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A new frontier in pelvic fracture pain control in the ED: Successful use of the pericapsular nerve group (PENG) block

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ABSTRACT

The pericapsular nerve group (PENG) block is a novel ultrasound-guided regional anesthesia technique derived from recent anatomic studies detailing the sensory innervation of the hip. Targeting these terminal sensory branches, the PENG block was originally developed as a potentially more effective block for perioperative hip fracture anesthesia, with the added benefit of preserving motor function. Subsequent research with higher volumes of local anesthetic demonstrated the successful utilization of PENG block for perioperative acetabular fractures. This raises the possibility that the PENG block may have a role in the Emergency Department (ED) where regional anesthesia options for pelvic fractures are lacking. Herein, we present the first description of PENG blocks successfully used for pelvic fractures in the ED setting.

1. Background

Pelvic fractures are common, painful, and debilitating. Nearly 8% of ground-level falls in patients aged >70 years result in a pelvic fracture, and these fractures cause significant morbidity and mortality with an almost 2.4-fold increase in risk of death [1,2]. Younger adults involved in traffic accidents make up the opposite peak of the bimodal age distribution [2]. Like hip fractures, pain control to promote early mobilization is an essential component of the acute management of stable pelvic fractures, ideally utilizing multimodal analgesia to reduce morbidity and length of hospital stay [3,4]. Unfortunately, existing applicable regional anesthesia techniques such as lumbar plexus blocks are difficult to perform, require repositioning an injured patient out of the supine position, risk epidural spread, and are not readily available in the ED [5,6]. This leaves emergency medicine without a pathway for pelvic fracture regional anesthesia.

The PENG block was derived from recent anatomical studies detailing the paths of the articular branches of the femoral nerve, obturator nerve, and accessory obturator nerve that provide sensory innervation to the anterior capsule of the hip joint, and was developed as a safe and potentially more effective alternative to femoral nerve block (FNB) and fascia iliaca block (FIB) for hip fractures [7-12].

Subsequent research, using higher volumes of local anesthetic, demonstrated more extensive blockade, including blockade of the obturator nerve which lies more distant from the PENG injection target, and effective acetabular fracture perioperative anesthesia [6,13,14] (Fig. 1). This raises the possibility that PENG may be a viable option for ED management of the pain associated with pelvic fractures.

Additionally, as the injection targets the terminal branches of sensory nerves, there is the potential for a motor-sparing effect, facilitating early mobilization [7,9]. In contrast, the FNB and FIB are both motor and sensory blocks.

2. Case series

The PENG block was performed in three patients with pelvic fractures: A 76-year-old male who sustained ground-level falls resulting in inferior pubic ramus fracture, an 82-year-old female who sustained ground-level falls resulting in pubic body fractures,

