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CASE REPORTS CASE SERIES

Real-time ultrasound-guided spinal anesthesia using the SonixGPS® needle tracking system: a case report

La rachianesthésie échoguidée en temps réel avec le système de suivi de l'aiguille SonixGPS®: une présentation de cas

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Abstract

Purpose *The SonixGPS® is an electromagnetic needle tracking system for ultrasound-guided needle intervention. Both current and predicted needle tip position are displayed on the ultrasound screen in real-time, facilitating needle-beam alignment and guidance to the target. This case report illustrates the use of the SonixGPS system for successful performance of real-time ultrasound-guided spinal anesthesia in a patient with difficult spinal anatomy.*

Clinical features *A 67-yr-old male was admitted to our hospital to undergo revision of total right hip arthroplasty. His four previous arthroplasties for hip revision were performed under general anesthesia because he had undergone L3-L5 instrumentation for spinal stenosis. The L4-L5 interspace was viewed with the patient in the left lateral decubitus position. A 19G 80-mm proprietary needle (Ultrasonix Medical Corp, Richmond, BC, Canada) was inserted and directed through the paraspinal muscles to the ligamentum flavum in plane to the ultrasound beam. A 120-mm 25G Whitacre spinal needle was then inserted through the introducer needle in a conventional fashion. Successful dural puncture was achieved on the second attempt, as indicated by a flow of clear cerebrospinal fluid. The patient tolerated the procedure well, and the spinal anesthetic was adequate for the duration of the surgery.*

Conclusion *The SonixGPS is a novel technology that can reduce the technical difficulty of real-time ultrasound-guided neuraxial blockade. It may also have applications in other advanced ultrasound-guided regional anesthesia techniques where needle-beam alignment is critical.*

Résumé

Objectif *Le SonixGPS® est un système électronique de suivi de l'aiguille destiné aux interventions échoguidées avec une aiguille. Les positions actuelle et anticipée de la pointe de l'aiguille sont affichées sur l'écran d'échoguidage en temps réel, ce qui facilite l'alignement de l'aiguille avec le faisceau et le guidage de l'aiguille jusqu'à sa cible. Cette présentation de cas illustre l'utilisation du système SonixGPS afin de réaliser avec succès une rachianesthésie échoguidée chez un patient présentant une anatomie complexe de la colonne.*

Éléments cliniques *Un homme de 67 ans a été admis à l'hôpital pour subir une arthroplastie de correction totale de la hanche droite. Ses arthroplasties de correction de la hanche précédentes avaient été réalisées sous anesthésie générale parce qu'il avait subi une instrumentation au niveau L3-L5 en raison d'une sténose spinale. Le patient a été positionné en décubitus latéral gauche afin de voir l'espace intervertébral L4-L5. Une aiguille brevetée 19G de 80 mm (Ultrasonix Medical Corp, Richmond, BC, Canada) a été insérée et dirigée à travers les muscles paradorsaux jusqu'au ligament jaune sur le même plan que le faisceau d'ultrason. Une aiguille spinale Whitacre 25G de 120 mm a ensuite été insérée via l'aiguille-guide de façon conventionnelle. La ponction durale a réussi au deuxième essai, comme l'a indiqué un flux de liquide céphalorachidien*

Author contributions *Simon W. Wong* made a substantial contribution to writing the manuscript and obtained patient consent and images for the study. *Ahtsham U. Niazi* contributed to writing the manuscript. *Ahtsham U. Niazi* and *Ki J. Chin* contributed to revising the manuscript, and *Vincent W. Chan* approved the final draft of the manuscript for publication.

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clair. Le patient a bien tolé́ré́ l'intervention et la rachianesthé́sie é́tait adapté́e pour la duré́e de la chirurgie.
Conclusion *Le SonixGPS est une nouvelle technologie qui peut ré́duire la difficulté́ technique des blocs neuraxiaux é́choguidé́s en temps ré́el. Cet outil pourrait é́galement avoir des applications dans d'autres techniques avancé́es d'anesthé́sie ré́gionale é́choguidé́e dans lesquelles l'alignement entre l'aiguille et le faisceau est crucial.*

In the past two decades, ultrasound imaging has become popular in locating and anesthetizing peripheral nerves. This new application of technology has also shown to facilitate central neuraxial blockade in patients with challenging anatomy, such as those with scoliosis, obesity, or previous spinal surgery.[1] Nevertheless, the use of ultrasound for neuraxial blockade has thus far been limited mainly to the pre-procedural ultrasound imaging of the spine. This is used to delineate the underlying anatomy and thus facilitate the performance of spinal and epidural anesthesia, particularly in patients in whom difficulty is expected.[1,2] On the other hand, despite its promise of greater precision,[3,4] real-time ultrasound-guided neuraxial blockade remains a largely experimental technique due to its technical difficulty. The SonixGPS® (Ultrasonix Medical Corp, Richmond, BC, Canada) is an electromagnetic needle tracking system for ultrasound-guided needle interventions. Both current and predicted needle tip positions are displayed on the ultrasound screen in real-time, facilitating needle-beam alignment and guidance to the target. Our report illustrates the use of this novel technology to perform real-time ultrasound-guided spinal anesthesia in a patient with lower back instrumentation and difficult spinal anatomy.

