Original Article

Comparison of sensory posterior articular nerves of the knee (SPANK) block versus infiltration between the popliteal artery and the capsule of the knee (IPACK) block when added to adductor canal block for pain control and knee rehabilitation after total knee arthroplasty---A prospective randomised trial

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ABSTRACT

Background and Aims: Adductor canal block (ACB), though an effective procedure for postoperative analgesia in total knee arthroplasty (TKA), does not provide analgesia to the posterior articular aspect of the knee joint. Infiltration between the popliteal artery and the capsule of the knee (IPACK block) and sensory posterior articular nerves of the knee (SPANK block) are two single injection techniques that have been shown to provide effective analgesia in posterior knee pain. This study aims to compare the effect of IPACK block and SPANK block when combined with ACB for analgesia and postoperative rehabilitation in TKA. **Methods:** A total of 82 patients were randomised into two groups: (1) ACB combined with IPACK, (2) ACB combined with SPANK block. The primary outcome was the pain scores from 6 h to 48 h after surgery and the duration of postoperative analgesia. The secondary outcome measures were 24 h opioid consumption, ambulation parameters like mobilisation ability, quadriceps muscle strength and patient satisfaction score at discharge. **Results:** Numerical rating scale (NRS) scores at rest and on movement, duration of analgesia, total opioid consumption, and patient satisfaction were significantly better ($P < 0.05\%$) in the IPACK group than in the SPANK block. There were no significant differences in the knee rehabilitation parameters between the blocks. **Conclusion**: ACB with IPACK block offers better analgesia, less opioid consumption and better patient satisfaction with comparable knee rehabilitation parameters in the immediate postoperative period after TKA compared to ACB with SPANK block.

Key words: Analgesia, arthroplasty, knee, nerve block, ultrasonography

INTRODUCTION

The primary analgesic goals in total knee arthroplasty (TKA) include minimising postoperative pain and improving the patients' functional outcomes to promote early ambulation.[1] The various modalities described for pain management after TKA include epidural analgesia, femoral nerve block, adductor canal block (ACB) and intra-articular injections.[2] Though

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quite effective in providing postoperative analgesia, most of these techniques result in postoperative quadriceps weakness, which hampers ambulation.[3] ACB has gained immense popularity in the recent past due to its distinct advantage of providing satisfactory postoperative analgesia without any associated quadriceps muscle weakness.[4] However, ACB has a critical shortcoming that it does not provide analgesia to the posterior articular aspect of the knee joint, in the sciatic nerve territory, which is of moderate to severe intensity after TKA and hence needs to be addressed.[5]

Infiltration between the popliteal artery and the capsule of the knee (IPACK) block and sensory posterior articular nerves of the knee (SPANK) block block are two single injection techniques that have been shown to provide effective analgesia in posterior knee pain[6] without any associated motor weakness. However, being emerging techniques, there is no research yet to advocate the superiority or recommend one over the other. Thus, we designed this study to compare the effect of SPANK block and IPACK block when combined with ACB primarily for postoperative analgesia after TKA with secondary objectives of comparing the effect of the two blocks on immediate postoperative rehabilitation including ambulation and quadriceps muscle strength.

METHODS

The present study, a randomised controlled trial, was conducted in a tertiary care hospital with a high volume orthopaedic centre between December 2020 and June 2021, after institutional ethics committee approval and prospective registration with the Clinical Trials Registry -India (CTRI/2020/11/029180). Inclusion criteria were patients with American Society of Anesthesiologists (ASA) physical status I, II of either sex, aged between 40 and 60 years, and body mass index less than 45 undergoing unilateral TKA. Patients with known allergy to the medications used in the study, coagulopathy, local site infection, opioid consumption of more than 30 mg morphine equivalents per day, were excluded from the study.

During the pre-anaesthetic checkup, the enroled patients were explained about the numerical rating scale (NRS) for pain assessment, the straight leg raise (SLR) test and the timed up and go (TUG) test. In the operation theatre, all the patients were administered subarachnoid block at L2/3 or L3/4 with 3.0 ml of 0.5% hyperbaric bupivacaine. On completion of TKA, patients were randomised to two groups (Group-I and Group-S) using sealed opaque envelopes containing computer-generated random numbers, accessible only to the anaesthesiologist performing the block. Both the patients and the data collection team were kept blinded to the block administered. The nerve blocks were performed on completion of TKA, after application of the primary wound dressing under strict aseptic precautions.

