GE HealthCare

Nerveblox

AI for ultrasound scanning in regional anesthesia

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Background

The clinical practice of regional anesthesia has experienced rapid growth over the last two decades.[1] Patient benefits include superior pain control, reduced opioid consumption, potential reduction in the development of chronic pain, less post-operative nausea and vomiting and improved outcomes for certain surgeries (e.g., fistula formation). Institutional benefits include shorter hospital stays and improved operating room efficiency.[2]

However, the delivery of these techniques is often limited by the availability of an expert with the requisite expertise.[1] Strategies that have been deployed to address this challenge include focusing on the delivery of specific high-value peripheral nerve blocks (PNBs),[3] standardization of practice[4,5] and the use of artificial intelligence (AI) to support ultrasound scanning.[6, 7]

Peripheral nerve blocks are widely used across anesthesiology, both to provide anesthesia that facilitates surgery without the need for general anesthesia and to deliver analgesia that alleviates pain during surgery or following injury. They are also employed by other specialties for pain management, including chronic pain, emergency medicine and critical care.

This paper introduces Nerveblox™, an AI tool developed by SmartAlpha™ and delivered by GE HealthCare, designed to support ultrasound scanning for regional anesthesia on the Venue™ Family of point of care ultrasound systems.

The evolving technique of peripheral nerve blocks

Regional anesthesia involves the targeted injection of local anesthesia to block sensations and pain in selected body regions. The first reported peripheral nerve block was performed in 1884 by William Halstead, a surgeon at Roosevelt Hospital in New York. Early techniques involved needle insertion and injection based on anatomical landmarks.[8]

These approaches were prone to being ineffective and having a high risk of complications. In 1962, Greenblatt and Denson proposed the use of a nerve stimulator to pass a current through the needle to evoke a response (movement or sensation) in the target nerve.[9] While this approach was associated with some improvement, it remained suboptimal.

These two techniques share a common limitation: they are blind methods in which neither the anatomical structures nor the needle can be directly visualized. Then, in 1989, continuous ultrasound imaging was first reported for PNBs,[10] to allow real-time visualization of anatomical structures and the needle. Now, ultrasound-guided regional anesthesia (UGRA) is the standard.[11]

Key benefits

Continuous, real-time ultrasound guidance visualizes the nerve and anatomical structures, an approach associated with the following benefits:[11]

01
Increased nerve block success

02
Reduced risk of vascular damage

03
Reduced time for nerve block onset

04
Improved duration of nerve block

05
Reduced amount of local anesthetic required

06
Reduced the rate of pain during the procedure

Ultrasound-guided regional anesthesia

UGRA relies on two fundamental skillsets: acquisition and interpretation of optimal ultrasound images to identify the relevant sono-anatomy and needle-probe coordination to ensure an inserted needle is visualized on the ultrasound screen at all times.

However, UGRA does carry some limitations. The use of ultrasound relies on the operator's anatomical knowledge, interpretation of the image and training in these skills, and there is also unequal patient access to UGRA.[6] AI has been proposed as the next technological advance, which enables universal delivery of UGRA by supporting ultrasound scanning amongst non-experts.[6, 7]

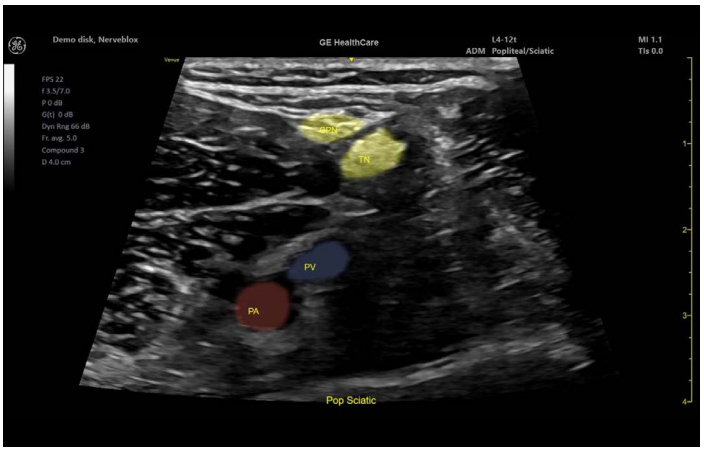


Fig. 1 Ultrasound image of popliteal sciatic nerve.

