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A case report of an innovative ultrasound-assisted patient tailored lumbar plexus block with alternative anatomical landmarks in a traumatic femur fracture in a 16 year old boy

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Keypoints

This case-report describes an innovative and alternative ultrasound-assisted patient-tailored operating protocol to perform a safer and consistent lumbar plexus block in a traumatic femur fracture of a 16-year-old boy. Our protocol involves sonography and the use of patient-tailored alternative anatomical landmarks derived from Traditional Chinese Medicine.

Abstract

Lumbar plexus block (LPB) is an advanced regional anesthesia technique practiced by relatively few experienced regional anesthesiologists. Difficulties are linked to the depth of structures and the high risk of accidental punctures, lowering its safety expecially in obese or unfavorable patients.

Although modern ultrasound guidance may allow visualization of the lumbar plexus, ultrasound-guided techniques (i.e., Shamrock and Trident techniques) still require additional expertise while being operator-dependent and not suitable in every patient, which represents the most frequent "real world" scenario. Given its usefulness in lower limbs surgery, we struggled to develop a new ultrasound-assisted patient-tailored Traditional Chinese Medicine based operating protocol to increase its safety and constancy of performance and applied it to a traumatic right femur fracture surgery of a 16-year-old boy.

Keywords

Pediatric lumbar plexus block; traditional Chinese medicine; CUN; bladder meridian acupuncture, lumbar plexus real world sonography; alternative anatomical landmarks on lumbar plexus block; sonography assisted lumbar plexus block.

Introduction

Lumbar plexus consists of ventral roots of the first three lumbar nerves and the greater part of the ventral root of the fourth nerve. The first lumbar nerve, frequently supplemented by the twelfth thoracic nerve, splits into an upper branch that divides into iliohypogastric and ilioinguinal nerves; the lower branch unites with a branch coming from the second lumbar, forming the genitofemoral nerve. From the remains of the second lumbar nerve, the third and fourth nerves divide into ventral and dorsal divisions. Anterior divisions unite to form obturator nerves, while the dorsal ones unite to form the lateral femoral cutaneous nerve and the larger femoral nerve (*Figure 1*). Lumbar plexus and its branches are located within the psoas major muscle, facing the anterior aspect of lumbar vertebrae transverse processes. The anterior two-thirds of psoas muscle originate from the anterolateral aspect of vertebral bodies, while the posterior one-third of the muscle originates from the anterior aspect of transverse processes, creating a fascial plane between both muscle compartments. Erector spinae muscle covers the lumbar spine posteriorly and medially, while quadratus lumborum muscle covers it laterally. Lumbar plexus block (LPB) is an advanced regional anesthesia technique practiced by relatively few experienced regional anesthesiologists, as it represents the most proximal approach to the lumbar plexus, providing the most reliable block of its major branches (femoral, obturator, and lateral femoral cutaneous nerves, as shown in *Figure 2*). LPB is ideal for knee, hip and above-knee surgeries; when combined with a sciatic nerve block, it provides a complete unilateral lower limb anesthesia suitable for lower extremity surgeries; continuous infusion trough perineural catheter can be used for prolonged anesthesia and analgesia. Challenges in performing LPB are related to safety because of depth of target structures and the high risk of accidental punctures; complications include damages to abdominal viscera (renal puncture), vascular punctures, retroperitoneal haematomas, psoas abscess and intrathecal spread or injection. Traditionally, LPB is performed using standard measured surface anatomical landmarks (Tuffier line based) to identify the site for needle insertion and eliciting quadriceps muscle contraction in response to electrical neural stimulation (ENS); small errors in landmark estimation or angle miscalculations during needle advancement can result in wrong and dangerous needle placements. Although modern ultrasound guidance may allow visualization of the lumbar plexus, ultrasound-guided techniques (i.e., Shamrock and Trident techniques) still require additional expertise while being operator-dependent and not suitable in obese or unfavourable patients, which represents the most frequent "real world" scenario. Given LPB usefulness in lower limbs surgery, we struggled to develop an alternative ultrasound-assisted patient-tailored operating protocol to increase its safety and constancy of performance.