Under ultrasound guidance, Group-I patients were administered ACB plus IPACK block, and Group-S patients received ACB plus SPANK block. All the blocks were performed using a linear (5--13 MHz, Sonosite nanomax) or curvilinear (2--5 MHz) ultrasound probe with the help of 22G echogenic needle (Stimuplex®, B. Braun). The local anaesthetic solution for the block was prepared in two syringes, one for ACB and the other for either IPACK or SPANK block.

Technique for ACB: With the linear ultrasonography (USG) probe at the mid-thigh level, the Sartorius muscle was identified. Underneath the Sartorius, the adductor canal was identified containing the femoral artery and the saphenous nerve. The echogenic needle was advanced into the adductor canal by the in-plane technique. Correct needle placement was confirmed by demonstrating the spread of 3 ml of saline in the adductor canal. 15 ml of 0.25% ropivacaine was then injected in the adductor canal.

IPACK Block: To begin scanning, a curvilinear USG probe was placed on the lower third of the medial thigh to identify the femoral vessels. The transducer was then translated caudally into the popliteal fossa observing the femoral artery becoming the popliteal artery. At this position, by in-plane USG technique, with the knee in 90° flexion, the needle was advanced medially (medial to lateral trajectory) into the space between the popliteal vessels and the posterior capsule of the knee joint.[7] With the needle tip positioned 2 cm beyond the lateral border of the popliteal artery, an injection of 15 ml of 0.25% ropivacaine was used for the IPACK block [Figure 1a].

SPANK Block: The USG linear probe was placed sagittally over the junction of the femoral shaft with the medial femoral epicondyle. The probe was then moved proximally so as to visualise the adductor tubercle. Under USG guidance, needle was inserted to position the needle tip at the bony cortex 1 cm anterior to the peak of the adductor tubercle to avoid

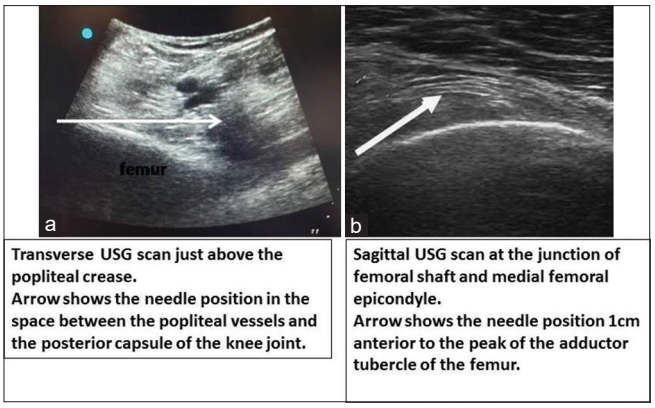

Figure 1: (a) IPACK Block. (b) SPANK Block

being in the periosteum and local anaesthetic injected after aspiration to rule out intravascular placement.[8] It was ensured that popliteal vessels are avoided in the needle trajectory and an injection of 15 ml of 0.25% ropivacaine was used for the SPANK block [Figure 1b].

The requisite parameters were assessed and recorded in the post-anaesthesia care unit (PACU) every 6 h for 24 h, and motor weakness was evaluated for two postoperative days. The pain scores and duration of postoperative analgesia were evaluated from 6 h to 48 h after surgery and 24 h opioid (tramadol) consumption was recorded. Patients were asked to verbally rate their pain intensity on a scale (NRS) from 0 to10, with 0 being the absence of pain and 10, the worst pain possible.