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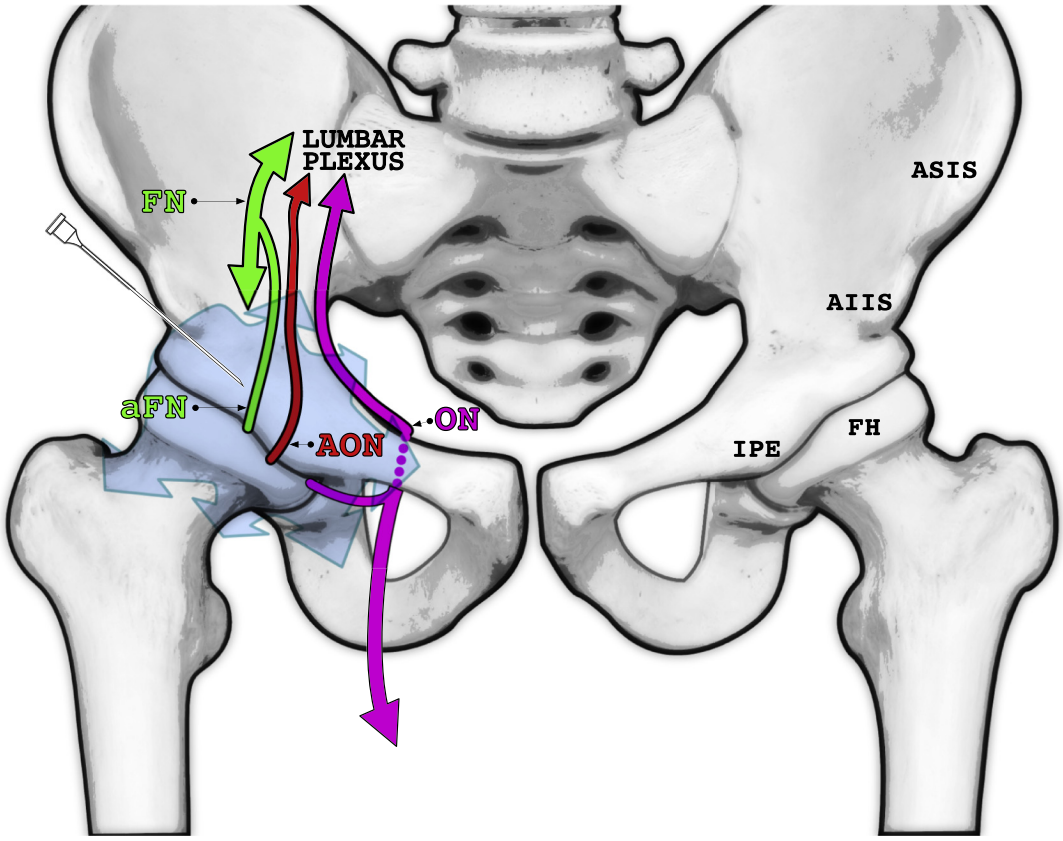

Fig. 1. Branches of the lumbar plexus that contribute to pelvis innervation and possible directions of local anesthetic spread with high volume PENG block. The obturator nerve is relatively distant from the injection target. A common branching pattern is illustrated, with variations known to exist. FN = femoral nerve, aFN = articular branch of the femoral nerve, AON = accessory obturator nerve, ON = obturator nerve, ASIS = anterior superior iliac spine, AIIS = anterior inferior iliac spine, IPE = iliopubic eminence, FH = femoral head, blue = possible areas of local anesthetic spread. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

respectively, and a 67-year-old female bicycle rider who was struck at low speed by a vehicle and ejected onto the asphalt, sustaining multiple pelvic fractures including superior and inferior pubic rami fractures. In all cases, the PENG block was performed using 20 mL of 0.5% bupivacaine with epinephrine and 10 mL of normal saline to expand the injected volume to a total of 30 mL.

All patients had severe pain prior to their PENG block. Within 30 min of receiving a PENG block, all patients had effective analgesia, restoring the ability to range the hip with minimal or no pain. There were no complications.

The PENG block is performed with the patient in the supine position. Elevate the bed and position the ultrasound system so that the needle, transducer, and ultrasound system screen can all be viewed in direct line-of-site with minimal head movement.

Place a low frequency curvilinear transducer on the proximal thigh rotated approximately 45 degrees from the transverse orientation, roughly parallel with, and adjacent to, the inguinal crease (Fig. 2, Fig. 3). For patients with low body mass, a high frequency linear transducer may be used [11]. Identify the femoral artery and the femoral head (Fig. 3A). Keeping the femoral artery in view on ultrasound, slide the transducer cephalad to bring the ilium into view, with the anterior inferior iliac spine and iliopubic eminence visible (Fig. 3B) [15]. The psoas tendon lies between the anterior inferior iliac spine and the iliopubic eminence, and the injection target is the bone surface of the ilium lateral to the psoas tendon (Fig. 3B, Fig. 4) [9,16].