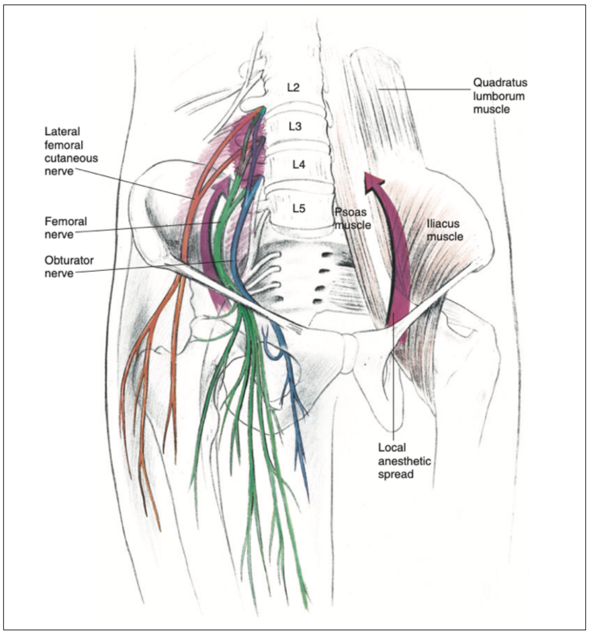

Figure 1. Lumbar plexus anatomy.

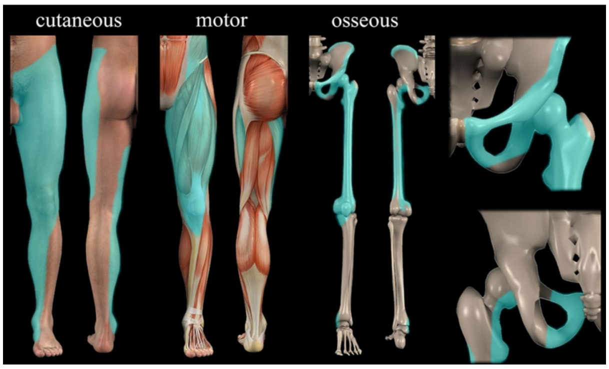

Figure 2. Cutaneous, motor and osseous coverage guaranteed by LPB.

Case report

In the emergency department, a 16-year-old boy presented with a right lower limb trauma. He underwent brain and pelvis CT scan, spine, chest and bilateral femur x-rays and blood chemistry tests showing nothing but a traumatic right femur fracture requiring reduction and osteosynthesis. Anesthesiological management started with the collection of an accurate familiar, physiological, pharmacological, past and recent pathological anamnesis, which showed anything relevant; anthropometric data (72 kg; 182 cm; BMI 21,7) was collected. Anesthesiological preoperative evaluation involved patient's parents aswell. Subarachnoid anesthesia for surgery and a continuous lumbar plexus block to ensure proper post-operative analgesia were proposed and accepted by patient and his family. Additional postoperative backup analgesia was planned to be based, if needed, on ev paracetamol 1g x3/die and, if VAS > 4, ev tramadol 100 mg.

Discussion

After providing a peripheral venous access and monitoring vital parameters (ECG, SpO2, NIBP, ETCO2, temperature by spot-on sensor) mild sedation with midazolam 0,03 mg/kg was performed. With patient in lateral decubitus position and operative side uppermost, our ultrasound-assisted patient-tailored LPB block protocol started with placing a convex probe in paravertebral position, longitudinal orientation, to localize **L5 level** in sagittal plane (*Figure 3*). Once identified, probe was rotated 90 degrees to show a transverse plane image; L5 spinous process showed as a "shadow cone" in the center of the image while **transverse processes** were recognized and their depth from skin measured. Transverse processes were detected as a safe target considering that lumbar plexus lies 2-3 cm deeper (*Figure 4*).

