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REVIEW

Ultrasound-guided vascular cannulation in critical care patients: A practical review

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Abstract Vascular cannulation is common practice in critical care, and is traditionally performed using the landmark technique – though failures and complications are not uncommon. In this regard, ultrasound guided vascular cannulation (USGVC) has been shown to improve the procedure success rate and reduce its associated complications. This review addresses the fundamental aspects of USGVC and discusses some training issues related to this technique which is currently regarded as essential for intensivists.

PALABRAS CLAVE
Ecografía;
Canulación vascular;
Técnicas;
Cuidados críticos

Canulación vascular eco-dirigida en pacientes críticos: una revisión práctica

Resumen La canulación vascular es una práctica común en cuidados críticos. Este procedimiento se realiza clásicamente siguiendo referencias anatómicas, siendo comunes los fallos y complicaciones relacionadas al mismo. Al respecto, la canulación vascular eco-dirigida (CVED) ha demostrado mejorar el rédito del procedimiento y reducir las complicaciones asociadas al mismo. Esta revisión trata sobre los elementos fundamentales de la CVED, como también menciona algunos aspectos del entrenamiento en esta competencia considerada hoy día fundamental para los intensivistas.

Introduction

Venous and arterial cannulations are common and necessary practices in critically-ill patients worldwide. Although vascular accesses are usually obtained using the anatomical landmark technique, this practice is not exempt from failures and complications. In this respect, ultrasound-guided vascular cannulation has been shown to improve first pass success, reduce the number of attempts, improve patient's satisfaction and reduce overall procedure-related complications. Therefore, this method is increasingly used

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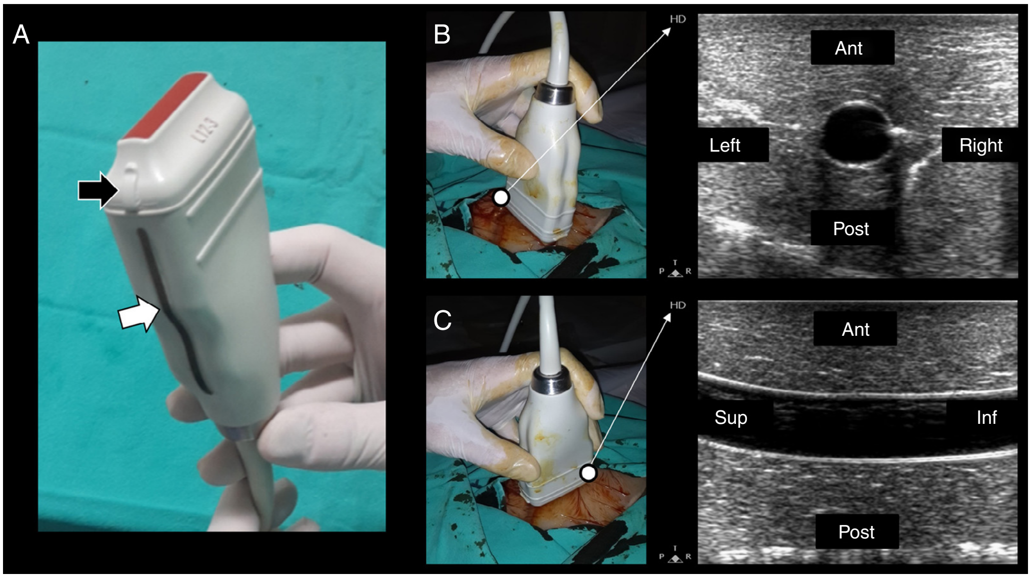

Figure 1 (A) Lineal transducer. The transducer indicator is in this case represented by a salient (black arrow) and a dark-gray line (white arrow). This indicator demarcates the beam leading edge that corresponds to a mark on the screen (in this machine, ''HD'' in B and C). (B) In the short axis, the probe indicator is pointing toward the operator's left side, matching the left side of the ultrasound machine screen. In this axis, the vessels are shown round (arteries) or oval (veins). (C) Starting from the short axis, the transducer is rotated 90 degrees clockwise, thus obtaining the vessel long axis. The probe indicator is located furthest from the operator (Sup.) and matching, again, the screen left side. In this axis, the vessels appear tubular. Ant.: anterior; Post.: posterior; Sup.: extreme of the transducer furthest from the operator; Inf.: extreme of the transducer close to the operator.

as a first choice to obtain tool to obtain a secure vascular access in critical care patients.[1–5]

The proposal of this review is to summarize and simplify the fundamental sonographic aspects at the moment of deciding and executing an ultrasound-guided vascular access, and it also intends to highlight some aspects related to the optimal training for this practice.

Technique and ultrasonographic vascular anatomy

Since vascular structures are superficial, a linear array transducer (7–10 MHz) (Fig. 1A) is commonly used to recognize the vessels, with the selection of a preset corresponding to veins or arteries, as the case may be.

Two-dimensional imaging is primarily used, both in the short and long axis of the vessels. In some circumstances, color and spectral Doppler can be required.[1,2,6,7] Three-dimensional ultrasound, although an interesting technique, is scarcely used and is not actually recommended in practice for vascular cannulation.[1]

In terms of orientation, the probe indicator is pointed toward the operator's left side for short-axis views; to obtain long-axis views, the probe is rotated 90° clockwise from the latter position. In this way, the left side of the screen matches the operator's left side in short-axis views, while it matches the probe end located furthest from the operator in long-axis views (Fig. 1B and C).

Regarding transducer manipulation, resting the medial edge and/or the transducer operator's fingers on the patient is the best way to prevent the transducer from unintentionally slipping; on the contrary, vague hand positions will predispose to fatigue and unintentional transducer movement.[8]

Depth, gain and focal zones are the most important machine parameters that practitioners always need to optimize to carry out the best possible evaluation on the vessels. Preferably, tissue harmonic imaging must be switched off, especially for further needle recognition[8] (see below) (Fig. 2).

In the short axis, the veins are more oval than round, have an anechoic content, their walls are thin, they are fully compressible and, lastly, they are not pulsatile. On the contrary, the arteries are round, also have an anechoic content, have a thicker wall in comparison with veins, are poorly compressible and, lastly, they have pulsatility[2,7] (Fig. 3A).

In the long axis, the vessels appear tubular (Fig. 3B and C). Valves can sometimes be observed in the veins, with the corresponding normal opening and closing movements. Arteries lack valves. In some cases, when a proximal tourniquet is applied in the veins, stagnant blood, also called rouleaux, can be observed as internal mobile echoes within the vein, fully cleared when compressed with the transducer.

Using color and spectral Doppler, veins normally have a phasic flow (Fig. 3D) (having augmentation with distal compression), whereas arterial flow is pulsatile (Fig. 3E).

Superficial veins are found above the deep fascia and muscle, and they are not accompanied by arteries. On the contrary, deep veins are located below the deep fascia and are always accompanied by arteries (and nerves) in the neurovascular bundle (Fig. 3F).