With the transducer fixed over the injection target, identify a block needle insertion site aligned with the long axis of the

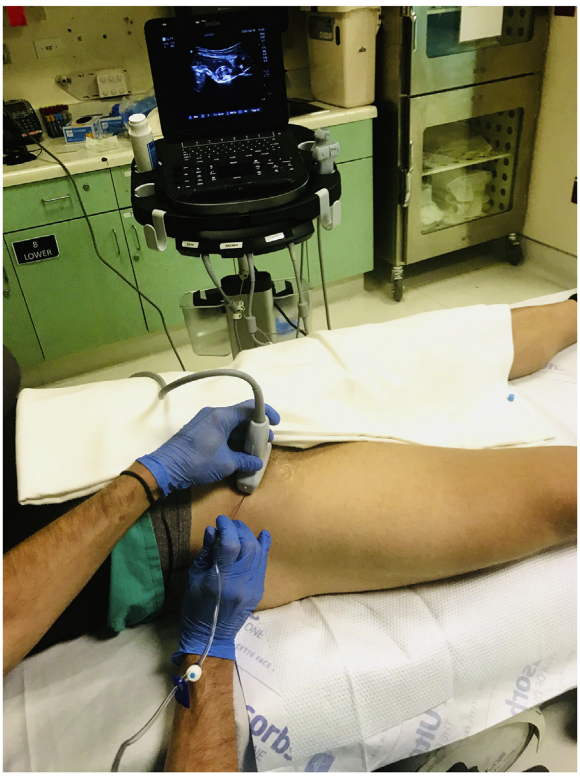

Fig. 2. Patient, provider, and ultrasound system positioning for a PENG block.

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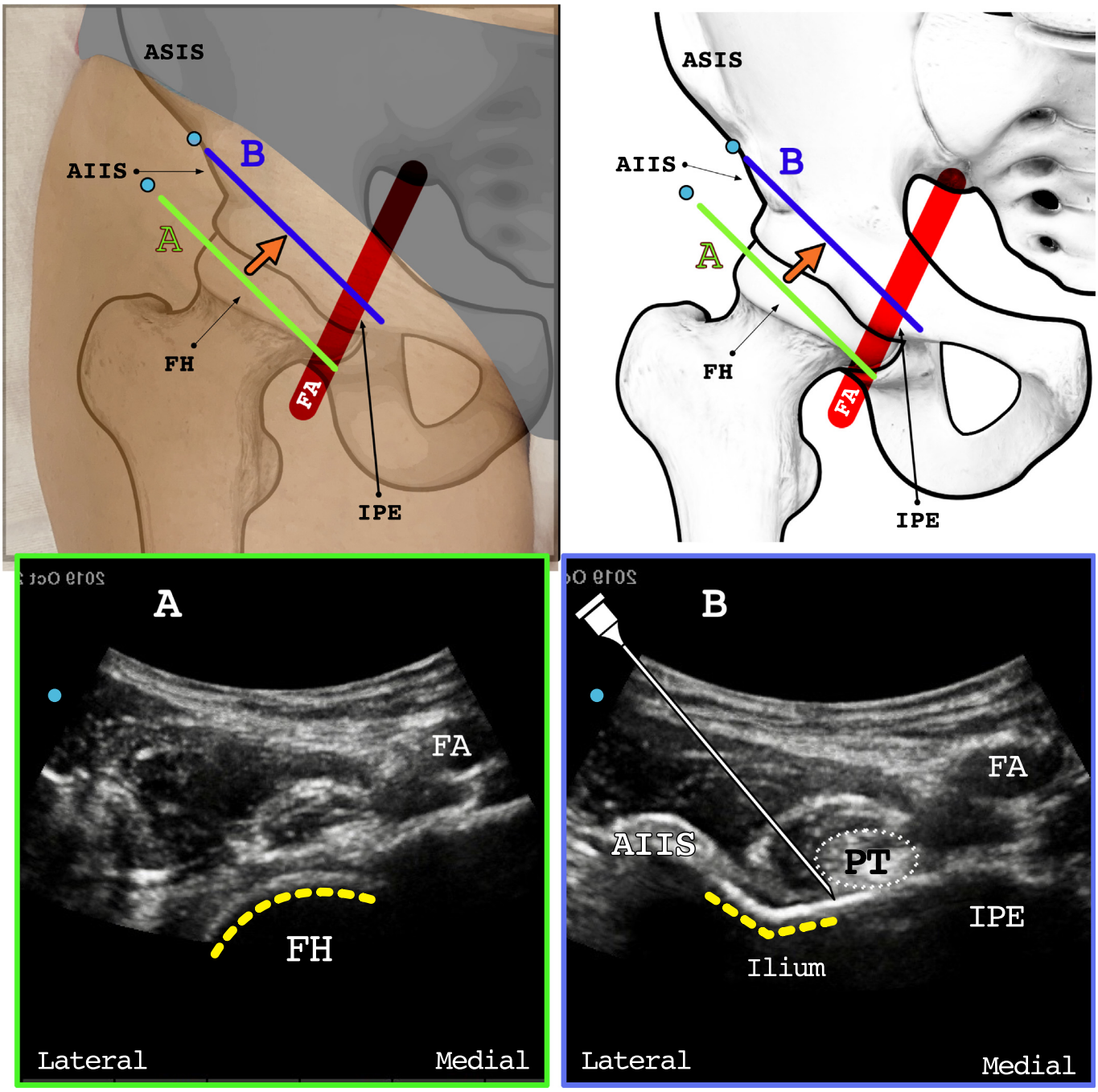

