



# Ultrasound guided 4 in 1 block – a newer, single injection technique for complete postoperative analgesia for knee and below knee surgeries

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## ABSTRACT

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**Introduction:** The demand for better outcome with increased incidence of lower limb surgeries have increased interest in advanced techniques which, reduce complications and lower perioperative morbidity and mortality. The regional analgesia techniques, which provide better outcome, for knee and below knee surgeries provide excellent options for perioperative care for every age group of patients. The combination of the femoral nerve block with sciatic nerve block has provided adequate analgesia with lower consumption of perioperative opioids and rescue analgesia, for knee and below knee surgeries. We describe a novel and single injection technique for the combined 4-in-1 block (saphenous nerve, obturator nerve, nerve to vastus medialis and sciatic nerve) with a single injection point.

**Relevant Anatomy:** The adductor canal consists of the femoral vessels (vein and artery) along with the branches of the femoral nerve namely the femoral cutaneous nerves, the saphenous nerve and the Nerve to vastus medialis. The posterior division of the obturator nerve enters the popliteal fossa through the adductor hiatus. The knee is innervated by the genicular branches from the nerve to vastus medialis, saphenous nerve, sciatic nerve and the posterior division of obturator nerve. The skin around the knee is supplied by the cutaneous branches from the femoral nerve and the saphenous nerve. The nerve supply of the leg and foot is from the sciatic nerve, except the skin in the medial aspect is supplied by the sensory saphenous nerve.

**Methodology:** We describe the functional anatomy of the nerve supply to the lower limb, especially the knee joints and below knee areas. We describe the proposed '4 in one' nerve block technique for adequate postoperative analgesia of the body parts under discussion.

**Description of Technique:** The patient was kept in supine position with the ipsilateral leg kept in Frog leg position. The medial femoral condyle was marked. A linear high frequency Ultrasound probe (6-13Hz) was used. The probe was kept over the femoral condyle and vastus medialis muscle and the Vastus and sartorius intersection (antero-medial intermuscular septum) was identified and the probe was slid proximally till the superficial femoral artery appeared in the Adductor Hiatus. The probe was slid slowly proximally till the descending genicular artery branching from superficial femoral artery was visualized in the hiatus. This point was the injection point.

**Conclusion:** The positional and technical difficulties with the blocks being performed can be overcome by using a single injection, 4 in 1 block, technique described by here with ease, adequacy and surety.

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## INTRODUCTION

An ever increasing number of lower limb surgeries, e.g. total knee arthroplasty, arthroscopic knee surgeries, lower limb fracture fixations and ankle and foot surgeries etc., demand better outcomes with minimal morbidity and mortality and early mobilization and discharge. The central neuraxial and regional anesthesia and analgesia techniques significantly reduce perioperative morbidity and mortality.<sup>1,2,3</sup> The regional anesthesia techniques also reduces the endocrine and metabolic responses to surgery.<sup>4</sup> The central neuraxial blocks were associated with higher complications, morbidity and delayed ambulation.<sup>5,6</sup> The regional techniques provide a better and early outcome as compared to the central neuraxial techniques.<sup>7</sup> The regional anesthesia techniques used for knee and below knee surgeries have been extensively studied and have provided excellent options for perioperative care for every age group of patients.<sup>8,9</sup> Various studies have confirmed the early

recovery with adductor canal block over femoral nerve block, with motor sparing effect for knee surgeries.<sup>10</sup> The combination of the femoral nerve block with sciatic nerve block has provided adequate analgesia with lower consumption of perioperative opioids and rescue analgesia, for knee and below knee surgeries.<sup>11</sup> The superior efficacy of the combined adductor canal block with the sciatic nerve block comes with associated technical difficulties including positioning of patients differently for both the blocks. We describe a novel and single injection technique for the combined 4-in-1 block (saphenous nerve, obturator nerve, nerve to vastus medialis and sciatic nerve) through a single injection point.

## RELEVANT ANATOMY

The adductor canal is a musculo-aponeurotic tunnel from the apex of the femoral triangle to the adductor hiatus, between the vastus medialis muscle anterolaterally and the adductor longus and adductor magnus muscles posteromedially. It is roofed in its entire length by the vastoadductor membrane (VAM).<sup>12-15</sup> Sartorius muscle with its fascia lies anteriorly. The femoral vessels enter the adductor hiatus to form the popliteal vessels. (Figure 1, 2)

The canal contains the femoral vessels (vein and artery) along with the branches of the femoral nerve, e.g. the femoral cutaneous nerves, the saphenous nerve and the nerve to vastus medialis. The anterior division of obturator nerve was also found in the proximal part of the canal. The posterior division of the obturator nerve along with femoral vessels enters the popliteal fossa through the adductor hiatus.<sup>16,17</sup>

The medial part of knee is supplied by the intramuscular, extramuscular and the genicular branches from the nerve to vastus medialis. The saphenous nerve gives off the superficial patellar, posterior and the deep genicular