The Venue Family* AI solution: Nerveblox

To provide real-time guidance and support to anesthesia providers when delivering UGRA as part of bedside exams, GE HealthCare looked to the Venue Family of point of care ultrasound systems and integrated Nerveblox.

Nerveblox is designed to highlight key, sono-anatomical structures for 12 PNB regions in real-time during the scouting stage of the PNB (ultrasound scanning before needle insertion). During this stage, users familiarize themselves with the sono-anatomy of the patient and plan the needle approach.

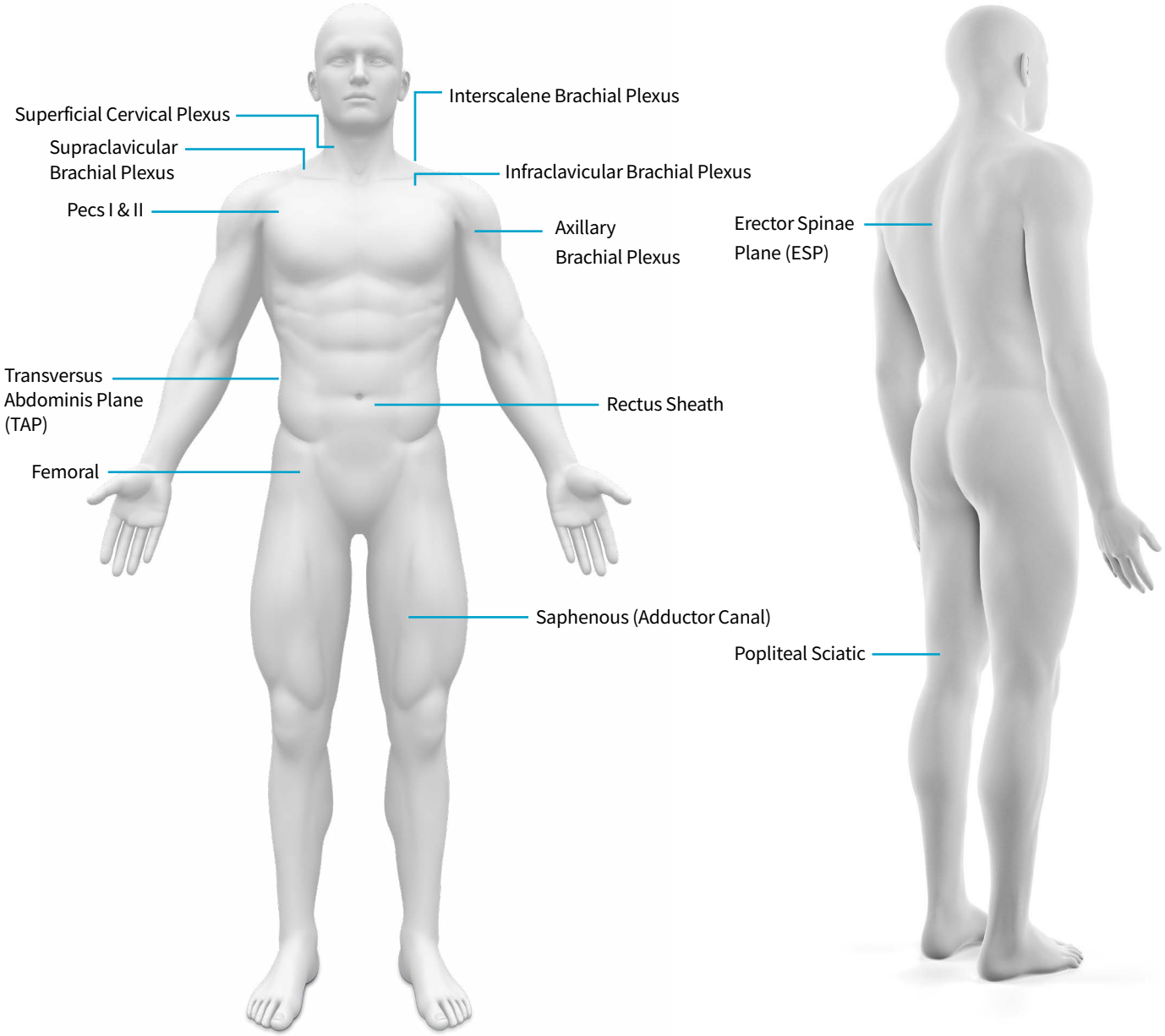
Designed for AI-driven assistance

Nerveblox utilizes deep learning to automatically identify nerve structures on real-time ultrasound images. The tool has been designed and validated to support peripheral nerve blocks commonly used in anesthesiology and pain management.

