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ORIGINAL ARTICLE • KNEE - ARTHROPLASTY

Comparison of adductor canal block and IPACK block (interspace between the popliteal artery and the capsule of the posterior knee) with adductor canal block alone after total knee arthroplasty: a prospective control trial on pain and knee function in immediate postoperative period

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Abstract

Background Adductor canal block (ACB) is a peripheral nerve blockade technique that provides good pain control in patients undergoing total knee arthroplasty which however does not relieve posterior knee pain. The recent technique of an ultrasound-guided local anesthetic infiltration of the interspace between popliteal artery and the capsule of posterior knee (IPACK) has shown promising results in providing significant posterior knee analgesia without affecting the motor nerves.

Materials and methods A prospective study was conducted from September 2016 to March 2017 in a total of 120 patients undergoing unilateral total knee arthroplasty. The initial 60 consecutive patients received ACB + IPACK (Group 1, $n = 60$), and the subsequent 60 patients received ACB alone (Group 2, $n = 60$). All patients were evaluated with VAS score for pain recorded at 8 h, postoperative day (POD) 1 and POD 2 after the surgery. The secondary outcome measures assessed were the range of movement (ROM) and ambulation distance.

Results VAS score showed significantly ($p < 0.005$) better values in ACB + IPACK group compared to the ACB group. The mean ROM of knee and ambulation distance also showed significantly better values in ACB + IPACK group compared to the ACB group.

Conclusion ACB + IPACK is a promising technique that offers improved pain management in the immediate postoperative period without affecting the motor function around the knee joint resulting in better ROM and ambulation compared to ACB alone.

Keywords IPACK · Adductor canal block · Knee arthroplasty · Postoperative analgesia

Introduction

Postoperative pain management after total knee arthroplasty (TKA) continues to evolve with better treatment strategies being formulated to improve patient satisfaction, clinical outcomes and reduce opioid use in the immediate postoperative period [1–3]. Appropriate perioperative pain management has been shown to result in faster recovery and rehabilitation leading to better functional outcome in patients undergoing TKA. This has necessitated the development of multimodal analgesia regimens involving the use of both regional anesthesia and systemic analgesics [4]. Peripheral nerve blockade has been reported to deliver optimal postoperative pain relief and is increasingly preferred in patients undergoing orthopedic procedures, and various different techniques such as sciatic nerve block, femoral nerve block and adductor canal block have been described [5–7].

Adductor canal block (ACB) is a popular peripheral nerve block that has been shown to decrease pain significantly and thereby opioid consumption with minimal effect

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on quadriceps function [8]. Though ACB provides analgesia to the peripatellar and intra-articular aspect of knee joint, it does not relieve posterior knee pain which is moderate to severe in intensity [9, 10]. The recent technique of an ultrasound (US)-guided local anesthetic infiltration of the interspace between popliteal artery and the capsule of posterior knee (IPACK) has shown to provide significant posterior knee analgesia without affecting the common peroneal nerve (CPN) [11]. We postulated that the combination of ACB + IPACK will provide better pain relief and improve knee function in the immediate postoperative period compared to ACB alone and therefore have conducted this prospective study to verify this hypothesis.

Materials and methods

The entire treatment protocol was approved by the Institute Ethics Committee and was conducted according to the principles established in the Declaration of Helsinki. However, due to the non-existence of previously documented comparative studies in the literature, our ethics committee has suggested that we conduct a non-randomized pilot study to evaluate the preliminary outcomes. Consent for the publication of clinical details, radiographs and photographs was obtained from the patients. A prospective non-randomized study was conducted from September 2016 to March 2017 in our institution in a total of 120 patients undergoing unilateral total knee arthroplasty. The initial 60 consecutive patients received ACB + IPACK (Group 1, $n = 60$), and the subsequent 60 patients received ACB alone (Group 2, $n = 60$). Patients undergoing bilateral or revision total knee replacement, with history of bleeding diathesis or prior vascular surgery on femoral vessels on operated site, severe renal insufficiency, history of arrhythmia or seizures, sepsis, pre-existing lower extremity neurological abnormality and difficulties in comprehending visual analog scale (VAS) pain scores, were excluded from the study. All patients were given spinal anesthesia with 2.5 ml 0.5% hyperbaric bupivacaine at the L3/4 interspaces (alternatively at the L2/3 or L4/5 interspaces). All the surgeries were performed by a single surgeon (AVGR) using the medial parapatellar approach, and posterior stabilized knee prosthesis was used in all the patients.