To establish **lateral needle entry point** we refered to the "CUN" concept, a Traditional Chinese Medicine patient-tailored unit of measurement corresponding to the maximum width of patient's thumb finger. Given that the bladder meridian point 26, located at **1,5 CUN laterally to the lower edge of L5 spinous process**, if stimulated deeply with an acupuncture needle allows to reach the 3rd-4th-5th lumbar metamere, we considered it a good target to reach lumbar plexus.

We converted the 1,5 CUN measure (traditionally defined as the distance between the 2nd and 3rd paired fingers measured at the level of the distal interphalangeal joint of patient's non dominant hand) in centimeters (about 4 cm in this case).

Puncture was carried out on right L5 transverse process (identified by ultrasound) with a lateral drift of 1.5 CUN (4 cm) from the interspinous line (*Figures 5 and 6***)**; after bone contact at 6 cm depth (depth from skin was sonographically estimated at 6 cm and was needle confirmed), needle was slightly cranially orientated to pass L5 transverse process advancing 2-3 cm deeper until ENS confirmation (right patella twitches) and its scaling stimulation intensity (from 1 mA to 0,2 mA).

As an objective, no twitches were evoked under 0,48 mA stimulation; aspiration test, Raj test and absence of evoked pain at injection test were correctly performed as additional safety elements.

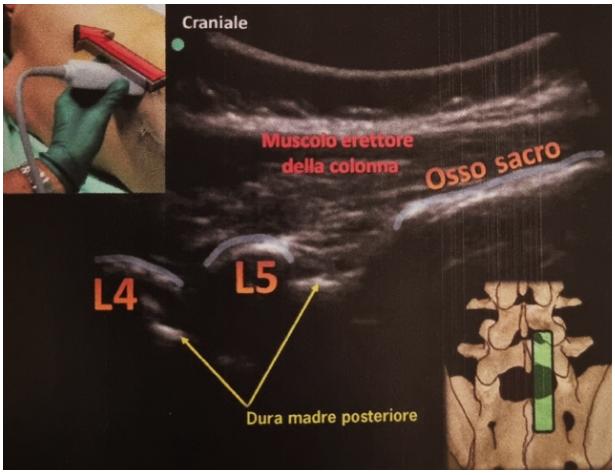

Figure 3.

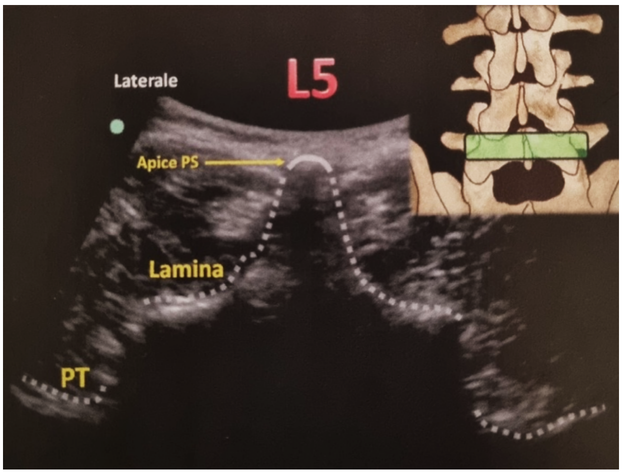

Figure 4.

Figures 3 and 4. First and second step of our ultrasound-assisted protocol for lumbar plexus block. Figure 3: L5 level localization. Figure 4: L5 transverse process (PT) localization and depth from skin sonographic estimation.

