Evidence-Based Medicine for Ultrasound-Guided Regional Anesthesia

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KEYWORDS

• Ultrasound guidance • Peripheral nerve blocks • Central neuraxial blocks
• Complications • Peripheral nerve injury • Local anesthetic systemic toxicity

KEY POINTS

- Ultrasound guidance (USG) has had a profound effect on regional anesthesiology and acute pain medicine.
- Despite the heterogeneity in the design of multiple randomized controlled trials, USG has consistently provided improved outcomes regarding block procedure time, block onset time, and (depending on the varying definitions) increased block success for single-injection and continuous peripheral nerve blocks.
- More recent data support a role for preprocedural USG in patients with predictors of technically difficult spinal anesthesia.
- Although the evidence for decreasing the risk of peripheral injury is currently lacking, accumulating evidence confirms that USG decreases but (just as important) does not eliminate the risk of local anesthetic systemic toxicity.
- The focus of research has appropriately changed to investigating the optimal USG techniques for specific nerve blocks and emerging data should further expand the applications and benefits of regional anesthesia.

INTRODUCTION

Ultrasound guidance (USG) has gained widespread acceptance in anesthesiology and perioperative medicine.[1,2] Evidence strongly supports increased safety, effectiveness, and efficiency of vascular access with USG compared with anatomic landmark-based techniques.[3] Regional anesthesia, especially for peripheral nerve blocks (PNBs), has increased in popularity during the last decade primarily due to the widespread adoption of USG as the dominant technique for nerve localization. In 2010, The American Society of Regional Anesthesia and Pain Medicine published an executive summary and

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accompanying series of articles, providing evidenced-based recommendations on the use of USG for regional anesthesia.[4–9] This series of articles critically appraised outcomes (**Box 1**) comparing USG to traditional landmark-based techniques (predominantly peripheral nerve stimulation [PNS]) as a nerve localization tool. Central to this series was the inclusion of only randomized controlled trials (RCTs), systematic reviews, meta-analyses, comparative studies, and large case series investigating the specific primary outcomes (see **Box 1**). Overall, these articles demonstrated that, for PNBs, USG provided a more rapid onset of sensory and/or motor block, increased block success, improved block quality (sensory and/or motor), decreased block performance time, and decreased local anesthetic dose requirements.[4–9] Almost all studies did not specifically investigate or were not powered for success of surgical anesthesia as the primary outcome. At that time, there was insufficient evidence demonstrating a decrease in the incidence of clinically relevant patient-safety outcomes of peripheral nerve injury (PNI), local anesthetic systemic toxicity (LAST), or pneumothorax. Notably, there was a lack of published data directly comparing USG to traditional landmark-based techniques for central neuraxial anesthesia. Two subsequent meta-analyses specifically investigated the primary outcome measure of anesthesia sufficient for surgery without supplementation (additional nerve blocks or exceeding a predetermined amount of intravenous systemic analgesia) or conversion to general anesthesia. The pooled data from these 2 meta-analyses showed that USG was associated with an increased success rate of surgical block.[10,11] However, caution is warranted when interpreting the results from these pooled data because surgical anesthesia was not the primary outcome in almost all of the individual RCTs in these meta-analyses.

Box 1
Outcome variables examined in ultrasound-guided regional anesthesia

- Block performance time (imaging and needle-guidance times)
- Successful placement and success of quality of CPNBs
- Number of needle passes and redirections
- Patient comfort during block placement
- Block onset
- Anesthesia-related time (performance and onset times)
- Local anesthetic requirements
- Block success (predefined quality of block within a specified timeframe)
  - Density of sensory block
  - Density of motor block
  - Surgical anesthesia without need for conversion to general (spinal) anesthesia or supplemental (systemic analgesics or additional nerve blocks)
- Complications
  - Vascular puncture (injury)
  - Peripheral nerve injury
  - Pneumothorax
  - Hemidiaphragmatic paresis
  - Local anesthetic systemic toxicity
- Cost-effectiveness