Fig. 3. Ultrasound transducer positions and associated ultrasound images for a simplified approach to optimize imaging for a PENG block. *The upper left and upper right illustrations are the similar in all respects other than the upper left illustration includes a semi-transparent surface landmarks overlay for orientation, and this is overlay is absent from the upper right illustration to aid visualization of the relevant bony anatomy.* Start with the transducer in position A aligned with the inguinal crease, rotated approximately 45 degrees from the transverse plane. Identify the femoral head and the femoral artery on ultrasound. Then, keeping the femoral artery in view, slide the transducer cephalad to the ilium at position B. This brings the anterior inferior iliac spine, iliopubic eminence and psoas tendon into view. The iliopubic eminence is just below the femoral artery. The injection target is the surface of the ilium just lateral to the psoas tendon. A. Ultrasound image corresponding to transducer position A. Yellow dashed curve = the curved surface of the femoral head which serves as a readily identifiable landmark, FH = femoral head, FA = femoral artery. B. Ultrasound image corresponding to transducer position B. The wide field of view from the curvilinear transducer allows simultaneous visualization of the AIIS, IPE and femoral artery. Yellow dashed line = the notch on the surface of the ilium between the AIIS and IPE which serves as a readily identifiable landmark, AIIS = anterior inferior iliac spine, IPE = iliopsoas eminence, FA = femoral artery, dashed circle = psoas tendon, green circle = injection target lateral to the psoas tendon. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

ultrasound beam that is lateral to, and approximately 1–2 cm away from, the transducer. After sterile prep and placing a transducer cover on the transducer, inject a local anesthetic (LA) skin wheal at the insertion site using a 25–27 G needle. Then insert a block needle (e.g. Quincke 20 G 3.5-in [90-mm] lumbar puncture needle) through the skin wheal and advance the needle at a 30–45-degree angle towards the ultrasound beam. After initial insertion of 1–2 cm stop further needle advancement and make slight transducer and needle adjustments until the needle tip is visible on ultrasound. Continue advancing with in-plane ultrasound guidance

