

Total postoperative analgesia for total knee arthroplasty: Ultrasound guided single injection modified 4 in 1 block

Ritesh Roy, Gaurav Agarwal, Chandrasekhar Pradhan, Debasis Kuanar

Department of Anaesthesia and Pain Management, CARE Hospitals, Bhubaneswar, Odisha, India

Abstract

Background and Aims: Total pain free outcome following total knee arthroplasty has led to the evolution of regional blocks. In this series, the authors have revisited and modified Roy *et al.*'s technique of Ultrasound guided 4 in 1 block for knee and below knee surgeries, to provide a complete comprehensive yet simple single injection technique for postoperative analgesia for Total Knee Arthroplasty (TKA). **Material and Methods:** After Institutional ethics approval, we performed the modified 4 in 1 block on 10 consenting patients scheduled to undergo total knee arthroplasty. A linear USG-probe was used to identify medial femoral condyle, then vastus and sartorius intersection was identified. The probe was slid till the descending genicular artery branching from superficial femoral artery was visualized proximal to hiatus. At this point the needle with PNS attached, was guided into the Vastus medialis muscle till the stimulation of the nerve to Vastus medialis (0.4-0.5 mA). At this point 5–7 mL of 0.2% Ropivacaine was injected. The needle was guided in plane to perivascular region and after negative aspiration 0.2% ropivacaine 20–25 ml was injected, visualised to push the femoral artery. **Results:** All ten patients considered in this study had an optimum pain score of <5 and were comfortable along with no quadriceps weakness, except one patient had a pain score of more than 5 after 36 hr post-operatively and required rescue analgesia. **Conclusion:** The addition of USG and PNS guided Vastus medialis nerve block to USG 4-in-1 block in the technique gives good post-operative analgesia for TKA.

Keywords: Total Knee arthroplasty, Postoperative analgesia, modified four in one block

Introduction

Total knee arthroplasty or replacement (TKA) has paved the way for a better quality of life for our geriatric population. The evolution from central neuraxial blocks like combined spinal epidural etc.^[1-3] to regional blocks like the Femoral, sciatic, Adductor, combined femoral and sciatic^[4-6] for targeting pain free TKA has paved way to more and more research into the subject. As the knee joint is supplied by various nerves (genicular nerves) from the femoral, obturator and sciatic nerves^[7] hence needs a comprehensive yet simple technique for complete

analgesia postoperatively. In this series, the authors have revisited and modified Roy *et al.*'s technique of Ultrasound guided 4 in 1 block for knee and below knee surgeries,^[8] to provide a complete comprehensive yet simple single injection technique for postoperative analgesia for Total Knee Arthroplasty (TKA).

Relevant Anatomy

The Vasto-adductor membrane (VAM) forms the roof of the musculo-aponeurotic tunnel (Adductor Canal) between

Address for correspondence: Dr. Gaurav Agarwal,
Department of Anaesthesia and Pain Management, Care Hospitals,
Bhubaneswar - 751 016, Odisha, India.
E-mail: dr.agarwalgaurav@gmail.com

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the vastus medialis muscle anterolaterally and the adductor longus and adductor magnus muscles posteromedially and the sartorius anteriorly.^[9-12] Laurant *et al.* and De Souza *et al.* have shown that the canal consists of the femoral vessels along with the femoral nerve (mainly femoral cutaneous, Saphenous, and the nerve to vastus medialis), along with the anterior division of obturator nerve in the proximal canal. The Femoral vessels enters the Adductor Hiatus to form the Popliteal vessels [Figures 1 and 2]. The posterior division of the obturator nerve enters the adductor hiatus along with the femoral vessels.^[13,14] The knee joint is innervated by genicular nerves from: The nerve to vastus medialis (NVM) through its distal muscular branch continuing as medial retinacular nerve, Saphenous nerve, Tibial nerve and posterior division of obturator nerve.^[14,15]

Material and Methods

An Institutional ethical committee clearance was obtained. A series of ten patients of ASA physical status I and II were chosen. Informed consent was obtained from each of the patients posted for TKA. All standard ASA minimum mandatory monitoring were instituted. A wide bore intravenous line was secured prior to induction of anesthesia.

All ten patients received subarachnoid block with 0.5% bupivacaine heavy using 25-gauge Quincke spinal needle in sitting position. Patients were then 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 (6–13 Hz) was used. The probe was placed over the femoral condyle and vastus medialis muscle was identified and scanned proximally. The vastus and sartorius intersection (anteromedial intermuscular septum) were

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 point of interest. The point was 8–10 cm above the femoral condyle.^[8] At this point the superficial structures were re-visualised and needle with PNS attached. The needle was guided under USG guidance into the Vastus medialis muscle till the stimulation of the nerve to Vastus medialis, generating a Vastus medialis contraction, which was elicited even at the threshold current of 0.4-0.5 mA. At this point 5–7 mL of 0.2% Ropivacaine was injected [Figure 3]. The needle was guided further in plane from lateral to medial side under USG guidance to reach perivascular region and after negative aspiration 0.2% ropivacaine 20–25 ml was injected, visualised to push the femoral artery posteriorly [Figure 4].

