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CONTINUOUS EPIDURAL ANALGESIA VS USG GUIDED CONTINUOUS SAPHENOUS NERVE BLOCK IN UNILATERAL TKA

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Conflicts of Interest: Nil

ABSTRACT:

Background: The main indication for TKA is to improve function, pain relieve and to increase quality of life in patients with degenerative knee joint disease. TKA is associated with severe postoperative pain and effective postoperative analgesia after TKA remains a challenge. Early mobilization is a challenge after TKA when a patient has severe pain and is receiving pain treatment. Despite a comprehensive multimodal analgesic regimen, TKA is often associated with intense postoperative pain. Epidural analgesia being a viable alternative, however, faces a relatively high failure rate and may result in side effects such as urinary retention and motor block, with the latter potentially hindering mobilization. PNB with preserved muscle function and an adequate analgesic effect is desirable. Saphenous nerve block (SaphNB) blocks the largest sensory branch of the femoral nerve to the knee, the saphenous nerve, which is a component of the adductor canal. SaphNB thus provides analgesia with only sensory blockade and is as effective as FNB in reducing postoperative pain. This prospective study compared continuous Saphenous nerve block with continuous lumbar epidural block in patients undergoing total knee arthroplasty. This study assessed the efficacy of postoperative analgesia and rehabilitation scores of continuous epidural analgesia or continuous SaphNB after total knee arthroplasty.

Material and Methods: Patients received lumbar epidural or saphenous nerve block as a component of a multimodal analgesia. Quadriceps strength and pain score, rehabilitation scores, total bupivacaine consumption and rescue analgesic consumption was assessed in both groups preoperatively and at 6 to 8, 24, and 48h post anesthesia. Thirty patients received epidural analgesia (Group E), whereas 30 patients received continuous SaphNB(Group S). Pain scores were similar between the two groups. Difference in total bupivacaine consumption was insignificant among both the groups. One patient in Group E and 2 patients in Group S required for supplemental analgesics ($p<0.05$). Maximum knee flexion degrees were not different between the two groups. In this study, an effective pain control was obtained with both continuous epidural analgesia and SaphNB after total knee arthroplasty.

Conclusion: The authors hypothesized that SaphNB, compared with lumbar epidural block, would exhibit less quadriceps weakness and demonstrate noninferior pain score and opioid consumption at 6 to 48 h post anesthesia. Converting an established mode of pain therapy to a modified protocol may decrease incidence of adverse events rather than improve the quality of analgesia.

Key Words: Continuous Peripheral Nerve Blocks; Adductor canal block, Postoperative Analgesia; Epidural Analgesia, Knee Arthroplasty.

Introduction

Postoperative analgesia management after total knee arthroplasty is very important for improving the function of knee joint, strengthening muscular contraction and early mobilization of patients.TKA is associated with severe postoperative pain and effective postoperative analgesia after TKA remains a challenge. The incidence of moderate-to-severe pain after TKA is reported to be about 50%, and it can contribute to immobility related complications, delay in hospital discharge, and may interfere with functional outcome.[1] Multiple and multimodal

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approaches to pain relief have been tried, which include neuraxial blockade, systemic opioids, intrathecal opioids, systemic steroid/non-steroidal analgesics, local infiltration analgesia, and peripheral nerve blockade (PNB).[2] Early mobilization is a challenge after TKA when a patient has severe pain and is receiving pain treatment. Despite a comprehensive multimodal analgesic regimen, TKA is often associated with intense postoperative pain.[3] Epidural analgesia being a viable alternative, however, faces a relatively high failure rate[4] and may result in side effects such as urinary retention and motor block,[5] with the later potentially hindering mobilization. The concerns about interactions of anticoagulants and central neuroaxial techniques increased the interest in peripheral nerve blocks [6-9].

PNBs are commonly used to relieve pain and to reduce opioid requirements and their adverse effects. PNB for TKA is associated with significantly lower hospital length of stay (LOS) and also with a lower risk of re admission. Femoral nerve block (FNB) is one of the most commonly used nerve blockades and has been shown to be effective in reducing the usage rate of opioid pain killer and shortening hospital stays. Nerve blocks involving the femoral nerve, however, lead to quadriceps muscle weakness.[10] Quadriceps weakness results in functional impairment and is associated with an increased risk of fall.[11,12] Attempt to overcome quadriceps involvement after FNB, without compromising analgesia, has failed. PNB with preserved muscle function and an adequate analgesic effect is desirable. saphenous nerve blocks the largest sensory branch of the femoral nerve to the knee, which is a component of the adductor canal.[13] saphenous nerve block thus provides analgesia with only sensory blockade[14] and is as effective as FNB in reducing postoperative pain. When compared with FNB, saphenous nerve block has been reported to be associated with similar pain scores and better quadriceps strength postoperatively ensuring better ambulation after TKA.[15]