All patients received ACB in the immediate postoperative period under a high-frequency ultrasound guidance (SonoSite™, Inc., Bothell, WA 98021, USA) in which the adductor canal was identified beneath the sartorius muscle and 20 ml of 0.2% ropivacaine was injected in the canal using a 22-gauge 100-mm short-beveled regional block needle (Stimuplex® insulated B Braun Medical Germany). The patients in Group 1 received IPACK according to the technique described by Elliott et al. [12] in which the patient was placed in a supine position and knee placed in position of 90° flexion. A low-frequency ultrasound probe was positioned in the popliteal crease, and spinal needle was inserted from medial aspect of the knee from anteromedial to posterolateral direction in a plane between the popliteal artery and the femur. The tip of the needle was placed 1–2 cm beyond the lateral edge of the artery, and 15 ml of 0.2% ropivacaine was injected (Fig. 1).

All the patients received celecoxib 200 mg and gabapentin 300 mg preoperatively 12 h before the surgery and received the same postoperative analgesic regimen which was paracetamol 1 g intravenously every 8 h for 3 days followed by oral paracetamol 1 g every 8 h for 1 month, gabapentin 300 mg given orally once daily for a period of 4 weeks. Intravenous diclofenac 75 mg along with a transdermal

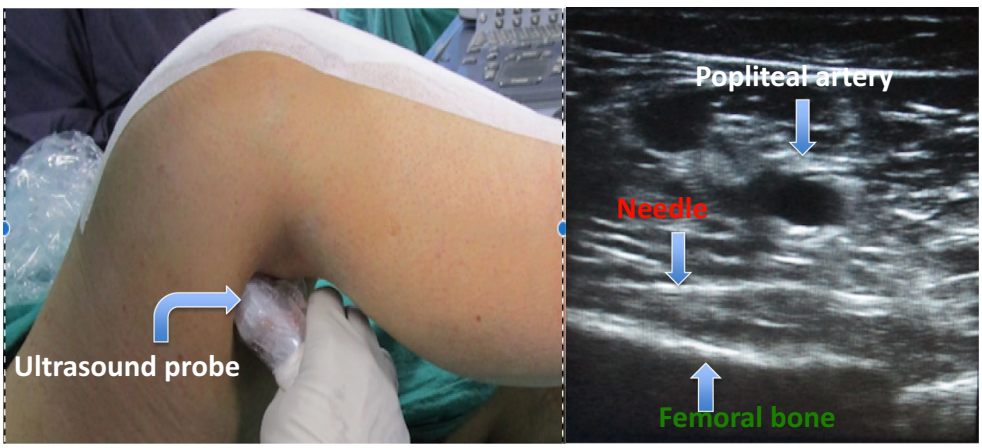

Fig. 1 **a** The ultrasound probe is placed in the popliteal fossa on the lateral side and the needle introduced posteromedially with the patient placed in supine position. **b** Popliteal artery, femoral bone surface identified on the ultrasound and the needle placed in capsular space between the artery and femur and anesthetic injected

buprenorphine patch (5 mcg/h) was considered in the form of rescue analgesia in patients experiencing breakthrough pain. A uniform supervised rehabilitation protocol was followed after the surgery, and all patients were discharged 3 days after the surgery from the hospital. Postoperative pain at rest was the primary outcome measure which was assessed using the visual analog scale (VAS) (scale 0–10, where 0 = no pain and 10 = worst imaginable pain). All the patients were explained and taught the VAS score for self-assessment of pain at the time of enrollment for the study. VAS score was recorded at 8, 12, 24 and 48 h after surgery. The secondary outcome measures assessed were the range of movement (ROM) 2 days after the surgery and ambulation distance assessed by the number of steps walked by the patient 3 days after the surgery.

Statistical analysis

We compared the primary and secondary outcomes between the ACB and ACB + IPACK group. Assessment of whether the data are normally distributed was made using the Kolmogorov–Smirnov test. Continuous variables were analyzed using the Student's *t* test or the Wilcoxon signed-rank test. Categorical data were analyzed using the Chi-squared test or by Fisher's exact test, as appropriate. The SPSS 19.0 software (SPSS Inc., Chicago, IL, USA) was used for the statistical analysis. The nature of the hypothesis testing was two-tailed, and $P < 0.005$ was considered statistically significant.

Results

A total of 120 patients were included in the study in which 60 patients received ACB + IPACK and 60 patients received ACB alone. The entire study group included 40 male patients and 80 female patients of which 22 males and 38 females were in ACB +IPACK group and 18 males and 42 females were in the ACB group. The mean age of the patients in the study group was 64.95 years with patients in ACB + IPACK group having a mean age of 66.6 years and patients in ACB group with a mean age of 63.3 years. The overall demographic and perioperative characteristics in both the groups were similar and are depicted in Table 1.

