Original Article

Flow dynamics of ultrasound-guided lumbar plexus block in adults

Sandeep Diwan, Abhijit Nair[1], Nitin Gawai, Parag Sancheti[2]

Department of Anesthesiology, Sancheti Hospital, Pune, Maharashtra, India, [1]Department of Anaesthesiology, Ibra Hospital, North Sharqiya Governorate, Ibra-414, Sultanate of Oman, [2]Department of Orthopedics, Sancheti Hospital, Pune, Maharashtra, India

Abstract

Background and Aims: The outcomes of plexus and peripheral nerve blocks depend on needle-nerve contact and the spread of local anesthetic (LA) around the plexus or nerve. Needle-nerve distance and spread of LA could be visualized during US-guided lumbar plexus block (LPB).

Material and Methods: After Institutional Ethics Committee approval and after obtaining informed consent, 24 American Society of Anesthesiologists'-physical status I–III patients who underwent surgical fixation of fractures of proximal femur were enrolled. Spinal anesthesia was a primary anesthetic in all patients. At the end of the surgery, all patients received US and neurostimulation-aided LPB at the third lumbar nerve root (LNr). The primary aim was to determine the spread of LA in the lumbar plexus area with the relation of the needle tip and LNr contact. The secondary aim was to understand block efficacy in terms of pain scores monitored at regular intervals and 100 mg intravenous tramadol was administered as a rescue analgesic if VAS >4.

Results: In all 24 patients, we observed an oval and antegrade LA spread after lumbar plexus was identified with neurostimulation at L3. With the needle closer to intervertebral foramina (IVF), a retrograde spread was visualized. Only 2/24 patients received rescue analgesia in the first 24 h.

Conclusion: The type of spread after the US-guided LPB could predict block success of block and a possible epidural spread.

Keywords: Acute pain, lumbar plexus, nerve block, neurostimulation, regional anesthesia, ultrasonography

Introduction

The efficacy of a block depends on needle–nerve contact and an eventual spread of local anesthetic (LA) around the plexus or the nerve.[1] An ultrasound (US)-guided shamrock method identifies the L3–4 paravertebral area in lateral position, which is commonly implemented for lumbar plexus block (LPB).[2-4] To our knowledge, there are no studies that visualized various patterns of LA spread in real time with the US in intra-psoas compartment, i.e., in the posterior and medial quadrant of psoas major (PMQ)] at the level of third LNr. In 24 American Society of Anesthesiologists'-physical status (ASA-PS) I/II patients, our primary objective was to determine the spread pattern of LA after neurostimulation-aided needle tip placement to the third lumbar nerve root (LNr) contact under US guidance, with quadriceps contractions as the endpoint at 0.4–0.6 mA. Secondary objectives were to assess block efficacy in terms of time to first analgesic and pain score monitored at various time points.

Address for correspondence: Dr. Abhijit Nair,
Department of Anaesthesiology, Ibra Hospital, North Sharqiya Governorate, P.O. Box 275, Ibra-414, Sultanate of Oman.
E-mail: abhijitnair95@gmail.com

Access this article online

Quick Response Code:

Website: www.joacp.org

DOI: 10.4103/joacp.JOACP_584_20

How to cite this article: Diwan S, Nair A, Gawai N, Sancheti P. Flow dynamics of ultrasound-guided lumbar plexus block in adults. J Anaesthesiol Clin Pharmacol 2021;37:565-8.

Submitted: 03-Oct-2020 **Revised:** 02-Dec-2020
Accepted: 14-Feb-2021 **Published:** 06-Jan-2022

Material and Methods:

An Institutional Ethics Committee approval was obtained for this study (10th September, 2020). Twenty-four American Society of Anesthesiologists'-physical status (ASA-PS) I–III patients, aged 18–65 years who were scheduled for major orthopedic lower limb surgery were enrolled in this study after obtaining informed consent. The surgical procedures included fractures of the proximal, mid-shaft, and distal shaft of the femur. Patients with bilateral lower limb injuries, associated acetabulum fractures, polytrauma with intra-abdominal or intra-thoracic injuries, conversion to general anesthesia ASA-PS 3 and 4 were excluded. The primary anesthetic was spinal anesthesia using 3 ml of 0.5% heavy bupivacaine without an adjuvant. In the immediate postoperative period, all patients received US-guided neurostimulation-aided LPB and 0.3 ml/kg of 0.2% ropivacaine was injected.