Materials and Methods

After approval from our institutional ethics committee and written informed consent from each patient, 60 ASA physically fit patients scheduled for elective unilateral total knee artroplasty under spinal anesthesia were included in this prospective study. The patients were randomly allocated to one of two postoperative analgesia groups; first group received continuous epidural analgesia (Group E, n=30), second group received continuous Saphenous nerve block (Group F, n=30). Exclusion criteria: Patients with veterbral column deformities, mental detoriation, chronic analgesic use, peripheral neuropathy, coagulation abnormalities, systemic arthritis, arthralgy, allergy to local anesthetics and patients with weight <50 or >100 kg were excluded from the study. Low molecular weight heparin once a day beginning 12-16 h before anesthesia, was used for thromboprophylaxis. At preoperative interview, the patients were instructed to the use of the visual analogue scale (VAS 0=no pain, 10=severe pain) and the patient controlled analgesia (PCA) device (Acute Pain Manager-APM, Abbott, IL, USA). Patients were premeditated with midazolam 0.07 mg/kg im before surgery. In the operation room before performing spinal anesthesia. Routine monitoring included ECG, noninvasive blood pressure heart rate and SpO_2 measurements.

Saphenous nerve block:

The saphenous nerve block SaphNB, also referred to as adductor canal block) is a modification of the FNB.[16]. The SaphNB has been gaining popularity in the anesthesia community over the last few years, particularly supported by the increased use of ultrasound. The saphenous nerve is the terminal sensory branch of the femoral nerve. It is located within the adductor canal in conjunction with a branch of the femoral artery; it further divides into two branches, the infrapatellar branch supplies the anteromedial area of the knee, the sartorial branch travels further distally and provides innervation of the medial area of the leg and ankle[17]. Motor weakness, which has been traditionally linked with regional anesthesia with FNB, is still under suspicion to contribute to dreaded complications like inpatient falls[18]. Therefore, a more sensory specific approach may have its advantages provided the analgesic potency is equally comparable to other block techniques. Mansour provided one of the first descriptions for a more sensory specific block (rather than a FNB) for orthopedic surgery using the subsatorial approach [19]. He described a landmark technique including the use of a nerve stimulator. The development of the technique and the success rate of the SaphNB were facilitated through the emerging use of ultrasound. Catheters were threaded 2-3 cm into the adductor canal and fixed to skin with adhesive dressing to avoid catheter dislodgement. After negative aspiration test for blood, 20ml of bupivacaine 0.25 % was given through the catheter as initial bolus dose. Sensory block was assessed in the distributions of the medial and anterior aspect of the knee 20 minutes after injection of local anesthetic. Motor block was assessed by testing the knee extension. Presence of block was defined as weakness at operative leg against the resistance made by the hand of examiner. The results of sensory and motor tests were reported as either yes or no.

In group S, patients received combined spinal-epidural anesthesia in the L3-4 or L4-5 interspace by using loss of resistance technique. After subaracnoid a 20 G epidural catheter was threaded 5 cm into the epidural space and fixed. After spinal anesthesia, mean arterial pressure (MAP) and heart rates (HR) were recorded every 5 min during the first 30 min and then every 15 min until the end of the surgery.

The sensorial and motor block levels 20 min after spinal anesthesia, operation time and ephedrine consumption during the surgery were noted for both groups. At the end of the operation, all patients were taken to the recovery room. When the level of the sensorial block regressed to L1, patients in both groups received a bolus dose of 10 ml 0.25 % bupivacaine through the catheters and then the catheters were connected to the PCA device which was adjusted to deliver PCA boluses of 0.05 ml/kg 0.125 % bupivacaine with the lockout time of 30 min and 0.1 ml/kg/h continuous infusion during the first 48 h postoperatively. Pain at rest and on movement of the operated leg was assessed with VAS at 0, 6, 12, 24 and 48 h after the operation. When VAS pain score was $\geq$ 4, patients received morphine 0.1 mg/kg subcutaneously as a rescue analgesic. Postoperative hemodynamic parameters were evaluated at the same times. The Bromage scale was used to assess the duration of motor block due to spinal anesthesia

in both groups. Early rehabilitation was initiated on the first day after operation and maximum knee flexion degree of each patient was assessed and recorded at first and second days. Supplemental analgesic consumption, total bupivacaine use, total number of bolus demands and side effects like nausea-vomiting, hypotension, headache, backache and urinary retention were recorded. All of the catheters were removed at the end of postoperative 48h. Local inflammatory signs (focal pain, redness, and induration) at the insertion site were defined as catheter infection. The length of hospital stay and satisfaction of patients from the analgesic technique used (good, moderate, and inadequate) were noted. All of the patients underwent a neurological evaluation at discharge from the hospital.