Case description

Informed patient consent was obtained for the publication of this case report. A 67-yr-old male was scheduled for revision of total right hip arthroplasty following four previous arthroplasties on the same hip at another institution. All previous procedures had been performed under general anesthesia primarily due to prior L3-L5 instrumentation for spinal stenosis.

On examination, the patient's height was 178 cm and his weight was 84 kg. Results of the cardiovascular, respiratory, airway, and neurological examinations were within normal limits. On inspection of the patient's spine, there was a midline longitudinal scar from his previous spine surgery. The L3-L5 spinous processes were not palpable, and the precise neuraxial midline was difficult to determine clinically. The spinous process of L2 was palpable, but considering the difficulty in clinically identifying the L2-L3 interspace and midline due to scar tissue, we concluded that the procedure would be technically difficult and may require a number of attempts. Consequently, we anticipated that ultrasound-guided spinal anesthesia would be feasible, and following a discussion of the risks and benefits, the patient agreed to the procedure.

Routine monitoring was applied, and intravenous access was secured with an 18G intravenous cannula. The patient was provided with supplemental oxygen via facemask and placed in the left lateral decubitus position. A pre-procedural scan was performed using a curved-array low-frequency (2-5 MHz) ultrasound probe (Ultrasonix Medical Corp, Richmond, BC, Canada) placed on the patient's back in a parasagittal plane. Using a technique previously described, the sacrum was identified and followed cephalad to visualize the ligamentum flavum and the posterior longitudinal ligament/vertebral body through the paramedian interlaminar space at each intervertebral level from L5-S1 to L1-L2.[5] These structures were seen most clearly at the L4-L5 intervertebral space, which suggested this to be the ideal space for needle entry. The probe was rotated 5-10° oblique to the parasagittal plane to bring the plane of the beam parallel with the intended trajectory of the spinal needle. The outline of the probe was traced on the patient's skin to provide a reference for subsequent probe placement (Fig. 1).

The patient's skin was then prepped with sterile solution and draped, and the ultrasound probe was covered with a sterile sheath. The ultrasound probe was placed in the previously marked position using a minimal amount of sterile ultrasound gel for probe-skin contact. Meticulous care was taken to ensure that the skin immediately adjacent to the probe, especially the needle insertion site, was free of gel. The skin and subcutaneous tissue were infiltrated with 3 mL of local anesthetic. The tip of a 19G 80-mm proprietary needle (Ultrasonix Medical Corp, Richmond, BC,

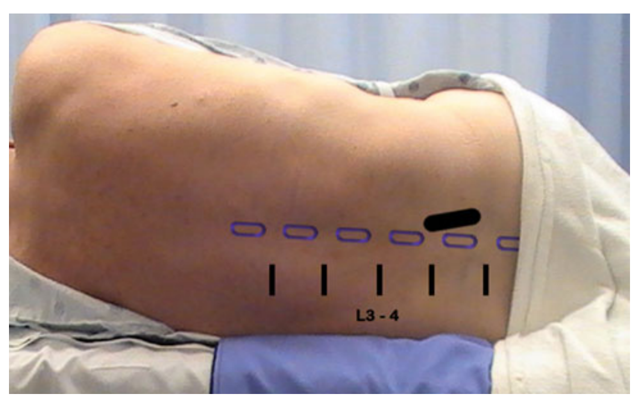

Fig. 1 Ultrasound probe placement in the lateral decubitus position at the L4-L5 interspace

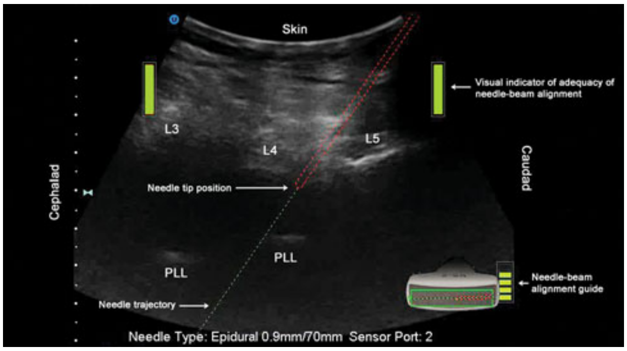

Fig. 2 Ultrasound image showing real-time needle advancement into the L4-L5 interspace. Needle trajectory is indicated on the screen by the dotted white line. The red outline indicates actual needle location. Needle-beam alignment is shown by the green bars on either side of the image (green = good; red = poor) and also by the picture of the probe at the bottom right-hand side of the screen. L3, L4, L5 indicate the lamina of the corresponding vertebrae. PLL = the posterior longitudinal ligament and vertebral body complex