Enhancing practitioner confidence

The algorithms used in the Nerveblox tool have been trained on hundreds of thousands of ultrasound images from hundreds of subjects. Once turned on and the appropriate block region is selected, the algorithm analyzes the ultrasound images frame-by-frame to identify and highlight key sono-anatomical structures. An image quality index produces an image quality score, supporting practitioners' confidence in the adequacy of the images acquired.

Nerveblox presents an opportunity to significantly advance UGRA for anesthesiology and pain management. By using this deep learning technology, you can improve accuracy and confidence when administering nerve blocks, helping to improve patient outcomes and satisfaction.



How to use Nerveblox

Nerveblox is activated with one touch by selecting the Auto Tools menu. After the user selects the anatomy location and as soon as the scan begins, the algorithm detects the relevant structures and places a colored overlay — highlighting the tissue in real-time (Fig. 2-7). As the user scans, the highlighted area tracks and changes along with the anatomy.

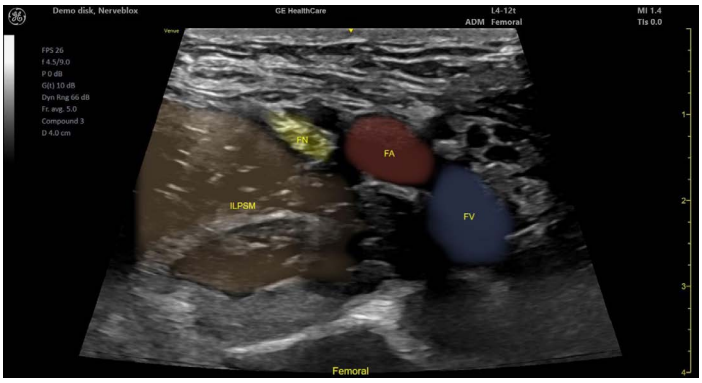


Fig. 2 Ultrasound image of femoral nerve block.

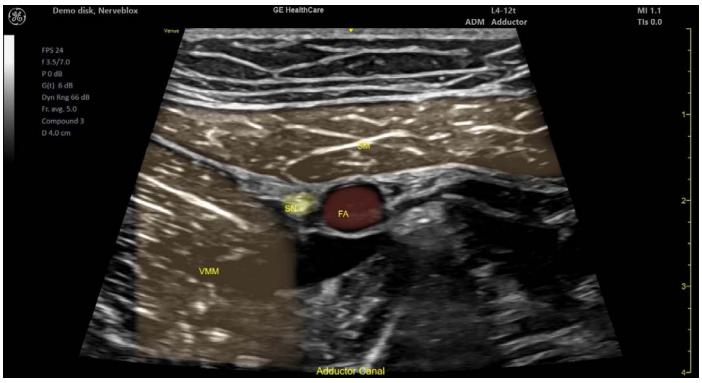


Fig. 3 Ultrasound image of adductor nerve block.

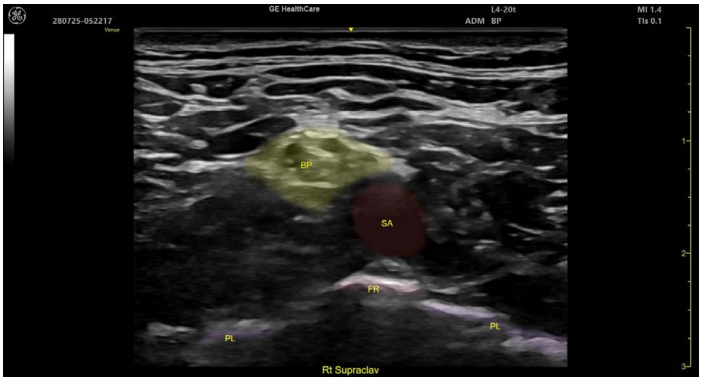


Fig. 4 Ultrasound image of brachial plexus (supraclavicular) nerve block.