Analysis: The statistical analysis was performed using SPSS 10.0 for Windows. Parametric data with normal distribution were compared by using Student’s t test and abnormal distribution with Mann Whitney U test. Nonparametric data were compared by using Chi square test and Mann Whitney U test with a Bonferoni correction for multiple comparisons as appropriate and a p value <0.05 was considered significant. All data are presented as mean ± SD, median (min/max) and percent.

Results

The demographic characteristics of patients and operation time were similar between the two groups in Table 1. No patient required general anesthesia due to failure of neuroaxial block and no patient was excluded at any stage of the study.

Table 1: Demographic data and operation

	Group E (n=30)	Group S (n=30)
Age (year)	63 ± 8	67 ± 8
Sex (M/F)	8 / 22	3 / 27
Weight (kg)	82 ± 14	81 ± 15
ASA I/II/III (n)	5 / 21 / 4	2 / 23 / 5

Sensorial block level 20 min after spinal anesthesia was at T10 in Group E and T8 in Group S. MAP, HR and ephedrine consumption during the surgery were similar between the groups. Number of attempts for catheter placement, difficulty of catheterization, regression time of sensorial block to L1 and resolution time of motor block were not significantly different between groups shown in Table 2.

Table 2: Block characteristics [Mean ± SD, median (min-max)

	Group E (n=30)	Group S (n=30)
Block level at 20. min	T10	T8
Ephedrine consumption [n (%)]	5 (%17)	8 (%27)
Regression of sensorial block to L1 (min)	166 ± 44	157 ± 41
Motor block resolution (min)	259 ± 74	234 ± 59
Catheter insertion, easy/moderate/difficult (%)	64 / 23 /13	70 / 26 / 3

Table 3: VAS pain scores at rest and on movement

	Group E (n=30)	Group F (n=30)	*p*
VASR (0-100)			
0 h	0 (0-25)	15 (0-32)	0.010
6 h	15 (0-45)	21(0-35)	0.778
12 h	22 (14-55)	25 (0-60)	0.567
24 h	16 (14-50)	16 (0-40)	0.666
48 h	15 (0-38)	15 (0-45)	0.969
VASM (0-100)			
6 h	29 (0-58)	25 (0-75)	0.630
12 h	27 (0-55)	25 (0-62)	0.805
24 h	25 (0-65)	28 (0-55)	0.556
48 h	21 (0-60)	25 (0-62)	0.976

Adequate pain relief was achieved with both regional analgesia techniques; no statistically significant difference was noted between groups. Postoperative MAP values were lower in Group E, and statistically significant at 6 and 12 h (Bonferroni correction $p<0.0083$). HR was not different between groups. Total amount of bupivacaine consumption was comparable in Groups. The total number of bolus demands from PCA infuser was found not to be significantly different between the groups.

Additional analgesic consumption was statistically similar between the groups (p<0.02). Maximum knee flexion degrees were 54 ± 16.8 in Group E and 48 ± 13.7 in Group S on the first postoperative day, 84 ± 10.0 and 79 ± 12.4 respectively on second day (Table 4).

Table 4: Morphine and bupivacaine consumption, bolus demand, maximum knee flexion degrees [Mean ± SD, median (min-max)]

	Group E (n=30)	Group S (n=30)	*p*
Morphine (mg)	0 (0-6)	6 (0-13)	0.02
Bupivacaine (ml)	420 (340-736)	476 (342-739)	0.049
Bolus demand	79 (8-179)	89 (17-218)	0.01
Maximum knee flexion degree			
1. day	54 ± 17	48 ± 14	0.125
2. day	84 ± 10	79 ± 12	0.124

In Group S, the preoperative sensorial block in the cutaneous distribution of the femoral nerve, lateral femoral cutaneous nerve and obturator nerve was obtained at a rate of 100 %, 93 % and 100 % respectively. Preoperative motor block was found to be 100 % for femoral nerve and 90 % for obturator nerve in the same group. After spinal anesthesia complete sensorial and motor block of lower extremities was obtained in both groups. The motor block was absent (Bromage 0) at postoperative 6h in the two groups. There were no statistically significant differences between groups with regard to side effects like nausea-vomiting, hypotension, headache, backache and urinary retention. The length of hospital stay and patient satisfaction were similar Table 5. None of the patients had local signs of infection or neurological deficit Table 5.