The other observed parameters were ambulation and mobilisation ability assessed by the TUG test, quadriceps muscle strength assessed by SLR, patient satisfaction score and adverse effects, if any following the block. Rescue analgesia with intravenous tramadol 2 mg/kg was administered on demand. Total tramadol requirement in the first 24 h was recorded. Quadriceps strength was assessed using the SLR preoperatively and then at 24 h postoperatively. SLR was assessed on a scale of 0 to 5 (0 = no voluntary contraction possible, 1 = muscle flicker, but no movement of the limb, 2 = active movement only with gravity eliminated, 3 = movement against gravity but without resistance, 4 = movement possible against some resistance and 5 = normal motor strength against resistance). Patients were encouraged to ambulate with assistance after 24 h when the motor strength was at least two. The TUG test was used to assess the ability to ambulate. It is the time taken by the patient to get up from the chair, walk 3 m, walk back to the chair, and sit down. Adverse events such as hypotension, bradycardia, nausea, vomiting, shivering, pain or paraesthesia in the thigh, or features of local anaesthetic toxicity, if any were recorded. Patient satisfaction score was assessed 48 h postoperatively based on a questionnaire to assess the general satisfaction of the patients on three grades of worse to good, carrying points one to three, respectively. The components of the questionnaire were derived from the Revised American Pain Society,[9] which included pain relief, pain induced sleeplessness or feeling anxious or depressed, ability to walk, and whether to opt similar pain relief measures in the future. Patients with total score of <6, 6--8, and ≥ 8 were marked dissatisified, slightly satisfied and very satisfied.

Barring no existing literature comparing IPACK and SPANK blocks, the authors had conducted a pilot feasibility study with 16 patients. The mean ± standard deviation of NRS score on movement at 12 h in the ACB plus IPACK group was 3.0 ± 1.9 versus 4.2 ± 2.2 in the ACB plus SPANK group. The effect size calculated from this data was 0.98 and 0.84, respectively. The sample size required to obtain an alpha error of 5% and power of 80% with the allocation ratio of 1:1 was 36 in each group. Assuming a 20% dropout rate, we enroled 86 patients, with 43 in each group.

Continuous variables were analysed using analysis of variance (ANOVA), categorical variables by Chi-square test and non-parametric data by Kruskal--Wallis test. Comparison of the duration of analgesia between the two groups was performed using ANOVA. Bonferroni test was applied for the difference between two groups if ANOVA was significant.

RESULTS

A total of 82 patients, 41 in each group, were included in the final analysis [Figure 2]. The baseline characteristics were similar in both groups [Table 1]. There was a statistically significant difference in the recorded pain scores between the two groups at all the measured times in the first 24 h after surgery. Patients in Group I had lower pain scores than Group S both at rest and on movement [Table 2]. Duration of analgesia, measured by the time to first rescue analgesia, was significantly longer in Group I than Group S, as revealed by the Bonferroni test. The number of patients requiring rescue analgesics and the total opioid consumption in the first 24 h after surgery was significantly less in Group I [Table 3]. Quadriceps motor strength as assessed by SLR at

