



Al Lawati, Z. M.R. and Varsou, O. (2020) Ultrasound lumbar spine clinical training phantom: Which is the best embedding medium? *Medical Ultrasonography*, 22(3), pp. 378-379.

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Deposited on 1 October 2020

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Title: Ultrasound Lumbar Spine Clinical Training Phantom: Which is the Best Embedding Medium?

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Keywords: Education; Clinical Training; Phantoms; Ultrasound

To the Editor,

Lumbar puncture and central neuraxial blocks (e.g. epidural) are common clinical procedures. These were traditionally performed using anatomical landmarks and haptic feedback [1]. However, landmarks are not always palpable (e.g. in patients with high BMI or edema) [1,2]. Ultrasound is increasingly used to guide healthcare professionals during such procedures. Ultrasound improves success rate on first attempt for central neuraxial blocks [1] and aids identification of lumbar puncture landmarks in patients with high BMI [2]. Additionally, ultrasound is characterized by real-time non-invasive scanning without any ionizing radiation [1,3].

Ultrasound phantoms (i.e. synthetic devices simulating human structures) are used for demonstration/clinical training [4]. Phantoms are not associated with incidental findings [3] and are easily accessible with good anatomical fidelity [4]. Their custom-made nature allows for tailored scanning and repetitive interventional training [3,4]. Novices can acquire clinical skills when using phantoms for training [5]. However, commercial phantoms can be costly to purchase [3,4].

We developed three ultrasound lumbar spine clinical training phantoms using different embedding media simulating adipose tissue; i) agar agar (Special Ingredients; UK) prepared as per the manufacturer's recommendations and using an adapted protocol from Scheppler et al. [6] ; ii) agar agar with psyllium husk (Planète au Naturel; France) prepared as per the manufacturer's recommendations using a layered approach for embedding; and iii) artificial gelatin number 0 (Humimic Medical; USA) prepared as per the manufacturer's recommendations. Standard latex tubing was used to simulate the dura mater within a pre-made model of the lumbar spine (Zgood Dental 1:1.5 Medical Spine Lumbar Disc Herniation Model; Zgood; China).

The agar agar phantom was the most affordable, whereas the agar agar with psyllium husk had the best background echogenicity. The artificial gelatin phantom had the longest shelf life allowing for repetitive use. Overall, each phantom had advantages and disadvantages (Table 1) with the final decision as to which one to adopt guided by its ultimate purpose. In the future, we will replace the latex tubing with an alternative that does not pose a potential allergy risk and we will start simulating additional anatomical structures (e.g. ligaments). We will also invite healthcare professionals to try the phantoms and provide feedback.

Location of Table 1.

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Table 1: Characteristics of the three different lumbar spine phantoms.

Characteristics	Agar Agar	Agar Agar with Psyllium Husk	Artificial Gelatin
Development	Easy	Moderate	Moderate
Development duration	2 hrs 45 min	3 hrs 15 min	3 hrs 30 min
Anatomical fidelity	Moderate	Good	Moderate
Tissue firmness	Firm	Average	Firm
Background echogenicity	Moderate	Good	Poor
Repetitive use	Once	Once	Several times
Shelf life	~45 min	~45 min	Long lasting
Cost*	£30.93	£40.92	£41.82
Use alongside cadaveric tissue	Yes	Yes	Yes

*Indicates cost in pound sterling, including VAT, at the time of the experiment (September 2019) calculated based on the purchase price of each item and not including any lab equipment.