The surgery commenced as proposed and all patients received a single dose of paracetamol 15 mg/kg intravenous along with tramadol 1 mg/kg. All patients received paracetamol 15 mg/kg intravenous along with tramadol 1 mg/kg every 8 hours, along with diclofenac (aqueous preparation) 1.5 mg/kg intravenous 12 hourly. The pain score was compared at 3, 6, 12, 24, 36 hours postoperatively and tabulated. Injection butorphanol 1 mg slow intravenous was proposed to be administered as rescue analgesic when the pain VAS score was more than 5.

Results

All of the patients considered in this study had an optimum pain score of <5 and were comfortable along with no quadriceps weakness, except one patient had a pain score of more than 5 after 36 hr post-operatively and required rescue analgesia. [Tables 1 and 2]

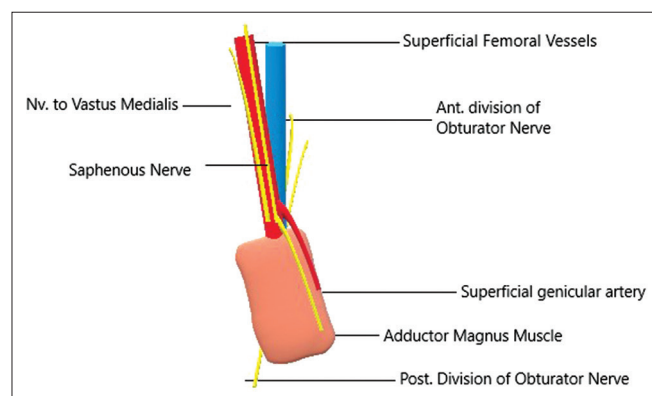


Figure 1: Schematic description of Adductor Canal. Femoral Artery enters the adductor hiatus and forms the Popliteal artery in the popliteal fossa. (Permission taken from Roy *et al.*)

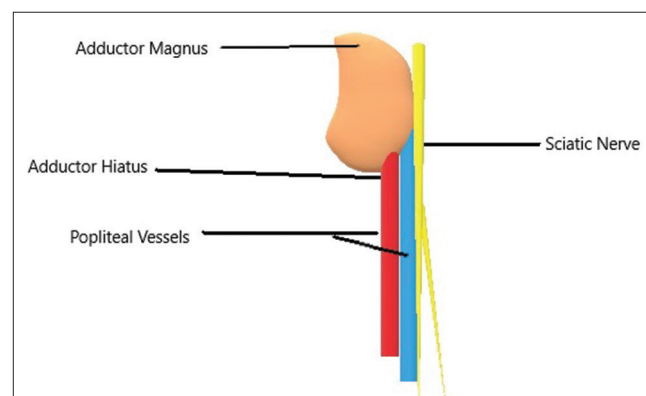


Figure 2: Schematic description of popliteal Fossa. Femoral Artery enters the adductor hiatus and forms the Popliteal artery in the popliteal fossa. (Permission taken from Roy *et al.*)

Discussion

The postoperative pain following a medial parapatellar arthrotomy, which is the most common modality of arthrotomy for TKA arises from the area innervated by mainly four nerves namely: The nerve to vastus medialis (NVM) through its distal muscular branch continuing as medial retinacular nerve, saphenous nerve, tibial nerve and posterior division of obturator nerve.

Roy *et al.* previously described 4 in 1 block technique^[8] aimed to block all these four nerves by spreading up to the adductor canal in mid thigh and below to the popliteal fossa but few of our patients who complained postoperative pain in the medial side even after successful spread of drug. We reviewed the course of nerve to vastus medialis and revisited the Roy *et al.* block technique. In this series of cases we observed that all patients who received this combination technique had an optimum pain score of less than five, and was comfortable with no quadriceps weakness, except one patient who required rescue analgesia after 36 hr.

Ozer *et al.* performed anatomical studies on twenty thighs from six male and four female cadavers perfused with 10% formalin. Ozer *et al.* observed that nerve to vastus medialis arises from the posterior division of the femoral nerve. It runs distally along the anteromedial border of vastus medialis muscle and saphenous nerve. The nerve gives three to four branches from the main trunk, supplying the middle third of the VM muscle in the tunnel. The remaining part of the nerve continues distally and pierces the distal third of the VM muscle and continues as medial retinacular nerve supplying the knee joint. The nerve to vastus medialis is close to femoral vessels and saphenous nerve proximally in its course but in mid thigh it runs in a different bilayer

fascial sheath separate from the Hunters canal or adductor canal.^[16]