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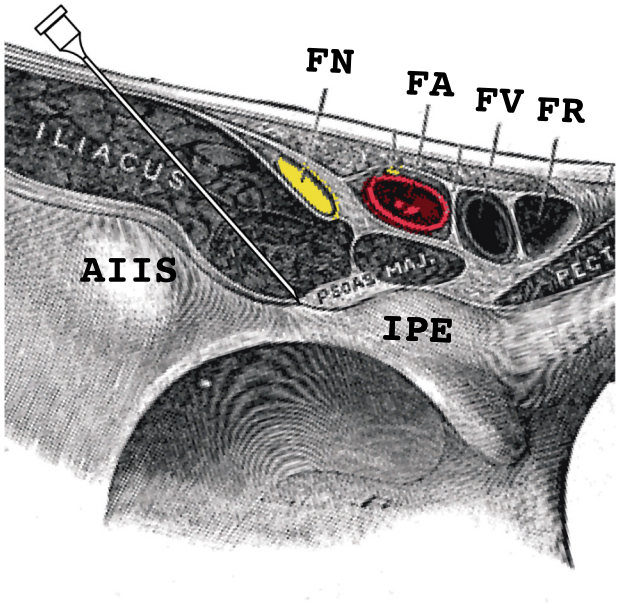

Fig. 4. Detail view of the pelvis at the PENG block injection target. The block needle is resting against the anterior surface of the ilium after puncturing the psoas fascia. Complete puncture of the psoas fascia by rotating the block needle between the index finger and thumb after having contacted bone. AIIS = anterior inferior inguinal spine, IPE = iliopubic eminence, FN = femoral nerve, FA = femoral artery, FV = femoral vein, FR = femoral ring.

through the iliopsoas to the injection target, deep and just lateral to the psoas tendon, with a final firm end point upon contacting the bone surface of the ilium. With the needle tip resting against the ilium, rotate the needle between the thumb and the index fingers to assist with complete puncture through the fascia of the psoas [16]. Alternate aspiration to confirm lack of inadvertent vascular puncture with injection of small aliquots of normal saline (NS). As confirmation of successful injection, anechoic fluid should be seen spreading adjacent to bone, deep to the psoas fascia, and elevating the iliopsoas muscle and PT with each injection (Fig. 5, Video 1). Once satisfied with fluid spread, and after injecting approximately 10 mL of NS, switch from NS to local anesthetic and gradually inject small aliquots until the desired total volume is injected, for example 20 mL of 0.5% bupivacaine expanded with the initial 10 mL of NS for a total volume of 30 mL. In our experience, total needling time is usually <5 min and analgesia develops within 30 min.

3. Discussion

The mechanism of the PENG bock effect when used for pelvic fractures is not fully understood, however the currently available evidence suggests the analgesics effect likely results from regional anesthesia of the articular branches of the femoral nerve, the accessory obturator nerve, and the obturator nerve [6-14]. There may be additional osseous sensory anesthesia by local anesthetic spread along the bone surface, and possibly even hematoma block at the fracture site [14]. This may be particularly true for acetabular fractures given the injection site is adjacent to the acetabulum. However, for the pubic bone fractures included in this case series, the