Canada) was placed on the proposed skin insertion site, and the hub was manipulated in three dimensions until needle-beam alignment was obtained and the anticipated needle trajectory was lined up with the L4-L5 interlaminar space, as indicated by the graphic overlay on the ultrasound screen of the SonixGPS system (Fig. 2). This 19G introducer needle was then inserted through the paraspinal muscles until the tip just reached the L4-L5 interlaminar space. Needle-beam alignment and correct trajectory were maintained by observing the indicators on the SonixGPS ultrasound screen. Once the 19G introducer needle was in position, a 120-mm 25G Whitacre spinal needle was inserted through the introducer needle to enter the interlaminar space. The bony lamina was encountered on the first needle pass, which prompted re-direction of the introducer needle more towards the midline. Re-insertion of the spinal needle resulted in a successful dural puncture, as indicated by a flow of clear cerebrospinal fluid from the hub. An intrathecal solution of 0.5% isobaric bupivacaine 3.5 mL and preservative-free morphine 100 mg was administered. The sensory block was assessed by pinprick sensation, and the motor block was assessed by an inability to perform a straight leg raise. A sensory block to the T10 dermatome with complete motor blockade was obtained within ten minutes of completion of the injection. The patient's subsequent intraoperative and postoperative course was uneventful, and he was discharged home on the fifth postoperative day.

Discussion

This case describes a novel approach to single-operator real-time ultrasound-guided spinal anesthesia using an electromagnetic needle tracking system. The first description of real-time ultrasound-guided neuraxial blocks involved two operators (one operator holding the probe and the other advancing the needle).[6] There have been subsequent case reports of single-operator real-time ultrasound-guided epidural and spinal anesthesia,[3,4,7] but the technique is deemed to be technically demanding. This is due primarily to the challenges of visualizing the needle at the depth and steep trajectory required to reach the vertebral canal and of maintaining needle alignment with both the beam and the target. To overcome the latter issue, Tran *et al.*[8] have described the use of an experimental needle guide attached to the ultrasound probe that directs an epidural needle along a fixed pre-planned trajectory. On the other hand, the SonixGPS needle tracking system addresses both issues. The location of the needle and its tip are displayed at all times as an overlay on the ultrasound screen, and there are clearly visible cues as to the adequacy of needle-beam alignment. The tracking system has the additional advantage of allowing the operator to make adjustments to needle trajectory during advancement, which ensures greater precision in reaching the target.

Previous back surgery and instrumentation pose a challenge to performing neuraxial anesthesia. The insertion of distraction rods involves decortication of vertebrae and removal of spinous processes along the extent of the curve. Scar tissue and bone grafts can hinder the entry of neuraxial needles into the desired space. Successful neuraxial blockade in these patients may therefore require multiple attempts at needle insertion and re-direction, which in turn may lead to a higher incidence of complications and failure. Chin *et al.* have described the use of ultrasound for neuraxial anesthesia in a patient with spinal instrumentation. In their report, ultrasound was used to perform a pre-puncture scan of the spine.[9] This served to locate a suitable interspace for needle insertion, but the needle had to be changed from a pencil-point needle to one with a cutting tip in order to penetrate the overlying scar tissue. In our patient, the SonixGPS system allowed us to insert the introducer needle under real-time ultrasound guidance as far as the ligamentum flavum, thus bypassing any resistance to subsequent insertion of the 25G Whitacre spinal needle.

Although the SonixGPS system with its transmitter and needle sensor provides an advantage over conventional ultrasound, there are some current limitations to its use. As the sensor is housed within the needle, the gauge of the needle is quite large. This may cause discomfort and pain on insertion. In our case, we performed local infiltration along the intended path of the needle under ultrasound guidance, and our patient tolerated the procedure very well. The SonixGPS system works only with its own proprietary needles, and needles designed for dural puncture are not currently available from the manufacturer. We overcame this issue by using a needle-through-needle technique, which also allowed us to use a 25G needle for dural puncture instead of the 22G needles described in other reports.[7,9] Although the SonixGPS facilitates needle-beam alignment, expertise in probe handling is still required to maintain a good view of the interlaminar space and vertebral canal. We find it helpful to perform a pre-procedural scan and to mark on the patient's skin the position of the probe that provides the optimal image of the interlaminar space. Following sterile preparation, the probe can then be replaced in the marked position. The SonixGPS technology allows needle-beam alignment to be achieved by moving the needle rather than the probe, and thus an optimal view of the target (the interlaminar space in this instance) can be maintained throughout.

In our view, the SonixGPS electromagnetic needle tracking system is an important technological advance that can facilitate real-time ultrasound-guided spinal anesthesia as well as other technically demanding procedures in ultrasound-guided regional anesthesia. Further investigation is underway to establish its utility in a larger number of patients and a wider variety of block techniques.

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Conflicts of interest None declared.

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