Table 5: Complications, discharge time, patient satisfaction.

	Group E (n=30)	**Group F** (n=30)	**P**
Nausea-vomiting (n)	11	6	0.152
Backache (n)	3	6	0.472
Urinary retention (n)	5	1	0.195
Headache (n)	4	4	1.000
Hypotension (n)	6	6	1.000
Discharge time (day)	9 (4-15)	9 (5-15)	0.100
Patient satisfaction; good/ moderate/inadequate (%)	80 /20 /0	67 /33 /0	

DISCUSSION

The main indication for TKA is to improve function however TKA in general is associated with significant postoperative pain [20]. Lumbar epidural analgesia in combination with patient controlled analgesia (PCA) has been considered to be the standard technique for pain control after hip surgery and knee replacement surgery [21]. However, placement of an epidural catheter carries a definite risk for neurological complications. Alternative techniques such as FNB combined with PCA or local anesthetic wound infiltration have been advocated for pain therapy after TKA [22].

Epidural anesthesia plus PCA has been used as a standard pain therapy after TKA for many years. The main reason to modify the perioperative pain therapy protocol was an increasing number of patients with defined contraindications against epidural catheterization. In addition, different studies have demonstrated that FNB may be an efficient mode of pain therapy after TKA although conflicting data had been published.

Moreover, opioid consumption within 0 to 72 hours after TKA was significantly lower in the FNB group as compared to the EA group, which may significantly decrease the risk of postoperative respiratory depression. FNB plus PCA was associated with less episodes of arterial hypotension. The avoidance of hemodynamic complications has a major impact in surgical patients of higher age [23]. In particular, perioperative hypotensive episodes affect outcome after non-cardiac surgery [24]. Thoracic and lumbar epidural anesthesia induces sympathetic blockade and vasodilatation in lower extremities. In patients with pre-existing hypertension, compensatory mechanisms are less efficient and may result in severe hypotension [25, 26]. FNB plus PCA is associated with less adverse events such as urinary retention, muscle blockade and pruritus. Although patient satisfaction after surgery is primarily affected by pain, adverse effects such as PONV and urinary retention have clearly an additional effect. A pain therapy protocol using FNB plus PCA may exert advantages in orthopedic surgery of the lower extremities. Anti-coagulants are routinely used after major orthopedic surgery which may limit the applicability of epidural catheter techniques [27]. Our data are in accordance with a previous study that demonstrated that staff nurses tend to accept higher VAS scores in patients with epidural catheters [28]. A prospective analysis describing a separate needle technique for combined subarachnoid and epidural analgesia revealed that 22 of 201 epidural catheters (almost 11 %) have not been used in the postoperative course [29]. Peripheral regional anesthesia may thus be favorable in orthopedic patients due to a higher acceptance by staff nurses and orthopedic surgeons. Some remarks must be included to assess the limitations of the present study. First, patients undergoing TKA with general anesthesia were excluded. This may have influenced our results since postoperative pain therapy is different in patients with contraindications against neuraxial and/or peripheral blockade. Nevertheless, the vast majority of TKA was performed under subarachnoid anesthesia during both periods, and the bias from excluding patients with general anesthesia is likely small. Opioids with different pharmacokinetics and pharmacodynamics such as morphine may result in different analgesic levels after TKA [30,31].

In this study, effective pain control facilitating knee rehabilitation was obtained with continuous epidural analgesia and modified technique of FNB, continuous Saphenous nerve block after total knee arthroplasty. Postoperative severe pain after total knee arthroplasty is associated with the reflex spasm of quadriceps muscle and adequate pain relief is necessary for postoperative knee rehabilitation and functional recovery [1]. When pain is inadequately treated, early mobilization of patients cannot be achieved; therefore capsular contraction and adhesions threating the success of surgery will occur [1,6]. All of the patients in this study have participated the exercise and early rehabilitation programme after knee arthroplasty at the orthopedic clinic. There was no significant difference in maximum degree of knee flexion between the two groups at the first and second postoperative days. At the end of the second day, 84 ± 10.0 and 79 ± 12.4 degrees were achieved in Group E and Group S respectively. The concentration of local anesthetic and the doses used in this study did not cause motor block which could hinder the early mobilization postoperatively. In the present study comparing the epidural block and Saphenous nerve block, we didn't find any difference in the analgesic efficacy between the two regional techniques. Although, lower doses of local anesthetics are used for epidural analgesia, disturbing side effects such as sympathetic block are likely to occur due to central blockade. The other frequent side effects of epidural block include orthostatic hypotension, nausea-vomiting and urinary retention. Although a significant difference was not shown in this study, the incidence of nausea-vomiting and urinary retention was higher in Group E. The similar incidence of headache and backache was thought to be associated with the spinal anesthesia performed for the surgery. Although, the intraoperative and postoperative hemodynamic variables were statistically similar between the two groups, MAP and HR were lower in Group E in the postoperative period. The orthostatic hypotension due epidural analgesia can cause a delay in functional recovery and rehabilitation by restricting early postoperative mobilization. In a prospective randomized study, it was reported that side effects were observed 4 times more with epidural analgesia than with continuous Saphenous nerve block [1]. And in another study, Saphenous nerve block has been shown to produce lower incidences of nausea and vomiting [6].