Bendtsen *et al.* performed dissections of the Adductor canal in four cadavers to elucidate the course of nerve to vastus medialis. All eight dissections showed that the nerve to vastus medialis lies outside the Adductor canal in a separate fascial tunnel on the medial vastus muscle. The medial retinacular nerve lies in a fascial tunnel between the sartorius muscle and the vastus medialis muscle.^[11]

Table 1: Demographical profile of the study population

AGE	SEX	ASA	SIDE
46	F	I	R
55	M	II	L
62	F	II	L
58	F	II	R
65	M	II	L
73	M	II	L
52	F	II	L
66	M	II	R
69	F	II	R
51	F	I	L

Table 2: Pain score post-operatively

Score 3 hr	Score 6 hr	Score 12 hr	Score 24 hr	Score 36 hr
0	2	2	3	4
0	1	2	2	3
0	1	1	2	2
0	2	2	2	2
0	1	1	2	3
0	2	2	4	6
0	1	1	2	3
0	2	2	2	2
0	1	2	2	3
0	2	2	3	3

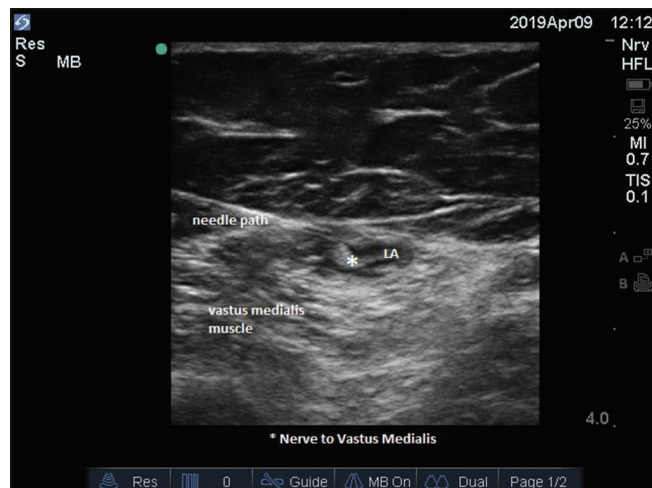


Figure 3: LA injection around nerve to Vastus Medialis

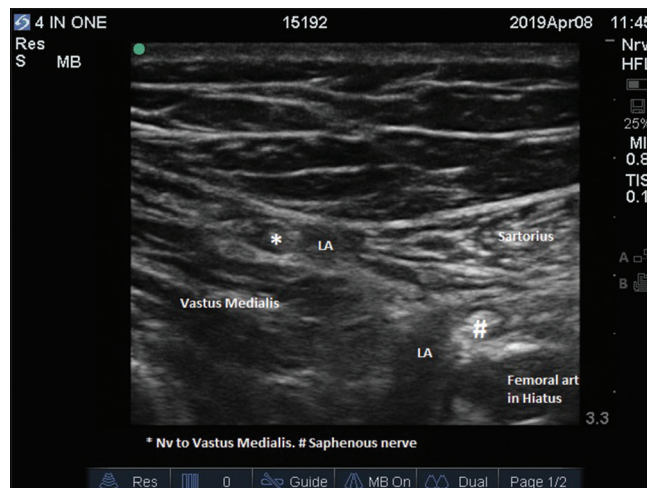


Figure 4: LA injection perivascular around Femoral artery in Adductor hiatus

Thiranyagama performed dissection of thirty human vastus medialis muscles and their nerves and revealed a consistent bipartite nerve supply from the posterior division of the femoral nerve. One part, a short and slender nerve termed the lateral branch, supplies the upper lateral portion of the muscle. The other part, a medial branch, supplies the middle and lower portion of the muscle. One of the distal set of terminal branches usually innervated the medial part of the capsule of the knee joint.^[17]

The above and many more cadaveric studies highlight that nerve to vastus medialis runs in a separate bilayer fascial sheath, rather than the adductor canal, in few of the individuals. This phenomena may be the cause of pain in on the medial side of thigh despite successful ultrasound guided 4-in-1 block with documented spread of drug in the adductor canal till mid thigh in few patients of our case series.

We revisited and modified Roy *et al.* 's ultrasound 4 in 1 block -a newer, single injection technique for complete post-operative analgesia for knee and below knee surgeries.^[8] We incorporated addition of blocking nerve to vastus medialis by eliciting peripheral nerve stimulation guided vastus medialis contraction at 0.4–0.5 mA current and rest of the technique as before for TKA.

Limitation

This being a case series, the modality needs extensive and larger sample size randomised controlled study for better corroboration of the results. The authors are in the process of registering a larger randomised study for this modality.

Conclusion

Total knee arthroplasty or replacement (TKA) with pain free post-operative period is the demand for the coming years and regional anaesthesia techniques have ensured the same for a better quality of lifestyle. The addition of USG and PNS guided Vastus medialis nerve block to USG 4-in-1 block in the technique provides good post-operative analgesia for TKA.

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Conflicts of interest

There are no conflicts of interest.

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