Ultrasound in Regional Anesthesia: Where Should the ''Focus'' Be Set?

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This is an exciting period in the history of regional anesthesia. The ability to ultrasonically visualize nerves, local anesthetics, and surrounding tissues has inspired many practitioners (veteran and beginner) to study, learn, and incorporate regional anesthetic techniques into their practices. The successful introduction of ultrasound technology into our hospitals and training programs has its origins in the passion and commitment of many of those anesthesiologists who constitute the readership of *Regional Anesthesia and Pain Medicine*. Without, in any way, detracting from those who prefer peripheral nerve stimulation or other methods of localizing neural targets, we would especially like to thank the community for contributing many outstanding original articles centered on ultrasound-guided regional anesthesia (UGRA).

Therefore, it is specifically to those UGRA researchers that we wish to throw down a challenge. When the Editorial Board announced the journal's new section on ultrasound in 2007,[1] we acknowledged that the novelty of UGRA allowed, if not demanded, that we publish basic descriptive articles, case reports, and even randomized controlled trials (RCTs) that otherwise may not have been published had they addressed more tried and true topics such as traditional methods of nerve localization or anatomic observations not directly linked to sonoanatomy. With every passing year, the ability to publish these basic studies will diminish as the underlying foundations of UGRA are constructed. As noted in our 2007 editorial,[1] meaningful advances in UGRA must be built on RCTs that compare ultrasound with other methods of nerve localization, demonstrate true improvements in efficacy or safety, or systematically examine technique questions that further refine the usefulness of the tool. Therefore, the journal will continue to emphasize the importance of publishing well-constructed RCTs comparing ultrasound techniques to alternative approaches, with efficacy and safety as important outcome variables. We also recognize that some important questions may not be able to be answered by RCTs. The ability to gain insight into safety differences between treatment groups is particularly vulnerable to the limitations centered around the need for very large and impractical numbers of study subjects. Therefore, the Editorial Board would welcome studies derived from well-organized multicentered outcome data registries that address some of these more challenging variables. An excellent example of such a registry used by the anesthesia research community is the Northern New England Cardiovascular Disease Study Group (NNECDSG).[2]

We now challenge the readership with a relatively new concept. Fundamentally, it is the "correct" spread of local anesthetic that results in an effective and safe nerve block. This is true for single-injection and continuous techniques, as well as acute and chronic pain applications. To date, very few data, defining the ideal morphologies and patterns of local anesthetic injections as observed under ultrasonic visualization, exist. This seems rather ironic given that local anesthetic is extremely easy to identify with a distinct anechoic appearance. Most studies lack a detailed description of what the goal of the injection was. The reader comes away with little or no insight into the ability of the investigators to reproduce the same morphologic injection for subjects enrolled in the ultrasound group. Further, most investigations simply assume that the ideal ultrasound technique is to inject local anesthetic in a circumferential pattern around the outermost layer of the circular white or black structure believed to be a nerve or part of a plexus. This may or may not be true. For example, during the performance of an interscalene brachial plexus block, a standard approach entails using the in-plane needle insertion technique, imaging the brachial plexus in short axis, and advancing the needle through the middle scalene muscle. Often, the end point for an injection is the needle visually and physically "popping" into a space between the first and second distinct hypoechoic circles (Fig. 1A). In fact, it is at this last "pop" where a corresponding motor response and/or paresthesia will likely occur. The spread of subsequent local anesthetic injection is usually a total encompassment of the visualized neural

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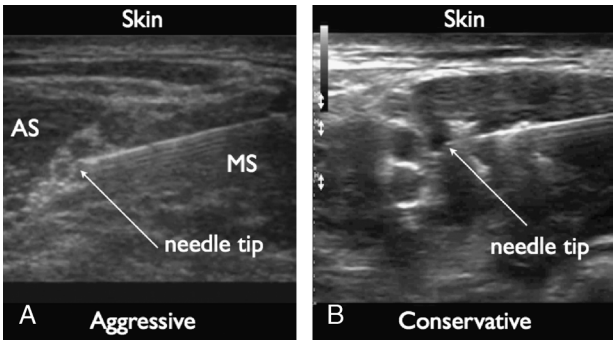