With the patient in lateral position at the end of the surgery, L5-S1 junction was located in mid-longitudinal plane. A curvilinear low-frequency probe (Sonosite Fujifilm, M-Turbo, 2–4 mHz, USA) was shifted cephalad until L3 spinous process (SP) was identified. The probe was rotated to a transverse plane across the L3 SP and shifted to the abdominal flank. A transverse lumbar paravertebral sonogram was performed at the level of L3 transverse process (TP) with the shamrock method, on a line joining the iliac crest and the 12th rib in the midaxillary line. The posterior and medial quadrants of psoas major muscle (PMA) was defined [Figure 1]. The third LNr was visualized at the junction of the vertebral body (VB) and TP at the level of L3 [Figure 1]. On swiping the probe cranial, the third LNr was visualized emerging from IVF. Three points on the third LNr were identified in the PMQ, these were (A) close to the junction of TP and the VB, (B) mid in the PMQ, and (C) distal in the PMQ [Figure 2]. A 100-mm insulated needle (Pajunk®, Germany) was introduced 4 cm lateral to the spinal line, and the needle tip was guided towards the LNr. The needle–nerve contact was confirmed with the elicitation of quadriceps contractions at 0.4–0.6 mA and the position of the needle tip was visualized along the third LNr at the above-mentioned points (A, B, and C). In case there was no elicitation of contractions, needle repositioning was performed until quadriceps contractions were elicited. The number of times the needle required repositioning was noted. LA injections were performed only after evoking a quadriceps response at 0.4–0.6 mA. On injection of 0.3 ml/kg of 0.2% ropivacaine, the spread of LA was visualized. The injection pressures were monitored using the compressed air injection technique.[5] During injection, the flow pattern and needle tip–LNr contact were observed under US with a transverse scan. On completion, dimensions were noted in the transverse and coronal scans. In a transverse scan, the vertical and horizontal dimensions of the spread in the PMA were noted [Figure 3]. From its position of the transverse scan, the probe was rotated to longitudinal along the mid-axillary line, to assess the spread of LA in the coronal plane. In the coronal scan in midaxillary line, the length of spread of LA was noted. [Figure 4].

In the postoperative period, the time to the first analgesic was noted in all patients and was administered 1 g paracetamol, followed by eighth hourly thereafter as a part of multimodal analgesia. VAS score was measured at various time points 0, 1, 3, 6, 9, 12, 18, and 24th h. IV 100 mg of tramadol was prescribed as rescue analgesia if VAS remained more than 4.

Continuous data were expressed as mean ± standard deviation or median/interquartile range whichever

