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Comparative analysis of combined spinal epidural and spinal plus single shot femoral nerve block as post-operative analgesia in total knee replacement surgery

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ABSTRACT

Background: Effective anaesthesia is required to overcome complications of epidural anaesthesia and relieve the patients undergoing lower limb surgeries such as total knee replacement from severe pain. **Aims and Objective:** The current study was aimed to study combined spinal- epidural anaesthesia (CSEA) and spinal plus single shot femoral nerve block (SSFNB) for post-operative analgesia in total knee replacement surgeries. **Materials and Methods:** This prospective observational and randomized study included 60 subjects undergoing Total knee replacement which were randomized into two groups and administered combined spinal epidural block and single shot femoral nerve block as per standardised protocol for post-operative pain management. Pain as per visual analogue scale and need of rescue analgesia and other haemodynamic parameters were compared between two groups and at different time interval. **Result:** Two study groups were found to be matched for age, gender, weigh, height and ASA grading. SSFNB group showed significantly high VAS score at 6 Hr, need for rescue analgesia, compared to CSEA group. CSEA group had significantly high number of patients with motor block. significant difference in the variation of pulse rate was observed within both the groups. Significantly higher systolic blood pressure at 6h, 12h, 24h and 36h., diastolic blood pressure at 6h, 24h and 48h and in mean arterial pressure at 6h, 24h and 36 h was observed in SSFNB group compared to CSEA group. **Conclusion:** We concluded that, patients undergoing total knee replacement show better analgesia and hemodynamic stability with CSEA in comparison to SSFNB, but at the cost of more motor blockade on non-operative limb and delayed recovery.

Keywords: Combined spinal- epidural anaesthesia; Spinal plus single shot femoral nerve block; Total knee replacement; Analgesia

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INTRODUCTION

Major knee surgery as in total knee joint replacement (TKR) is one of the most painful orthopaedic procedures, associated with pain. Post-operative pain is found to be a potent trigger for stress response and is also a causal factor for the adverse effects on various organ systems. Therefore, an effective analgesia may improve the quality of patient outcome as well as may promote attenuation of postoperative physiologic responses and morbidity.[1] Epidural anaesthesia (EA) is one such widely accepted anaesthesia and offers effective role in pain relief and better

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rehabilitation profiles in patients undergoing such surgeries compared with systemic opioids including intravenous patient controlled analgesia (PCA).[2,3] In orthopaedic surgery EA has been prevailing due to reduced blood loss and fewer thromboembolic complications.[4]

However, frequent hypotension, urinary retention, and pruritis have been observed patients receiving EA, whereas systemic opioids have been found to cause elevated sedation. Also, evidences suggest increased risk of serious neurological complications as a result of epidural blockade in patients undergoing TKR.[4] Regional anaesthesia (RA) is a preferable and an alternative with better postoperative pain management, sufficient and is devoid of opioids, higher patient satisfaction as well as it lowers the risk of pulmonary aspiration, which is the most feared complication of anesthesia.[5,6]

Combined spinal-epidural anaesthesia (CSEA) is a popular approach and reduces and to some extent eliminates the drawbacks of spinal anaesthesia (SA) and EA while preserving their advantages. It is though inappropriate in patients with compromised cardiovascular activity and pulmonary function. Femoral nerve block (FNB) anaesthesia overcomes such complications in the patients undergoing lower limb surgeries as in TKR.[6,7] Thus we aimed to comparatively study CSEA and spinal plus single shot femoral nerve block (SSFNB) for post-operative analgesia in TKR surgeries.

MATERIALS AND METHODS

This prospective randomized non blinded study was conducted in the Tertiary care health centre in Solapur. All subjects 40 to 80 years of age posted for unilateral TKR for osteoarthritis of knee and belonged to American Society of Anaesthesiologists (ASA) class 1 to 3 were included in the study. Subjects with history of allergy to local anaesthetics, infection or scarring at the site of FNB, history of surgery or trauma to the operative knee, any previous damage to the nerve/neuropathy, history of lower extremity bypass surgery, psychological disorders or linguistic difficulties that might interfere with pain assessment and patients who refused to give consent were excluded. Ethical approval was obtained from the Institutional ethical committee and written informed consent was obtained from all the subjects. The total of 60 subjects undergoing unilateral TKR surgery were randomized into two groups, CSEA and SSFNB using computer generated block randomization technique. Preoperative clinical assessment, routine investigations and weight of the subjects were recorded and counselling regarding the type of anaesthesia and visual analogue scale (VAS) was provided a day prior to the surgery. Patient was kept Nil by Mouth (NBM) six hours prior to the surgery.