FIGURE 1. A, Aggressive interscalene block in which the needle is physically inserted between two of the hypoechoic circles. B, Less aggressive interscalene block in which the needle is between the brachial plexus and the scalene muscle. The less aggressive injection results in a 'half moon' spread of local anesthetic. AS, anterior scalene muscle; MS, middle scalene muscle.

elements. Hence, the research questions: Is this last needle advancement necessary? Is circumferential spread around all visualized neural elements really necessary? The authors' opinions are no. Figure 1B reveals a less aggressive site of injection in which the needle is stopped at the border between the middle scalene muscle and the hypoechoic circles. At this location, there will be no popping sensation with the needle and the generation of a motor response and/or paresthesia will be unlikely. The injection will result in a "half-moon" pattern adjacent to the brachial plexus. In our anecdotal experience, this block will work equally well in comparison to the aggressive Figure 1A approach, based on all metrics of onset time, density, and duration. Thus, the proposed study: a randomized, single-blinded, controlled trial in which these 2 patterns of local anesthetic spread are compared based on the previously mentioned metrics. Most practitioners would probably agree that the preferred technique would be the one in which the needle could stay a little farther away from the target, thereby avoiding a discomforting sensation (for both the patient and the operator), generating the same quality block, and perhaps adding a degree of safety by maintaining some distance from the nerve.

We have used the interscalene block as an example; however, each block will likely be different, requiring a unique

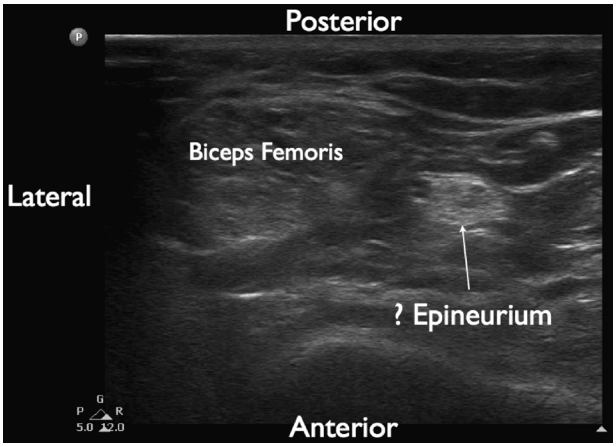

FIGURE 2. Short axis image of the sciatic nerve in the popliteal fossa. The nerve appears as a hyperechoic oval. The possible epineurium is labeled.

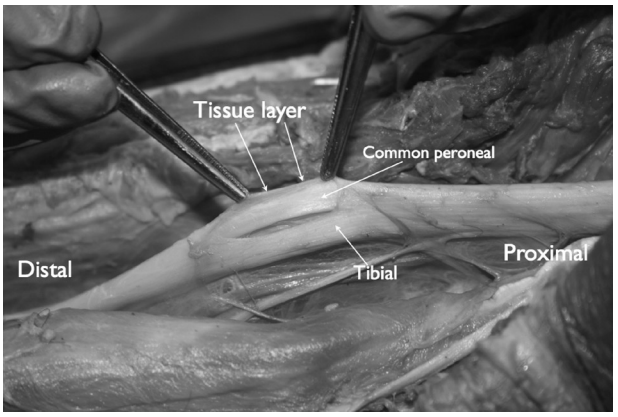

FIGURE 3. The gross anatomy of the sciatic nerve after the division into the common peroneal and tibial nerves in the popliteal fossa. This image displays a closely adherent tissue layer surrounding the actual nerves.

spread (or spreads) of local anesthetic. Thus, we again challenge our readership to critically assess whether "one size fits all" when it comes to UGRA of the various plexuses and individual nerves in the human body. We suspect that, like us, anyone who has tried to perform an ultrasound-guided popliteal sciatic nerve block for surgical anesthesia has realized that a simple half-moon injection will occasionally fail as a surgical anesthetic. This begs the question, do we really know that the outer white layer (Fig. 2) of the sciatic nerve is the epineurium as so many articles have suggested? Our sense is that this layer may not be the epineurium, but rather, it may actually be a complex fascial layer encompassing the sciatic nerve (Fig. 3), similar to that recently described for the distal brachial plexus[3]; these layers are beyond the ability of current ultrasound technology to be resolved and appear to be in continuity with the epineurium. This is why many practitioners have developed the untested impression they must puncture the outer hyperechoic layer to get an effective sciatic nerve block at the popliteal fossa. In contrast to the interscalene brachial plexus, our again untested impression is that aggressive circumferential spread, in which the injection appears to physically separate the tibial and common peroneal nerves, is usually required for a rapid surgical block.

