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CORRESPONDENCE

A trigonometric method to confirm needle tip position during out-of-plane ultrasound-guided regional blockade

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To the Editor,

A common challenge using the out-of-plane approach during ultrasound-guided regional blocks is ensuring that the hyperechoic dot visualized on the screen is the needle tip and not the cross-section of the needle shaft. For superficial targets (1-2 cm), this can often be overcome by employing the "walkdown" approach. This technique involves inserting the needle at incrementally steeper angles, allowing identification of the tip until it is observed adjacent to the target nerve.[1] With this method, the needle is inserted at a final angle of 45°, and the distance between the needle and probe equals the depth of the nerve.

At depths greater than 2 cm, the "walkdown" approach becomes impractical. Targeting any nerve deeper than 2 cm requires a long needle because the needle insertion depth increases in proportion to the target depth and insertion distance. For example, using the Pythagorean theorem ($a^2 + b^2 = c^2$), where a is a target depth of 3 cm, b is an insertion distance of 3 cm, and c is the needle insertion depth required to reach the target (see Figure), we find that a 5 cm needle would be barely long enough to reach the target ($c = \sqrt{(3^2 + 3^2)} = 4.24$). Moreover, the further distance the needle is from the transducer, the further distance the needle must traverse tissue without real-time ultrasound guidance, in effect "blinding" it to the structures in its trajectory.

Alternatively, we can circumvent these problems by reducing the distance between the insertion site and the ultrasound beam. Ideally, the needle would be inserted perpendicularly along the ultrasound scanning plane; however, in reality, the minimum distance is about 0.5 cm due to the space occupied by the footprint of the transducer. Again, applying the principles of trigonometry, a distance $\leq$ 1 cm between the needle and the ultrasound beam becomes negligible as the target depth increases, and the needle insertion depth becomes comparable with the target depth. For instance, the difference between the depth of needle insertion and the actual depth of the target is minimal when the needle is directly adjacent to the transducer with a maximum distance of 1 cm away from the ultrasound beam:

$$\text{Needle length required} = \sqrt{\left((2\text{ cm target depth})^2 + (1\text{ cm insertion distance})^2\right)} = 2.2\text{ cm}$$

Visualizing the needle tip and ensuring its position under ultrasound has been shown to be one of the more difficult tasks that the novice regional anesthesiologist must master.[2,3] The approach described above enables the clinician to determine whether the hyperechoic dot on the ultrasound screen is the needle tip or shaft by comparing the needle marking at skin level with the ultrasound depth of the dot (i.e., same depth = tip; needle > dot = shaft), as illustrated in the Figure. At a depth of 2 cm in the ultrasound image, the hyperechoic dot will likely be the shaft if the needle marking at skin level is greater than 2 cm. This information can be useful to avoid "overshooting" the target, and it is particularly important during out-of-plane nerve blocks where vital structures lie directly beneath the target (e.g., in a paravertebral block where the pleura can be directly underneath the paravertebral space). Thus, for targets deeper than 2 cm, we encourage clinicians to check the markings on the

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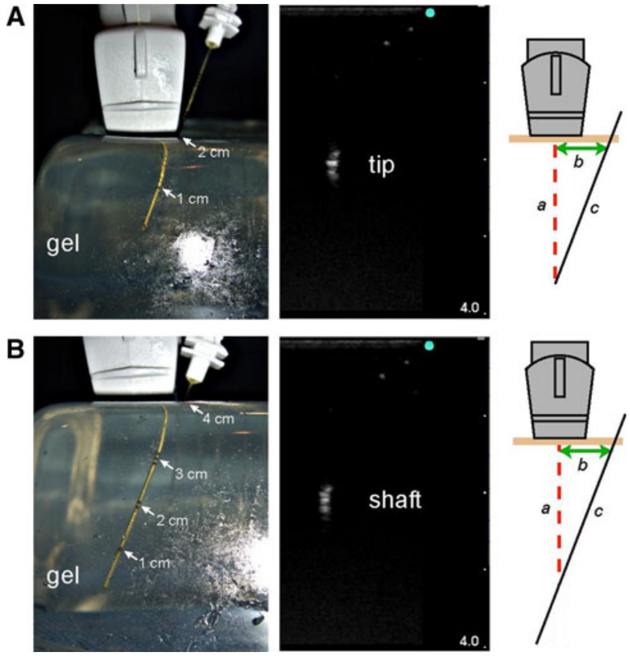

Figure (A) Needle insertion to a depth of around 2 cm will allow the user to visualize the tip on the ultrasound screen at a target depth of 2 cm and an insertion distance of 1 cm. (B) The hyperechoic dot on the screen will represent the needle shaft at any insertion distance beyond the 2 cm marker. Ultrasound and needle insertion was performed on a flexible gel phantom (*far left panels*); markings on the needle indicating insertion depth are labelled. Middle panels show the ultrasound image of the needle and the depth indicators (white dots on far right edge). Also shown is a schematic of the geometrical relationship of the ultrasound beam (*a*, red dashed line), the insertion distance (*b*, green line), and the insertion depth of the needle (*c*, black line) (*far right panels*) when the tip (A) or shaft (B) is in the path of the beam

needle during out-of-plane approaches. We anticipate that advancements in ultrasound imaging technology and needle materials will allow better guidance of needle placement in the future; however, nothing can replace a good knowledge of anatomy and simple trigonometry to ensure accurate needle placement and effective nerve blockade.

Competing interests None declared.

References

1. *Tsui BC*, *Dillane D*. Needle puncture site and a "walkdown" approach for short-axis alignment during ultrasound-guided blocks. Reg Anesth Pain Med 2006; 31: 586-7.
2. *Sites BD*, *Gallagher JD*, *Cravero J*, *Lundberg J*, *Blike G*. The learning curve associated with a simulated ultrasound-guided interventional task by inexperienced anesthesia residents. Reg Anesth Pain Med 2004; 29: 544-8.
3. *Sites BD*, *Spence BC*, *Gallagher JD*, *Wiley CW*, *Bertrand ML*, *Blike GT*. Characterizing novice behavior associated with learning ultrasound-guided peripheral regional anesthesia. Reg Anesth Pain Med 2007; 32: 107-15.