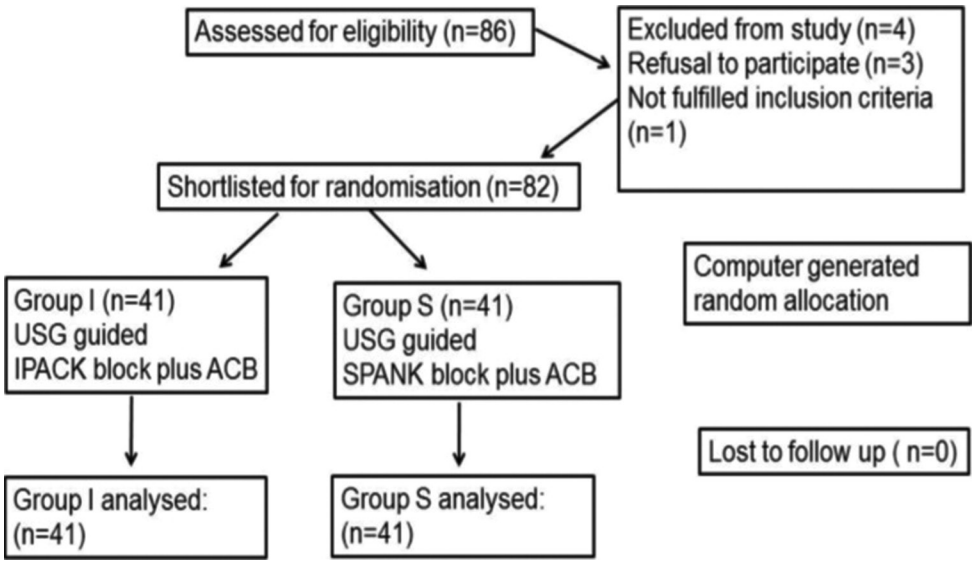

Figure 2: CONSORT flow diagram for patient enrolment and analysis

Table 1: Demographic characteristics

Parameter	Group I	Group S	*P*
Age (years) (mean±SD)	62.6 (7.4)	64.5 (7.7)	0.8
Sex (Male/Female)	55.3%/44.7%	52.7%/47.3%	0.4
No. of patients with ASA grade I/II	18/23	16/25	0.6
BMI (mean±SD)	26.5 (2.7)	25.9 (3)	0.5
Baseline HR (mean±SD)	71.9 (10)	69.4 (8.6)	0.9
Baseline MAP (mm hg)	114 (11.8)	112 (11.6)	0.3

ASA: American Society of Anesthesiologists, BMI: Body mass index, HR: Heart rate, MAP: Mean arterial pressure, SD: Standard deviation, No.: Number

24 h postoperatively and the mobilisation ability as assessed by the TUG test was comparable between both the groups [Table 4].

Post-hoc analysis revealed a statistically significant number of patients with a higher level of satisfaction, that is, satisfaction score 3 in Group I as compared to Group S (45.8% vs 20.1%, respectively; $P = 0.004$). Conversely, the number of patients with a lower satisfaction score of 1 was significantly more in Group S than Group I (20.5% vs 7.2%, respectively; $P = 0.003$). Only two patients in Group I and one patient in Group S complained of postoperative nausea. None of the patients in either group had other adverse effects like sedation, pruritus, paraesthesia or pain in the thigh or local anaesthetic toxicity.

DISCUSSION

This study showed that IPACK block as an addendum to the ACB results in significantly better pain scores, longer duration of analgesia, lower opioid consumption and better patient satisfaction than SPANK block while providing comparable ambulatory parameters.

Posterior knee pain is mediated by articular branches from the posterior articular branch of the posterior tibial nerve with contributions from the obturator nerve. They form a popliteal plexus of nerve divisions deep in the popliteal fossa to supply the posterior capsule. The genicular nerves also form network with the terminal branches of femoral and obturator nerve to supply the posterior capsule of the knee joint.[6] Of the many techniques that have been employed for posterior knee pain after TKA, IPACK and SPANK block have gained popularity in recent times for their motor sparing function. The SPANK block is a relatively new technique first described by Kardash *et al.* in 2015.[8] As the block is performed at the femoral epicondyle above the posteromedial aspect of the periosteum, it carries the theoretical advantage of being less invasive to the surgical field as compared to the IPACK block. We found the SPANK block was easier to perform in the postoperative scenario, as the femoral epicondyle could be easily palpated even through the dressings. The performance of IPACK block posed a definite disadvantage in this regard as the knee joint covered with bandages limited access or sometimes surgeon preference owing to proximity to the operated joint structure. However, there is no literature evaluating the efficacy of both the blocks for posterior knee pain in TKA.

Thobhani S *et al.*,[10] in their study on 106 TKA patients, established that IPACK block, when used as a supplemental technique, provided effective postoperative analgesia with lower opioid requirements and improved physical performance. Eccles CJ *et al.*[11]

Table 2: Post-operative Pain scores (NRS)						
Parameter	**Group**	**6 h**	**12 h**	**18 h**	**24 h**	**48 h**
Pain (rest)	I	1.5 (0-3)	2.5 (0-3)	2.5 (2-4)	2 (0-3)	2.5 (1-4)
Median (IQR)	S	3.5 (0.75-5)	4 (2-5)	4.5 (2-5)	4 (3-5.5)	3 (1-3.25)
P		0.006	0.008	<0.001	0.001	0.341
Pain (movement)	I	3 (2-4)	2 (0-5)	2.0 (1.75-4.25)	3.0 (2-5)	3 (0.75-5)
Median (IQR)	S	5 (4-6)	5 (2-6)	4 (2-3.5)	4 (2-5)	3 (2-4)
P		0.001	0.024	<0.001	0.011	0.324

Values depicted as median (25th-75th IQR); NRS: Numerical rating scale, IQR: Interquartile range