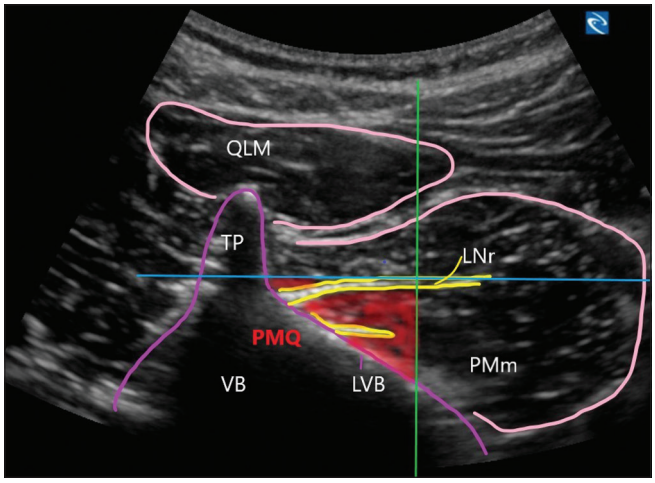

Figure 1: Paravertebral sonoanatomy. PMm- Psoas major muscle

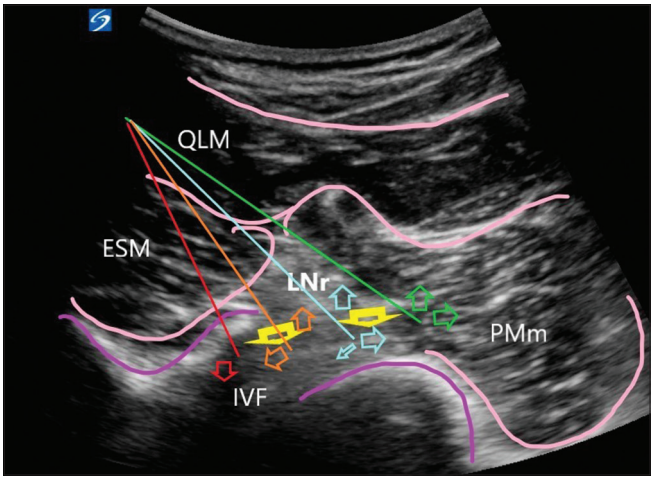

Figure 2: Probe placement at L3-4 intervertebral foramina with needle placements along the lumbar nerve root. PMm- Psoas major muscle

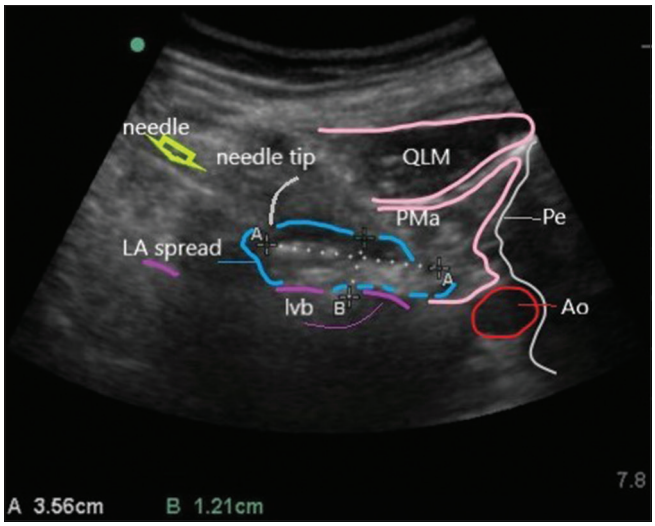

Figure 3: Spread of LA in the transverse scan at the level of intervertebral foramina. PMa- Psoas major muscle

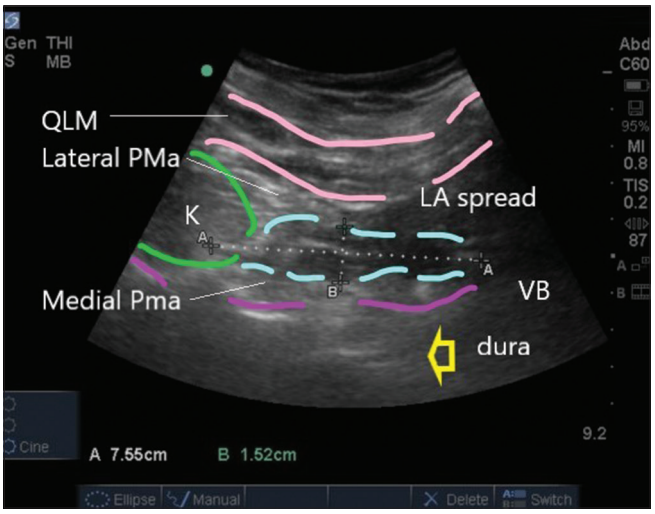

Figure 4: Coronal scan at the level of the mid-axillary line. PMa- Psoas major muscle

appropriate. Categorical data were expressed as numbers or percentages.