Fig. 5 Ultrasound image of brachial plexus nerve block.

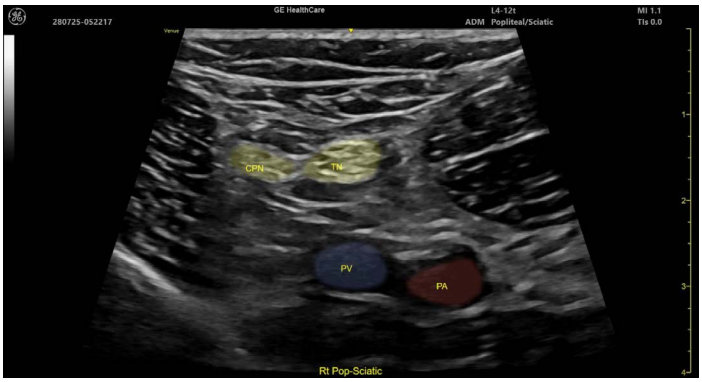


Fig. 6 Ultrasound image of popliteal sciatic nerve block.

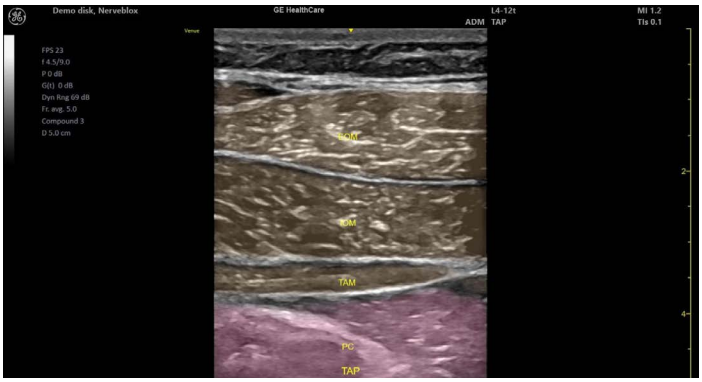


Fig. 7 Ultrasound image of transversus abdominal plane (TAP) nerve block.

The power of Nerveblox

A reading study was conducted to evaluate the performance of Nerveblox for the identification of the sono-anatomical structures and the ability to determine the image quality.

Eighty ultrasound scans, from each side of 40 healthy volunteers, were collected for each PNB region supported. The study population had a mean age of 37.9 years (min-max 18-66, +/- 12.38) and a mean BMI of 29.13 (min-max 18.24-39.93, +/- 4.76). Three US-based independent experts in UGRA reviewed each ultrasound scan (unmodified ultrasound videos were presented side-by-side with Nerveblox-enhanced videos).

The software demonstrated an accuracy (true positive and true negative) rate of 97.2%, a misidentification rate of 1.0% and a non-identification rate of 1.8%. The AI-based highlighting was judged to reduce the perceived risk of adverse events by 61.67% and block failure in 66.36%.

Image quality meter

The AI-based image quality score was evaluated against expert assessments to measure agreement. The evaluation indicates that all blocks demonstrated agreement with the panel of experts across each quality score level, with Positive Percent Agreement (PPA) ranging from 61.5% to 100% and Negative Percent Agreement (NPA) ranging from 88.9% to 100%.

Final thoughts

Regional anesthesia has undergone considerable evolution since it was first introduced to clinical practice in 1884. It's now predominantly based on ultrasound guidance, though the skills inherent to these techniques limit widespread deployment and patient access to the benefits of these techniques.

The Venue Family systems offer real-time, AI-based assistance to aid ultrasound scanning for regional anesthesia — supporting operators in acquiring and interpreting the optimal ultrasound image for each PNB through automated identification of key sono-anatomical structures and determination of the image quality. Nerveblox is helping usher in a new era of UGRA.

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*Venue Family, as referenced herein, includes Venue, Venue Go, Venue Fit and Venue Sprint systems.

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