VAS score at rest after 8 h postoperatively, on day 1 and day 2 showed significantly ($p < 0.005$) better values in ACB +IPACK group compared to the ACB group (Table 2). However, patients in both the groups did not experience severe pain that required any rescue medication. The mean range of movement (ROM) of knee on POD 2 was 71.8 degrees in ACB + IPACK group, which was significantly better ($p < 0.05$) than the ACB group (ROM = 62.2°). Similarly, the ambulation distance was better in the ACB + IPACK group compared to the ACB group (Table 2).

Table 1 The patient characteristics of both groups

Patient characteristics	Group 1	Group 2
Age	60	61
Sex (male/female)	38/22	42/18
Height (cm)	163	159
Weight (Kg)	78	73
Duration of surgery (min)	68	66
Preoperative VAS score at rest	6	5
Habitual analgesic intake		
None	12	14
Paracetamol/NSAID	38	32
Weak opioids	10	14

Table 2 The comparison of postoperative VAS scores and distance walked between both the groups

Variable	Adductor canal block + IPACK (Group 1, $n = 60$)	Adductor canal (Group 2, $n = 60$)	*P* value
VAS 8 h PO	1.4333 ± 0.6474	2.9167 ± 0.64550	< 0.001
VAS POD 1	2.05 ± 0.4323	3.1833 ± 0.72467	< 0.001
VAS POD 2	2.55 ± 0.7274	3.4500 ± 0.67460	< 0.001
ROM (°)	71.8333 ± 9.52	62.2500 ± 8.25	< 0.001
Distance walked day 3 (no. of steps)	8.51 ± 1.85	7.1333 ± 1.434	< 0.001

Discussion

The increase in number of TKAs performed worldwide has also resulted in greater emphasis on adequate pain management and faster recovery in the immediate postoperative period. This has led to emergence of various postoperative pain management strategies of which peripheral nerve blocks have attained popularity [13]. ACB is a peripheral nerve block, which has been reported to provide a significant pain relief and earlier mobilization in patients due to its quadriceps strength sparing [14]. However, this technique provides pain relief only anteriorly and medially due to its lack of effect on deep genicular nerves and as a result posterior knee pain is not addressed by this technique, which precludes complete knee extension and thereby early ambulation leading to delayed rehabilitation [15, 16]. Different techniques to block the contribution of sciatic nerve to the posterior capsule without involving the common peroneal nerve have been attempted without a significant success [17].

The technique of IPACK involves infiltrating the space between the popliteal artery and the posterior capsule with a local anesthetic to block the deep genicular nerves

supplying the posterior aspect of the knee joint. The technique involves a very selective block of the terminal sensory branches of the posterior aspect of the knee without the involvement of motor branches of the tibial and peroneal nerves leading to a reduced pain without effect on muscle power [18]. This leads to better ambulation which in turn translates to better rehabilitation and recovery of the patient. In our study of the two groups, we found that ACB + IPACK group reported better VAS scores on day 0 as well as day one with significantly better ROM and ambulatory distance when compared with ACB group. The main complaint of patients with only adductor block on day 1 was pain in posterior region of knee joint.

There are very few studies published in the literature evaluating the role of IPACK in pain management after TKA.

Elliot et al. [12] showed ACB + IPACK reduces the stay as well as improves the physical therapy response. Pain scores, opioid consumption, physical therapy performance and time to discharge were recorded. In their study, ACB/IPACK group had non-inferior VAS scores with slightly higher opioid consumption compared with the FNB/IPACK group. However, the ACB/IPACK group had significantly better ambulation distance and the group also had more discharges on POD 1 and POD 2, and all patients in this group were discharged by POD. In a RCT comparing the effect of sciatic nerve block (SNB), posterior capsule infiltration (P-LIA) and a control group receiving sham-SNB and sham-P-LIA, Safa et al. [19] concluded that patients receiving SNB had a transient reduction in cumulative opioid consumption in the early postoperative period (12 h) compared to the other groups. They concluded that P-LIA has no additive effect on patient pain control. However, the technique described by this study group was a non-specific infiltration done without the guidance of ultrasound.

This has some limitations. First, this study is non-randomized study as we could not get our ethics committee approval for a randomized study and thus could have led to a bias in the selection of the patients even though both the groups are comparable. The second limitation is that all the patients were discharged after 72 h and we therefore could not assess whether any of those patients had a delayed onset pain affecting their ROM and ambulation. Third, we evaluated only the regional effect of the block and did not take into consideration the potential systemic effect of ropivacaine. Fourth, this study does not evaluate whether the addition of a infusion catheter compared to a single-shot block would add any benefit. Further randomized studies in this direction might shed more light on the use of this procedure.

In conclusion, ACB + IPACK is a promising technique that offers improved pain management in the immediate postoperative period without effecting the motor function around the knee joint resulting in better ROM and ambulation compared to ACB alone. Further studies evaluating the dose, concentration and administration (single shot vs. continuous infusion) of the anesthetic used in this technique will probably help in having better pain control after TKA.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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