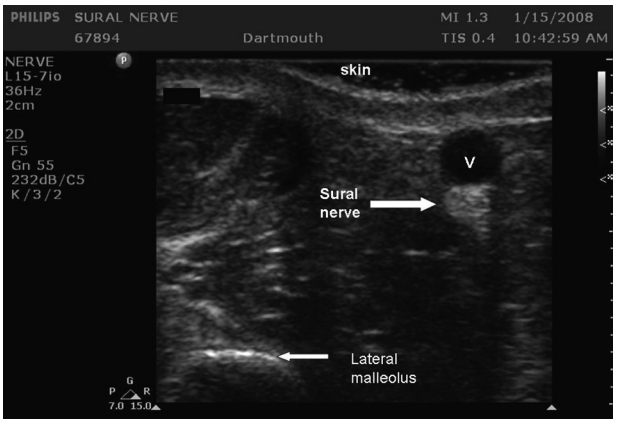

FIGURE 4. The short axis image of the lesser saphenous vein and the sural nerve in the distal fibula. This sural nerve probably appears brighter than it should given the presence of acoustic enhancement.

Other authors have suggested that, during a standard nerve stimulator–guided popliteal sciatic block, nerve swelling and compartmentalization can frequently be demonstrated without neurologic sequelae.[4]

In essence, we are asking for the research community's assistance in defining what a correct perineural spread(s) means for each type of block and clinical situation. Our hope is that through controlled research, rather than trial and error, we would take the artistic aspects out of performing UGRA and move toward a more scientifically based justification of our chosen techniques. If we were able to *objectively* confirm correct local anesthetic spread, we would likely improve on quality and efficacy in an analogous fashion to the fluoroscopist who can unequivocally identify the epidural and intrathecal spaces with contrast injections.

Yet another area in need of research is how best to teach and learn the skills associated with UGRA. This is a difficult area of investigation because researchers are challenged to demonstrate that a defined educational program effectively affects the acquisition of competencies. Further, how do we validate the competencies that such organizations as the American Society of Regional Anesthesia and European Society of Regional Anaesthesia have defined?[5] Ultimately, training studies must evaluate the ability of educational resources to increase accuracy and efficiency of UGRA as it pertains to novice (resident or experienced attending) behavior in the actual and simulated clinical arena.

As our final challenge, we wish to rectify an editorial issue by encouraging our authors to be extremely careful regarding the labeling of ultrasound images. It is very easy to mislabel structures based on what the author believes or wants the structure to be. Given that many investigations are dealing with structures for which there are no references or image confirmations, our recommendation would be to qualify the labeling with such terminology as "most likely," "probably," or "believe to be." Such qualifications will be less necessary in investigations where there are confirmatory data such as the sensory examination, nerve stimulator response, or documented trace back from an appropriate landmark such as a cervical transverse process. A case in point is a recent publication by the first author of this editorial. In this RCT, we were imaging the sural nerve at the distal fibula.[6] The image provided for the sural nerve reveals a circular hyperechoic structure immediately beneath the lesser saphenous vein (Fig. 4). A reasonable criticism of this image is that the structure may not be the sural nerve but, in fact, be a common artifact called acoustic enhancement.[7] We believe our article would have been of a higher quality if this possibility had been acknowledged. Most likely the best way to interpret this image of the sural nerve is that it is indeed the sural nerve, with its echogencity augmented by the presence of acoustic enhancement.

In closing, the editorial board anticipates exciting discoveries and investigations related to the use of ultrasound for the next several years. We welcome a diverse range of interests and hope a portion of the research community can focus their attention on defining exactly what an "effective perineural injection" means in the distribution and morphology of local anesthetic spread. Further, research related to how best to teach and learn UGRA will help our community acquire and nurture these important skills. We wish all readers and researchers a productive year and happy ultrasounding!

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