Results

Table 1 depicts the demographic data of all 24 patients. In 24 patients who received US-guided neurostimulation-aided LPB the following characteristics noted are depicted in Table 1. Mean LA volume used for LPB was 19.62 ml. In all cases, the needle – third LNr contact could elicit quadriceps contractions between 0.4 and 0.6 mA. The needle tip was positioned at A in one patient (4.16%), at B in 10 patients (41.6%), and C in 13 patients (54.16%) [Figure 1]. The number of times the needle tip was repositioned was <3.

On the injection of LA, the spread of LA was identified in the transverse scan. An oval spread hypoechoic LA spread around the lumbar plexus components in 13 patients (54.16%), an antegrade hypoechoic LA spread observed with a caudal probe movement along the LNr in eight patients (33.33%) and a retrograde spread (towards the junction of TP and the VB) at the level of an L3-4 nerve root in three patients (12.5%) were observed.

On a coronal scan in the mid-axillary line, with an injection of 0.3 ml/kg, the distance the LA had spread along the PMA close to the VB was noted. The longitudinal spread was a mean of 5.45 cm. The mean VAS scores at 0, 1, 3 6, 9, 12, 18, 24 h were 1.45, 1.66, 1.91, 2.41, 2.66, 2.7, 2.83, and 3.08, respectively. IV tramadol 100 mg was administered as a rescue analgesic in two patients once in 24 h.

Table 1:Details of demographic data, details of surgeries performed, needle tip identification, types of spread and mean VAS scores at various time frames

Age (years)	50.66 (mean)
Gender (M/F)	12/12
Weight (kg)	65.41 (mean)
ASA-PS (I/II/III)	6/15/3
Surgeries (*n*/%)	
Proximal femur	2 (8.33)
Mid-shaft femur	15 (62.5)
Distal shaft femur	7 (29.16)
Mean LA volume (ml)	19.62±4.04
Needle tip identification (*n*/%)	
Proximal of PMQ	1 (4.16)
Mid of PMQ	10 (41.6)
Distal of PMQ	13 (54.16)
Type of spread	
Oval	11
Antegrade	8
Retrograde	5
VAS (mean score)	VAS (mean score)
0 h	1.45
1 h	1.66
3 h	1.91
6 h	2.41
9 h	2.66
12 h	2.7
18 h	2.83
24 h	3.08

Discussion

We aimed to define the spread patterns of LA after a perineural needle tip placement at the level of third LNr with a quadriceps response at 0.4–0.6 mA. In our series, an oval hypoechoic and antegrade flow was visible with the needle tip identified in the B and C positions of the needle tip. [Figure 1]

With the needle tip at A, a medial, and retrograde flow was visible towards IVF. A neurostimulation-guided LPB without US at the level of third LNr produced a complete blockade of all nerves exiting the plexus but with a high incidence of epidural spread especially if the injection pressure is high (more than 20 psi).[6]

LPB is an advanced RA technique that was earlier done with landmark technique or neurostimulation. US has led to a description of newer approaches to LPB. In the trident approach to LPB, the needle path was inferred by jiggling or appreciated as a bright spot during the US.[7] The needle tip–LP was identified 60% of the times in the middle of the PMA and the LA spread was detected in 40% patients in an intervertebral transverse approach to LPB.[8] Comparing three US approaches to LPB, Sato *et al*. concluded that spread of injectate was significantly more at a paravertebral position between lumbar plexus and PMA (an approach similar to intervertebral transverse scan) and that lumbar plexus and PMA appears significantly brighter at the shamrock position. Strid concluded that shamrock LPB was faster, more comfortable with lesser needle insertions.[9] Magnetic resonance imaging analysis observed a similar perineural spread in shamrock and lumbar US trident LPB.[10]

