Ultrasound and central neuraxial blocks [Editorial]

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Central neuraxial regional anesthesia procedures are time-tested methods to provide analgesia and anesthesia. They are usually performed as landmark-guided techniques with the help of loss of resistance and tactile feedback from the needle to guide the needle tip placement. The landmark-guided techniques are blind in nature, demand a lot of experience, and there is always a possibility of failure and complication. Ready reported a 27% and 32% failure rate for lumbar and thoracic epidural anesthesia respectively, in a heterogeneous cohort of 2114 surgical patients.\(^1\) Upcoming use of ultrasound imaging has improved the quality and success rate of central neuraxial blocks.

Ultrasound facilitates localization, including the depth of the epidural space.\(^2\) A 2008 guidance from the National Institute for Health and Care Excellence (UK) has recommended the use of neuraxial ultrasound suggesting that it is safe and may be helpful in achieving correct catheter placement.\(^3\) The ultrasound-guided procedures can be broadly divided into (a) Real-time and (b) Pre-puncture ultrasound.

The Real-time two-dimensional ultrasound for central neuraxial blocks is evolving, but it is limited to advanced users due to increased complexity, for example, ultrasound probe placement competes with needle entry point, difficulty in scanning and performing needling single-handedly, difficulty in visualizing the needle and target tissue plane due to the bony framework, use of ultrasound gel, etc. On the other hand, pre-puncture ultrasound guidance is easy to perform and hence gaining popularity, which involves first performing a “scout ultrasound scan” to assess the target vertebral level and ligamentum flavum-dura complex, and adjacent anatomy. Compared to palpation of surface anatomical landmarks, pre-puncture ultrasound scan can identify the vertebral levels more accurately. A recent systematic review highlighted the poor correlation between vertebral levels determined by ultrasound and palpation, with rates of agreement varying from 14% to 64%. In the majority of cases, the levels determined by palpation were higher, and often by more than one interspace, than when determined using ultrasound.\(^4\) The depth of the epidural space depends on the trajectory of the needle; there is excellent correlation between ultrasound-measured and actual needle insertion depth.\(^5\) The operator marks the skin based on the ultrasound scan, and then introduces the needle free-hand, without the real-time use of ultrasound, using loss of resistance technique. This has many advantages over the landmark-guided technique, for example, it allows for any anatomical variances to be seen and their possible complicating effects adjusted for. The pre-puncture ultrasound guidance still relies on the experience of the clinician to orient the needle unaided and without real-time ultrasound visualization of needle insertion.

The efficacy of obstetric epidural analgesia has been reported to be better using ultrasound compared with surface-landmark-guided techniques. A 79% reduction in the overall procedure failure rate was observed when ultrasound guidance was described by Shaikh et al. in their systematic reviews. They also found significant reduction in both skin punctures and needle redirection attempts with the use of ultrasound.\(^6\)

Chin et al. reported that pre-procedural ultrasound significantly increased first-attempt success rates, and reduced both the median number of needle insertions and additional needle passes in morbidly obese patients and in patients in whom landmarks were difficult to palpate.\(^7\) An observational study performed by Chauhan et al. published in the current issue demonstrates a good correlation of epidural depth using transverse plane ultrasound scanning with that of real needle insertion depth, and a higher success rate in a single attempt for lumbar epidurals irrespective of the weight in patients with a body mass index <30 kg/m\(^2\).

Real-time ultrasound-guided needling techniques are not new; they started in the early 1970s; reference to the use of sonography for renal biopsy was reported even earlier in 1961.\(^8\) However, the uptake of ultrasound needle guidance, which can improve safety and speed of needling procedures, has been slow due to practical constraints, for example, availability of resources, purpose-built needles, assist devices, and expert operators.

Appreciating the challenges associated with the use of ultrasound guidance for central neuraxial blocks, we A Gaur and K Bouazza-Marouf have developed novel needle guides to be used with pre-puncture ultrasound guidance to bring the accuracy of needling close to the real-time
ultrasound guidance. These guides make the needling procedure accurate and systematic, and thus should promote the uptake of safe ultrasound assistance for epidural and spinal anesthetics. Clinicians have tested these guides during usability tests using phantoms. Use of these needle guides for central neuraxial blocks should improve patient safety and procedural outcome further through bridging the gap between novice and experienced clinicians. The additional advantage of using pre-puncture guides is to perform needle insertion without using ultrasound gel for which neurotoxicity is unclear. Furthermore, software has been developed, which performs intricate mathematics to help the clinician and provide information about the guides, needle depth, angle of insertion, etc.

One example of the pre-puncture ultrasound scan guides, a “Pen System” needle guide, is shown in Figures 1 and 2. The “Pen System” bracket is attached to a curvilinear ultrasound probe as shown in Figure 3. The procedure involves (1) placing the ultrasound probe in a sterile probe cover, then attaching the sterile bracket, including the two marking rods/pens to the ultrasound probe (over the sterile cover), (2) performing a scout scan and when satisfied with the position and orientation of the probe, pushing the two marking rods/pens to touch the skin, (3) locking the rods/pens in position and putting two dots to mark the skin as shown in Figure 4, (4) removing the ultrasound probe from the bracket and replacing the probe with a needle guide attachment as shown in Figure 5, (5) repositioning the guide assembly on the skin using the previously marked two dots (noting that the base of the guide assembly forms the third point of the tripod) [Figure 6], and (6) inserting the needle approximately one centimeter short of the desired/measured length to ligamentum flavum-dura complex, and finally confirming the needle placement using the loss-of-resistance technique when the needle enters into the epidural space. These pre-punctures guides can be freed/removed from the needle at any time without affecting the needle placement and allow the clinician to perform the procedure-free hand if desired.

The evidence shows that ultrasound guidance undertaken with a needle guide device is more advantageous when compared with free-hand ultrasound-guided needling procedures. This evidence supports the argument that use of pre-puncture needle guide devices for performing central neuraxial blocks are the next step in ultrasound-guided procedures, which may lead to relatively reduced complications, reduced number of needle passes, enhanced safety, and quality, as well as reduced time taken per procedure.

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Conflicts of interest
The authors Atul Gaur and Kaddour Bouazza-Marouf have been involved with the developmental project of the Pre scan needle guides.
Gaur, et al.: USG and Central neuraxial blocks

Department of Anaesthesia, University Hospital of Leicester, Leicester, Leicestershire, Department of Anaesthesia, Intensive Care and Pain Medicine, Lincoln County Hospital, Lincoln, Lincolnshire, Reader, Mechatronics in Medicine, Wolfson School of Mechanical, Loughborough University, Loughborough, Leicestershire, UK.

E-mail: gaur_atul@hotmail.com

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