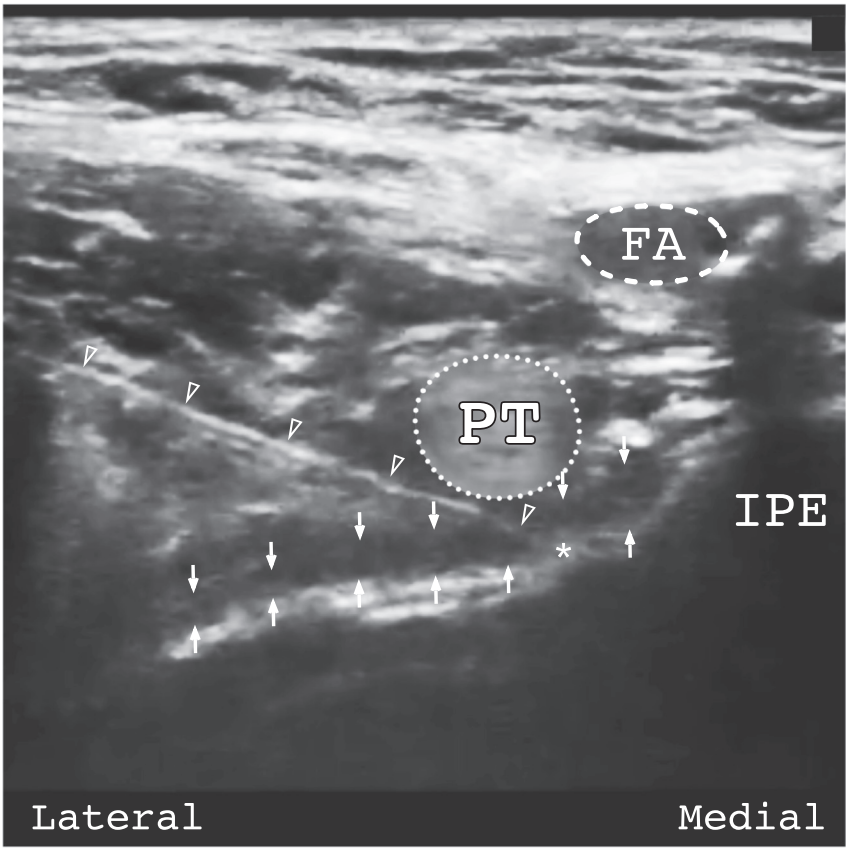

Fig. 5. Ultrasound-guided PENG block. The block needle (20 g 90-mm [3.5-in] Quincke lumbar puncture needle) has approached from lateral to medial to contact the ilium at the injection target deep to the psoas tendon and lateral to the iliopubic eminence. Hypoechoic local anesthetic injectate is seen hydro-dissecting (lifting) the iliopsoas muscle group, psoas tendon, and psoas fascia from the ilium confirming spread in the target plane deep to the psoas fascia. Triangles = block needle, asterisk = needle tip, PT/dotted circle = psoas tendon, IPE = iliopubic eminence, down arrows = psoas fascia, up arrows = anterior surface of the body of the ilium, FA = femoral artery.

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fracture location is relatively distant from the injection target and local anesthetic spread to the fracture may be impeded by fascial planes, bursa, or other anatomic barriers. Further research with clinical and anatomic studies with high volume PENG will help clarify the mechanism and extent of anesthetic effect.

Stable pelvic fractures in the elderly are common, often resulting from low-energy falls, and their incidence is projected to significantly increase in coming years as the elderly population grows [2]. They are associated with poor outcomes, and the pain associated with them is frequently difficult to manage. Furthermore, patients with stable pelvic fractures are typically weight bearing as tolerated and require early physical therapy, which they may be unable to participate in due to pain or over-sedation from IV opiate medication. Regional anesthesia has been successfully utilized in the ED to manage the pain associated with other common fractures such as hip, rib, and upper extremity fractures [17-22]. Pelvic fractures, despite their frequency and associated morbidity and mortality have been left behind. Hopefully the PENG bock fills this gap in treatment options.

This case series is limited in scope, focusing on elderly patients with pubic bone fractures. Additionally, as with all case series, the evidence of effectiveness is considered preliminary. Another limitation is that preblock and post-block pain assessments were not protocolized or quantitative. Larger, prospective studies with structured resting and dynamic pain score assessments would enhance our understanding of PENG block effectiveness. Additionally, further research is warranted that includes other populations such as younger patients, those with other types of pelvic fractures, and those with unstable fractures who require pelvic binders and operative fixation.

To our knowledge this is the first reported application of regional anesthesia for pelvic fractures in the ED setting. Our initial experience suggests the PENG block holds promise as a potent and technically feasible single injection block that may open a new frontier of regional anesthesia for acutely injured ED patients with pelvic fractures. With its rapid performance, distance from critical structures, and the possibility of providing analgesia while preserving motor function, it may be the ideal technique for emergency practitioners (EPs) to incorporate into the clinical care of this patient population.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajem.2020.05.085.

Prior presentations

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CRediT authorship contribution statement

Josh Luftig: Writing - original draft, Writing - review & editing. **Andrea Dreyfuss:** Writing - original draft. **Daniel Mantuani:** Writing - original draft, Writing - review & editing. **Kaitlen Howell:** Writing - original draft. **Angela White:** Writing - original draft. **Arun Nagdev:** Writing - original draft, Writing - review & editing.

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