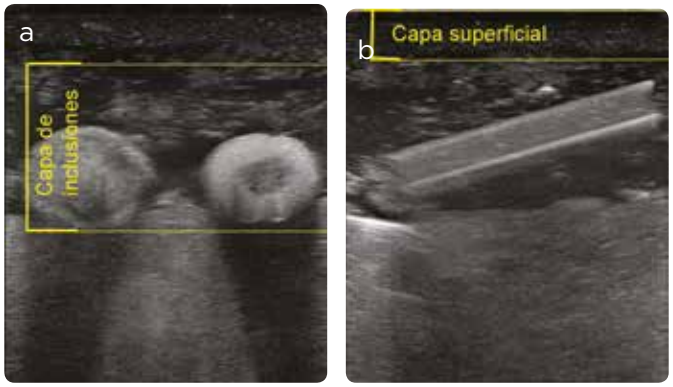

Figure 4. a) Anchoring of inclusions. b) Ultrasound aspect of inclusions.

Figure 5. a) Surface layer with vinyl coating. b) Ultrasound aspect of the surface layer.

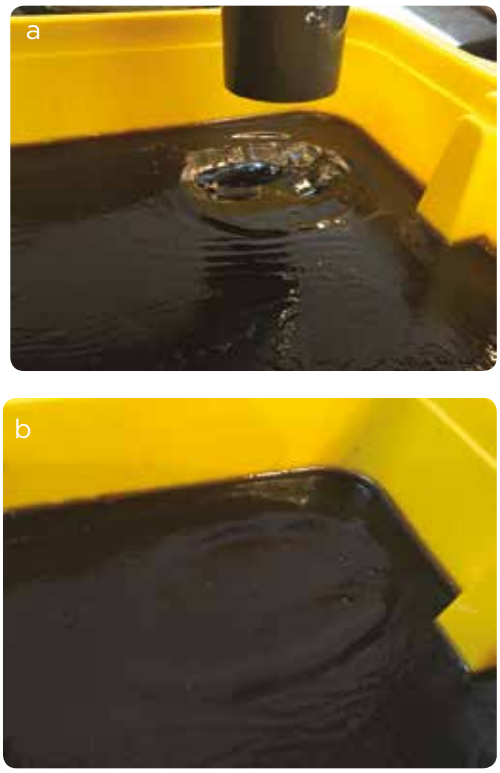

Figure 6. a) Repair process of coarse rupture using high temperature hair dryer. b) Appearance with finished repair.

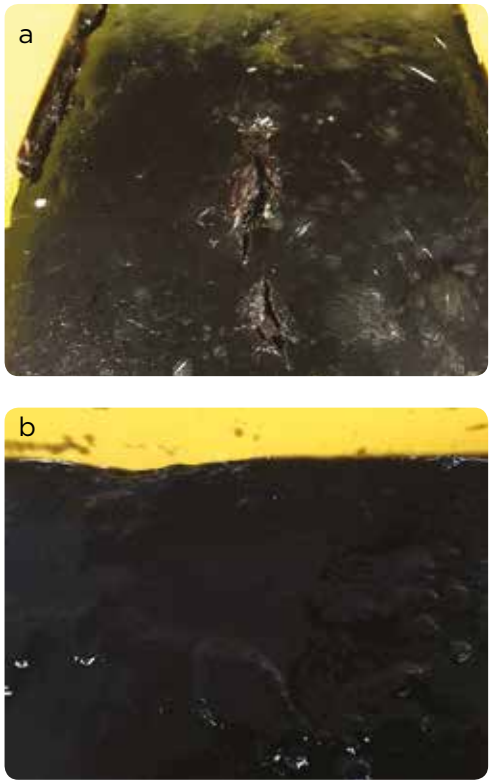

Figure 7. a) Surface deteriorated by use. b) Appearance of the surface with the restoration finished.

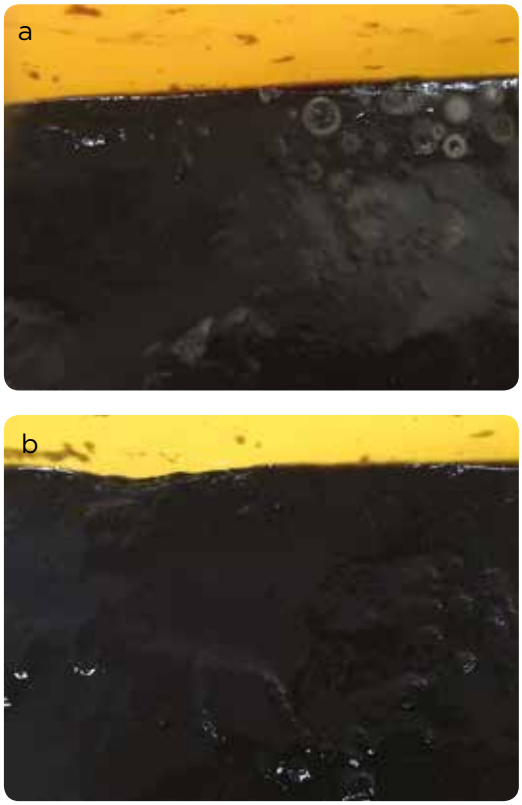

Figure 8. a) Growth of fungi on the surface. b) Appearance of the surface after the elimination of fungi.