Table 3: Duration of analgesia and Opioid consumption			
Parameter	**Group I**	**Group S**	***P***
Time to rescue analgesia (hours)	17.9±7.6	10.2±6.8	<0.001
Total 24 h tramadol dose (mg)	45.7 mg±54.2	92.9 mg±57.3	<0.001
Patients requiring rescue analgesia (%)	42.7%	82.8%	<0.001

Table 4: Knee rehabilitation parameters			
Parameter	**Group I**	**Group S**	***P***
Quadriceps motor strength			
Mean (SD)	2.6 (0.8)	2.8 (0.7)	0.70
Median (IQR)	3 (2-3)	3 (2-3)	
TUG test Time (sec) Median (IQR)			
24 h	68.4 (45.8-120.3)	71 (65.4-112.2)	0.70
48 h	66.9 (44.8-73.4)	70.1 (44.6-85.3)	0.67

TUG: Timed up and go, SD: Standard deviation, IQR: Interquartile range

demonstrated that patients receiving IPACK block in combination with ACB could be ambulated early, had decreased opioid consumption and duration of hospitalisation when compared to femoral and sciatic nerve blockade. However, both these studies were retrospective in nature. There are very few prospective studies evaluating the IPACK block. Kim DH *et al.*[12] reported similar findings as ours and strongly supported the use of IPACK block within a multimodal analgesic pathway after TKA. However, not all research is unanimous on the analgesic and pro-ambulatory benefits of IPACK block. Patterson ME *et al.*[13] did not find any advantage of IPACK block when administered with continuous ACB and advocate against the routine use of the block. A recent meta-analysis has shown that the analgesic and pro-ambulatory benefits of the block seem to be relevant only when IPACK block and ACB are administered in the absence of periarticular local anaesthetic infiltration (LAI).[14] However, as with many other centres, periarticular LAI is not a routine practice in our institution. We did not find any pro-mobilisation benefits of the improved analgesia conferred by the IPACK block on the day of surgery, probably because the patients in our centre are not ambulated for 24 h after surgery.

The SPANK block was based on trials, which found that radiofrequency ablation of the genicular nerves was effective in knee pain due to chronic osteoarthritis.[15] Using the same landmarks as for a medial superior genicular nerve block, Kardash *et al.*[8] demonstrated that the addition of SPANK block to ACB after TKA resulted in significant analgesia 4 h postoperatively without any motor weakness.

In our study, we found IPACK block to provide better analgesia with lower opioid consumption, albeit without any motor weakness or ambulatory benefits compared to the SPANK block. However, barring any existing literature to refute or support our study findings, further validation of this technique is required. Clinical trials are underway for research in this regard. Also, there is not much clarity on the optimal dosage of the local anaesthetic for the blocks. Our dosage regimen of 15 ml of 0.25% ropivacaine is similar to that used in other studies.[7] A cadaveric study designed to evaluate the spread of dye injectate after IPACK block suggests limiting the total volume of local anaesthetic to less than 20 ml to prevent any possible spread to sciatic nerve branches.[16]

The anatomical target of the IPACK block is the articular branches innervating the posterior joint capsule arising from the common fibular, sciatic, tibial, and posterior division of obturator nerve. The SPANK block aims to block the medial genicular nerve that contributes to sensory innervation to the posterior articular knee structures, thus providing effective analgesia for posterior knee pain after TKA. In this block, most of the local anaesthetic is injected posterior to femur, at this location just above the periosteum, where the superior medial genicular nerve is located. The authors surmise that the IPACK block could have provided superior analgesia as in this block, the USG guided injection point was precisely placed in the area between the popliteal artery and posterior capsule, thereby targeting all the terminal branches of the tibial nerve and other contributing branches from the popliteal plexus. Our theory is supported by a cadaver

study where methylene blue was injected for the block and spread to all the terminal branches was noticed.[17]

The study is limited by low sample size and single-centre setting. However, it is prospective in nature, and our findings open the door for the performance of future clinical trials to compare the two novel regional analgesia techniques. It would also be interesting to see if the better analgesia conferred by IPACK block over SPANK block translates into pro-ambulatory benefits, particularly in the immediate postoperative period.