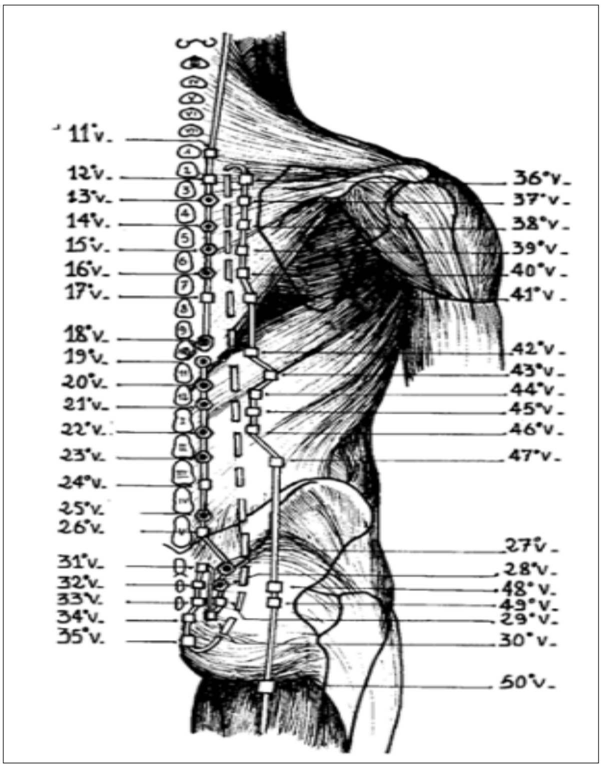

Figure 5. Bladder meridian point 26

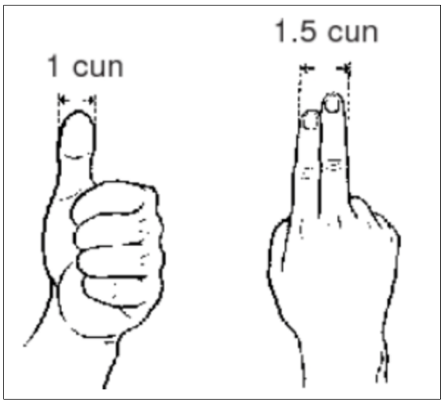

Figure 6. “CUN” concept

We opted, at first, for the execution of a single-shot lumbar plexus block by administering Ropivacaine 0,5% 30ml (150 mg, about 2 mg/kg) admixed with Dexamethasone 4 mg, followed by a subsequent placement of a perineural catheter to grant a backup continuous Ropivacaine 0,1% 4 mg/h infusion for a total pain relief of 50 hours. Block and catheter placement were successful, no complications occurred.

Once placed the patient in opposite lateral decubitus position, a superselective subarachnoid right lower limb anesthesia was then performed with 12 mg Heavy Bupivacaine 1% at L3-L4 level. Surgery was performed without complications.

It is worth noting, in this case, that standard measured surface anatomical landmarks (Tuffier line based) didn’t sonographically match the space between L4-L5 transverse processes nor L5 transverse process, and that would have made a classical landmark based LPB difficult, dangerous or unsuccessful.

Additional postoperative backup analgesia was planned to be based, if needed, on ev paracetamol 1g x3/die and, if VAS > 4, ev tramadol 100 mg; no backup analgesia was requested by the patient in the next days because of the LBP reliability and efficacy.

Conclusion

This case-report described an innovative and alternative ultrasound-assisted patient-tailored operating protocol to perform a safer and consistent lumbar plexus block in a traumatic femur fracture of a 16-year-old boy. Our protocol involved sonography and the use of patient-tailored alternative anatomical landmarks derived from Traditional Chinese Medicine. A quick sonographic identification of L5 process and its depth can be easily obtained even in obese patients or those with unfavorable anatomy, unlike known ultrasound-guided lumbar plexus blocks (i.e. Shamrock and Trident techniques) where deep target structures are usually poorly visible in a “real world” scenario, increasing the risk of complications and failures. Moreover, compared to the classic "blind method" (Tuffier line based anatomical landmarks) which doesn't consider anthropometric variants, the "1,5 CUN" measurement (and its conversion in cm) allowed a patient-tailored identification of the most appropriate paravertebral entry point for the electrostimulated needle. Our approach, based on quick sonography and CUN measures combination, allowed us to increase lumbar plexus block safety and constancy of performance.

Disclosures:
The approval of the regional ethical committee is not requested for case reports. Authors declare no funding for the production and publication of this article and no conflict of interest.

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