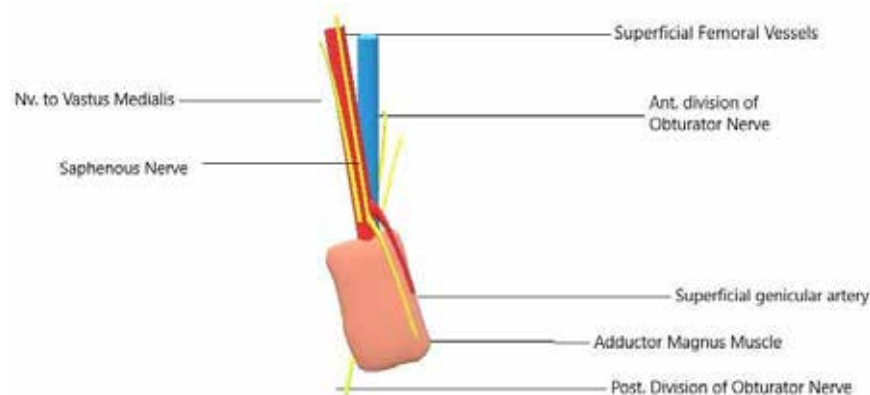


Figure 1: Schematic description of adductor canal. Femoral artery enters the adductor hiatus and forms the popliteal artery in the popliteal fossa.

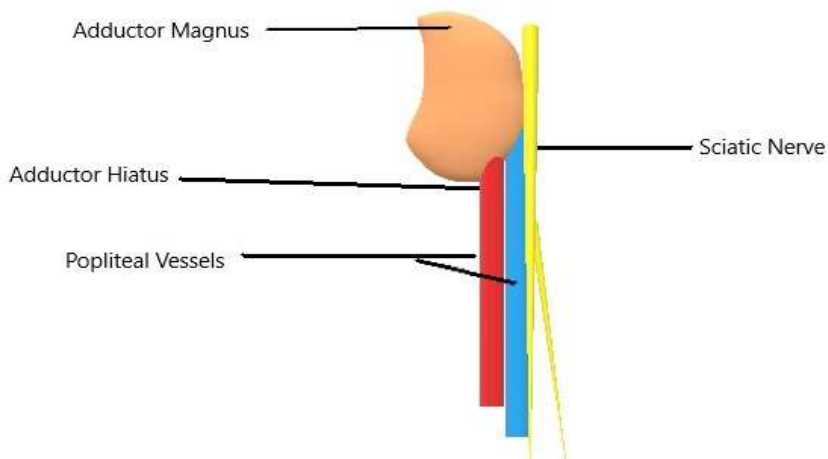


Figure 2: Schematic description of popliteal Fossa. Femoral artery enters the adductor hiatus and forms the popliteal artery in the popliteal fossa.

nerves.<sup>17</sup> The lateral part of the knee is supplied by the genicular branches from the sciatic nerve division of common peroneal nerve. The posterior part of the knee and the capsule is supplied by the popliteal plexus formed by the genicular nerves from the posterior division of obturator nerve and tibial division of sciatic nerve.<sup>18</sup> The skin around the knee is supplied by the cutaneous branches from the femoral nerve and the saphenous nerve. The nerve supply of the leg and foot is from the sciatic nerve (tibial nerve and peroneal nerves), except the skin on the medial aspect is supplied by the sensory saphenous nerve.<sup>10-12,18</sup>

## DESCRIPTION OF THE TECHNIQUE

The Institutional ethical committee clearance was obtained. Informed consent was obtained from each of the patients posted for knee or below knee surgeries. All standard ASA minimum mandatory monitoring attached. An intravenous line secured with a running intravenous fluid. The patient received subarachnoid block with 0.5% bupivacaine heavy using 25-gauge Quincke Babcock spinal needle in sitting position. The patient was made supine and the desired effect checked. The supine position was maintained with the ipsilateral leg kept in external rotation, slight abduction and knees slightly flexed (frog leg position). The medial femoral condyle was marked. A linear high frequency ultrasound probe (6-13Hz) was used. The probe was placed over the femoral condyle and vastus medialis muscle was identified and scanned proximally. The vastus and sartorius intersection (antero-medial intermuscular septum) was identified and the probe was slid proximally till the superficial femoral artery appeared in the adductor hiatus (Figure 3, 4). The probe was slid slowly proximally till the descending genicular

artery branching from superficial femoral artery was visualized in the hiatus. This point was the injection point. (Figure 3) The point was 8-10 cm above the femoral condyle. Under all aseptic precautions, the needle was guided in plane from lateral to medial side under USG guidance to reach perivascular region and after negative aspiration 0.2% ropivacaine 35 ml was injected, visualized to push the femoral artery posteriorly.