CONCLUSION

ACB with IPACK block offers better analgesia, less opioid consumption and better patient satisfaction with comparable knee rehabilitation parameters in the immediate postoperative period after TKA compared to ACB with SPANK block.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Stevenson KL, Neuwirth AL, Sheth N. Perioperative pain management following total joint arthroplasty: A review and update to an institutional pain protocol. J Clin Orthop Trauma 2018;9:40-5.
2. Wahal C, Kumar A, Pyati S. Advances in regional anaesthesia. Indian J Anaesth 2018;62:94-102.
3. Pelt CE, Anderson AW, Anderson MB, Van Dine C, Peters CL. Post-operative falls after total knee arthroplasty in patients with a femoral nerve catheter: Can we reduce the incidence? J Arthroplasty 2014;29:1154-7.
4. Krishna V, Govil N, Tripathi M, Jain G, Goyal T, Aggarwal S. Comparison of adductor canal block with femoral nerve block for post-operative pain relief after bilateral total knee arthroplasty. Indian J Anaesth 2021;65:S80-5.
5. Vora MU, Nicholas TA, Kassel CA, Grant SA. Adductor canal block for knee surgical procedures: Review article. J Clin Anesth 2016;35:295-303.
6. Kukreja P, Feinstein J, Kalagara HK, Huntley SR, Lee SR, Naranje S, *et al*. A summary of the anatomy and current regional anesthesia practices for post-operative pain management in total knee arthroplasty. Cureus 2018;10:e2755.
7. Sankineani SR, Reddy ARC, Eachempati KK, Jangale A, Gurava Reddy AV. 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 post-operative period. Eur J Orthop Surg Traumatol 2018;28:1391-5.
8. Kardash KJ, Noel GP. The SPANK block: A selective sensory, single-injection solution for posterior pain after total knee arthroplasty. Reg Anesth Pain Med 2016;41:118-9.
9. Gordon DB, Polomano RC, Pellino TA, Turk DC, McCracken LM, Sherwood G, *et al*. Revised American Pain Society Patient Outcome Questionnaire (APS-POQ-R) for quality improvement of pain management in hospitalized adults: Preliminary psychometric evaluation. J Pain 2010;11:1172-86.
10. Thobhani S, Scalercio L, Elliott CE, Nossaman BD, Thomas LC, Yuratich D, *et al*. Novel regional techniques for total knee arthroplasty promote reduced hospital length of stay: An analysis of 106 patients. Ochsner J 2017;17:233-8.
11. Eccles CJ, Swiergosz AM, Smith AF, Bhimani SJ, Smith LS, Malkani AL. Decreased opioid consumption and length of stay using an IPACK and adductor canal nerve block following total knee arthroplasty. J Knee Surg 2021;34:705-11.
12. Kim DH, Beathe JC, Lin Y, YaDeau JT, Maalouf DB, Goytizolo E, *et al*. Addition of infiltration between the popliteal artery and the capsule of the posterior knee and adductor canal block to periarticular injection enhances post-operative pain control in total knee arthroplasty: A randomized controlled trial. Anesth Analg 2019;129:526-35.
13. Patterson ME, Vitter J, Bland K, Nossaman BD, Thomas LC, Chimento GF. The effect of the IPACK block on pain after primary TKA: A double-blinded, prospective, randomized trial. J Arthroplasty 2020;35:S173-7.
14. Hussain N, Brull R, Sheehy B, Dasu M, Weaver T, Abdallah FW. Does the addition of iPACK to adductor canal block in the presence or absence of periarticular local anesthetic infiltration improve analgesic and functional outcomes following total knee arthroplasty? A systematic review and meta-analysis. Reg Anesth Pain Med 2021;46:713-21.
15. Kim PY, Cohen SP. Genicular nerve blocks and radiofrequency ablation for knee osteoarthritis: More nerves, more questions. Pain Med 2021;22:1019-21.
16. Niesen AD, Harris DJ, Johnson CS, Stoike DE, Smith HM, Jacob AK, *et al*. Interspace between Popliteal Artery and posterior Capsule of the Knee (IPACK) injectate spread: A cadaver study. J Ultrasound Med 2019;38:741-5.
17. Kampitak W, Tansatit T, Tanavalee A, Ngarmukos S. Optimal location of local anesthetic injection in the interspace between the popliteal artery and posterior capsule of the knee (iPACK) for posterior knee pain after total knee arthroplasty: An anatomical and clinical study. Korean J Anesthesiol 2019;72:486-94.