Additionally, before starting the training session, the vinyl membrane is replaced, avoiding the formation of air bubbles (figure 6).

Surface Restoration: The post-puncture surface wound restoration technique requires a similar technique. Initially the vinyl membrane is removed. 50 cm3 of boiling water (100 °C) is applied directly to the surface of the phantom so that it "melts" the surface slightly and restores its surface integrity after repeated punctures. Before the training session begins, the vinyl membrane is replaced to prevent the formation of air bubbles (Figure 7).

Fungi removal

The technique of restoring the surface by fungal growth is not described, so we developed our own technique. The vinyl membrane is removed. 50 cm3 of boiling water (100 °C) is applied directly to the surface of the phantom so that it "melts" the surface slightly and the surface is gently "scraped" so that the fungal colonies are detached. Before starting the training session, the vinyl membrane is replaced, preventing the formation of air bubbles (Figure 8).

Results

We used four phantoms for teaching interventionism guided by ultrasound for 8 weeks. The phantoms underwent maintenance after each use session, and were repaired multiple times for ruptures.

Additionally, the surface of each phantom was restored after each session, replacing the superficial vinyl membrane. After 6 weeks of use it was necessary to start the restoration to eliminate fungus. The four phantoms were able to continue to be used after 8 weeks.

Discussion and conclusions

The gelatine phantoms are useful elements for the ultrasound instruction and particularly for the instruction of intervention techniques. It is economical to build gelatine phantoms, which can be used to train different ultrasound guidance techniques for puncture, drainage and biopsy. People in training put excessive pressure on the phantom and can break it. Once this occurs, it is possible to repair it. In addition, it is important to restore the surface of the phantom after each use and, if necessary, eliminate the fungi that may appear on the surface by prolonged storage. The repair and restoration of the phantoms extends their useful life, according to our experience, up to 8 weeks.

References

1. Beaulieu Y, Laprise R, Drolet P, et al. Bedside ultrasound training using web-based e-learning and simulation early in the curriculum of residents. Crit Ultrasound J. 2015; 7:1.
2. Evans LV, Dodge KL, Shah TD, Kaplan LJ, Siegel MD, Moore CL, Hamann CJ, Lin Z, D'Onofrio G. Simulation training in central venous catheter insertion: improved performance in clinical practice. Acad Med. 2010;85:1462-9.
3. Hoskote SS, Khouli H, Lanoix R, et al. Simulation-based training for emergency medicine residents in sterile technique during central venous catheterization: impact on performance, policy, and outcomes. Acad Emerg Med. 2015;22:81-7.
4. Lenchus J, Issenberg SB, Murphy D, et al. A blended approach to invasive bedside procedural instruction. Med Teach. 2011;33:116-23.
5. Shanks D, Wong RY, Roberts JM, Nair P, Ma IW. Use of simulator-based medical procedural curriculum: the learner's perspectives. BMC Med Educ. 2010;10:77.
6. Lo MD, Ackley H, Solari P. Homemade ultrasound phantom for teaching identification of superficial soft tissue abscess. Emerg Med J. 2012;29:738-41.
7. Shao-Lun Chao, Kuo-Chih Chen, Li-Wei Lin, Tzong-Luen Wang, Chee-Fah Chong. Ultrasound Phantoms made of gelatin covered with hydrocolloid skin dressing. J Emerg Med. 2013;45(2):240-3.
8. Morrow DS, Cupp JA, Broder JS. Versatile, reusable, and inexpensive ultrasound phantom procedural trainers. J Ultrasound Med. 2016;35:831-41.
9. Wilson J, Ng L, Browne V, Lewiss RE. An easy-to-make, low-cost ultrasound phantom for simulation training in abscess identification and aspiration. J Ultrasound Med. 2017;36(6):1241-4.
10. Jeanty P, Jeanty T. How to make an ultrasound phantom to teach ultrasound biopsy and guidance [internet]. 2014 [citado 2018 abr. 2]. Disponible en: https://sonoworld.com/TheFetus/page.aspx?id=3450

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