## OUR EXPERIENCE

100 ASA I & II patients posted for knee and below knee surgeries, were consecutively chosen for this block. Institutional ethical committee clearance and written informed consent from all patients was obtained. Minimum ASA mandatory monitoring and asepsis was ensured, desired anesthesia for surgery was administered, and then block by the described single injection technique was given. The patients' adductor canal and the popliteal fossa were scanned using linear high frequency probe (6-13Hz) pre-block and images saved. (Figure 5) The post block similar images were saved. (Figure 6) We experienced the drug spread into the adductor canal as well as the popliteal fossa, with perivascular spread around the sciatic nerves as well. (Figures 7, 8, 9, 10) The postoperative analgesia and comfort level was also satisfactory (pain score < 2) in all of these cases. A detailed study is under process by the authors, the results of which will be published on completion of the study.

## DISCUSSION

Peripheral nerve blocks have been proven to be superior to central neuraxial blocks like epidural analgesia<sup>19</sup> and improve postoperative analgesia;



Figure 3, 4: USG description of anatomy. The LA spread peri-vascular area in the adductor canal as described in the text.

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Figures 5 & 6: USG images of Popliteal fossa pre-block and post block showing perineural LA spread in popliteal fossa



Figures 7 & 8: During 4-in-1 block 10 ml of Omnipaque 300 are injected after confirmation of the target location by USG and 10 ml drug is injected. After dye injection another 20 ml of drug is injected and fluoroscopic images taken. The drug spreads to the popliteal plexus.



Figure 9 & 10: Dye spread is noted in the proximal adductor canal also. Needle placed using USG guidance in the popliteal fossa perineurally (tibial nerve), fluoroscopic image taken shows drug spread in popliteal plexus.

lower side effects like urinary retention, hypotension, and epidural hematoma; better patient satisfaction and rehabilitation compared with IV narcotic therapy for knee and below knee procedures.<sup>20-22</sup> The knee is supplied by genicular branches from the nerve to vastus medialis, saphenous nerve,<sup>17</sup> posterior division of obturator nerve and the sciatic nerve (tibial and the peroneal components).<sup>18</sup> The skin around the knee is supplied by the cutaneous branches from the femoral nerve and the saphenous nerve. The nerve supply of the leg and foot is from the sciatic nerve (tibial nerve & peroneal nerves), except the skin in the medial aspect, which is supplied by the sensory saphenous nerve.<sup>10-12,18</sup>

The epidural analgesia has been considered gold standard for postoperative analgesia for lower limb surgeries; however, different peripheral nerve blocks have given comparable analgesia to epidural analgesia with lower side effects. Morin et al. have compared the continuous lumbar plexus block, continuous femoral nerve block, and combined femoral and sciatic nerve block and concluded that the combination of femoral and sciatic nerve block is required for complete analgesia for knee surgeries.<sup>23</sup> Pham et al. have studied the combination of femoral and sciatic nerve block reduces the postoperative opioid requirement significantly.<sup>24</sup> Various studies have concluded that the combination of sciatic with femoral nerve block improves the postoperative analgesia significantly.<sup>11,25,26</sup> The adductor canal block has been proven to be superior to femoral nerve block in providing analgesia and also provides better quadriceps strength.<sup>10</sup> The analgesia for knee and below knee surgeries can be achieved by combining adductor canal block and sciatic nerve block. Combining these two blocks needs a lateral position or change of position, from supine to prone or lateral position, causing discomfort and logistic difficulties in trauma patients. A single injection technique to block all these nerves can provide ease of practice and better postoperative care. Runge et al. in 2017, performed a cadaver study where they described the spread of drug to sciatic nerve when injected in the adductor canal. The dye injected in the distal part

of adductor canal was seen to spread in the popliteal fossa staining the sciatic nerve, the genicular branches of the posterior division of the obturator nerve and the saphenous nerve and the nerve to vastus medialis in the adductor canal.<sup>27</sup> Wong et al. also compared the cadaver studies and analyzed the location of adductor canal using ultrasound and concluded that the true adductor canal lies distal to the mid-thigh level and also injection of drug in the distal part of the adductor canal spreads drug into the popliteal fossa blocking the sciatic nerve also. We have described a technique to inject drug at the adductor hiatus level and blocked all the four important nerves supplying the knee, leg and foot.

## LIMITATIONS

This technique remains safe and easy to perform but a larger study is needed to validate its efficacy and reliability; the early rehabilitation potential with such a block also has to be documented. The need for the injection to be given in a relatively vascular area requires repeated aspiration and a watchful eye on the ultrasound screen to see the drug spread. In the 100 cases performed we have not faced any complications, but a larger study is needed to validate such findings.

## CONCLUSION

The peripheral nerve block, adductor canal block and sciatic nerve block combined, have better outcome in knee and below knee surgeries. But the positional and technical difficulties with these blocks can be overcome by using a single injection 4-in-1 block technique, described here with ease and surety. However, larger studies are recommended to validate the findings.

**Conflict of interest:** None declared by the authors

### Authors' contribution:

RR, GA, CP: Concept, conduction of the study work, manuscript editing

DJM: DK: Conduction of the study work

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