We used the same continuous infusion and bolus doses of local anesthetic in both groups for 48 hours. Although the safety of continuous infusion is reported, it may lead to the accumulation of the local anesthetic that is administered at large volumes and had a potential risk of toxicity after prolonged periods of infusions [10,11]. There were no clinical symptoms or signs of local anesthetic toxicity during the study period. The continuous infusion of 0.125 % bupivacaine at the rate of 0.14 ml/kg/h is considered as “gold standard” to maintain adequate and safe femoral analgesia [12]. We used 0.125 % bupivacaine 0.05 ml/kg with a lockout time of 30 minutes and 0.1 ml/kg/h continuous infusion as recommended during the first 48 h postoperatively. In this study, all the catheters were placed successfully in both groups. The number of attempts for catheterization was not different between the two groups. Comparing with the other regional techniques, Saphenous nerve blocks easier to perform requiring no special positioning of the patient [13]. Catheter placement into femoral nerve sheath using a peripheral nerve stimulator is found to be successful in 80-100 % of patients [2,14,15]. Although, the obturator nerve has beeen reported to be inadequately blocked with the Saphenous nerve block technique, we obtained adequate postoperative analgesia [32,33]. This can be associated with the individual variations in the innervations of the knee. In our study, we achieved adequate analgesia and early knee rehabilitation despite the absence of motor block of the obturator nerve. Bouaziz et al have reported that the cutaneous distribution of obturator nerve was absent in 57 % of their patients [21]. The discrepancy between the sensory and motor block can also be a result of the high variation in the cutaneous distribution of the obturator nerve in our study. None of the patients had motor block due to spinal anesthesia 6 h after the operation. Although continuous epidural analgesia with local anesthetic might be associated with a greater incidence of motor block, we didn’t observe any during the study [34]. This can be related to the use of low concentration of the local anesthetic and appropriate dose titration with PCA. An effective postoperative analgesia management can facilitate early mobilization and functional recovery, thus reduces the duration of hospital stay and costs after total knee arthroplasty. Mahoney and colleagues have reported that epidural analgesia had improved pain control and early rehabilitation was associated with a reduction of approximately 2 days in the length of hospital stay but the high incidence of side effects should not be ignored [35]. Many other studies have demonstrated adequate analgesia, accelerated rehabilitation, minimal side effects and short hospital stay after continuous Saphenous nerve block infusion [2,6,36,37,38]. In our study, the discharge times from the hospital were similar between the two groups. The incidence of catheter infections generally increases as long as the catheters stay in place. The risk of infection limits the duration of postoperative analgesic use through the catheters. Cuvillon et al have reported colonization of 57 % of femoral catheters in 208 patients after 48 h, 3 of which had infection requiring no antibiotics.

The rate of colonization was 28.8 % in 1443 epidural catheter series of Simpson at al and the incidence was not found to be related with the catheter duration [25]. Although bacterial analysis was not performed after the removal of the catheters, we did not observe any local infection signs or neurological deficit at discharge attributable to the blocks in our study. In this study, we concluded that continuous saphenous nerve block, providing similar analgesic efficacy, rehabilitation and ease of

mobilization, can be a good alternative to epidural analgesia that is still widely used for postoperative analgesia after total knee arthroplasty. Although the incidences of side effects were similar between the two groups, larger series of patients are needed for further evaluation.

CONCLUSIONS

Pain therapy using Saphenous nerve block plus PCA provides adequate analgesia in patients undergoing TKA. Converting an established mode of pain therapy to a modified protocol may decrease incidence of adverse events rather than improve the quality of analgesia.

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