To our knowledge, this is the first attempt to understand the perineural needle tip placement and demonstrate the spread patterns of LA in intrapsoas compartment that harbors LP. All blocks were performed in real time with the shamrock method at L3 level.[11] An additional coronal scan along the mid-axillary line revealed LA spread with the needle *in situ* and was associated with a horizontal spread as a hypoechoic shadow amongst the PMA fibers in its posterior and medial areas which was a mix of hyperechoic amongst hypoechoic planes. Since the endpoint of injection was based on a combination of neurostimulation and US with needle contact close to the nerve, probably the shift of needle tip away from the IVF could have decreased the incidence of retrograde spread which was visualized in one patient.

A major limitation of this study was sample size, and moreover, there was no control group. The perineural needle tip placement was established only after neurostimulation. This was despite the third LNr being visualized, leading to a minor needle tip adjustment. Only the L3 root was identified and underwent neurostimulation. L4 neurostimulation was not performed which could also be a limitation. We did not attempt to assess the epidural spread and delineate the sensory level of analgesia. An associated contrast-enhanced computed tomography study would have identified the exact number of cases of epidural translocation of LA.

To conclude, an appropriate perineural needle tip placement and an adequate spread of the LA observed in real time during an LPB determines the clinical outcomes. Following injection, an antegrade and oval spread around the LP is evident with appropriate needle tip – third LNr contact. Further studies regarding the spread pattern and block efficacy are warranted.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Warman P, Nicholls B. Ultrasound-guided nerve blocks: Efficacy and safety. Best Pract Res Clin Anaesthesiol 2009;23:313-26.
2. Amiri HR, Zamani MM, Safari S. Lumbar plexus block for management of hip surgeries. Anesth Pain Med 2014;4:e19407.
3. Karmakar MK, Li JW, Kwok WH, Soh E, Hadzic A. Sonoanatomy relevant for lumbar plexus block in volunteers correlated with cross-sectional anatomic and magnetic resonance images. Reg Anesth Pain Med 2013;38:391-7.
4. Nielsen MV, Bendtsen TF, Børglum J. Superiority of ultrasound-guided Shamrock lumbar plexus block. Minerva Anestesiol 2018;84:115-21.
5. Gadsden J. Current devices used for the monitoring of injection pressure during peripheral nerve blocks. Expert Rev Med Devices 2018;15:571-8.
6. Gadsden JC, Lindenmuth DM, Hadzic A, Xu D, Somasundarum L, Flisinski KA. Lumbar plexus block using high-pressure injection leads to contralateral and epidural spread. Anesthesiology 2008;109:683-8.
7. Karmakar MK, Ho AM, Li X, Kwok WH, Tsang K, Ngan Kee WD. Ultrasound-guided lumbar plexus block through the acoustic window of the lumbar ultrasound trident. Br J Anaesth 2008;100:533-7.
8. Karmakar MK, Li JW, Kwok WH, Hadzic A. Ultrasound-guided lumbar plexus block using a transverse scan through the lumbar intertransverse space: A prospective case series. Reg Anesth Pain Med 2015;40:75-81.
9. Sato M, Sasakawa T, Izumi Y, Onodera Y, Kunisawa T. Ultrasound-guided lumbar plexus block using three different techniques: A comparison of ultrasound image quality. J Anesth 2018;32:694-701.
10. Strid JMC, Sauter AR, Ullensvang K, Andersen MN, Daugaard M, Bendtsen MAF, *et al*. Ultrasound-guided lumbar plexus block in volunteers; a randomized controlled trial. Br J Anaesth 2017;118:430-8.
11. Sauter AR. The "Shamrock Method"-A new and promising technique for ultrasound-guided lumbar plexus blocks. Br J Anaesth 2013;111, Issue eLetters Supplement, No Pagination Specified, https://doi.org/10.1093/bja/el_9814.