Pulse oximetry, electrocardiography and blood pressure was monitored; antibiotics and 0.03- 0.05 mk/kg midazolam were administered intravenously in all the subjects.

CSEA was given in lateral position with affected side downwards under aseptic conditions with Chlorehexidine and Butadiene. L3- L4 interspace was palpated and infiltrated with 5mL of 2% lignocaine locally using 26-G hypodermic needle. Subarachnoid space was identified using 25-G whitacre spinal needle after confirming free and clear flow of CSF. For SAB 2ml of 0.5% of bupivacaine was used. Epidural space was identified using 16-G Tuhoys needle by loss of resistance to air technique. Further, 17-G epidural catheter was introduced 5cm into the epidural space. Catheter was secured using sterile transparent dressing. Preoperative sensory level of T10 was achieved. Epidural test dose given using lignocaine 2% with adrenaline 5mcg/ml and epidural infusion of 0.25% bupivacaine was started at 2ml/hour and later increased to 6-8ml/hour after 2 hours of surgery, on necessity basis.

In SSFNB group epidural was not activated, after completion of surgery single shot femoral nerve block under USG guidance was given using 0.25% bupivacaine 30ml.

Post-operative hemodynamic monitoring was continued and data on pain scores using VAS was noted and any associated adverse effects were noted for the next 48 hours. Patients were asked to point out the intensity of pain on the VAS pain scale. In case the subject complained of pain rescue analgesia in the form of Tramadol 50 mg was given intravenously. Total number of doses of rescue analgesics administered to the subjects during first 24 hours was noted. After 24 hours oral analgesic T. paracetamol 650mg QID was added as a part of multimodal analgesia in both the groups.

All the subjects were monitored on regular basis by an acute pain services (APS). Data was collected and expressed as frequency (percent) and mean± SD. P value <0.05 was considered as statistically significant. SPSS© for windows™ Vs 17, IBM™ Corp NY and Microsoft excel™ 2007, Microsoft® Inc USA was used to perform the statistical analysis.

RESULTS

Table 1 shows general characteristics in study subjects. Total 30 subjects were recruited in each group. The groups were matched for age (p>0.05), weight (p>0.05), height (p= 0.39), gender (p>0.05) and ASA grade (p>0.05).

Table 2 shows comparison of visual analogue score at activity in the studied groups. In both group observed rise in VAS score as compared with VAS of 0 hour was statistically significant when analysed by Wilcoxon signed ranked test with (p<0.05). Both groups showed significantly high VAS scores after 6 hours onward as compared to baseline 0 hour. Zero h, 12h, 24h, 36h and 48h no significant difference observed between the groups. However, at 6h VAS was found to be significantly higher in subjects who underwent SSFNB anaesthesia.

Figure 1 indicates the need for rescue analgesia and Bromage score of motor blockage on postoperative day one in the study groups. The need for rescue analgesia was significantly higher in SSFNB group (p<0.05). In CSEA group 60% patients had no motor blockade i.e. Bromage score of 1, while 40% patients had Bromage score of 2 (partial block) in both lower limbs, while in SSFNB group patients had no motor blockade, all patients had Bromage score of 1, on postoperative day 1 after surgery. CSEA group had significantly high number of patients with motor block (p<0.05) (Figure 2).

Table 3 shows comparison of mean pulse rate between the studied groups. There was no significant difference between two study groups regarding pulse rate (p >0.05).

Table 1: General Characteristics in study subjects

	Group (ICSEA)	Group II (SSFNB)	T value	P value
Age	63.7±8.06	62.9±5.36	0.87	p>0.05
Weight	74.2±8.38	73.0±8.48	1.33	p>0.05
Height	157.6±8.38	158.5±8.56	0.85	0.39
Gender				
Male	18 (60%)	12 (40%)	0.606	p>0.05
Female	12 (40%)	15 (50%)		
Grade				
ASA I	4 (13.33%)	3 (10%)		p>0.05
ASA II	26 (86.66%)	26 (86.66%)		
ASA III	0	1 (3.33%)		

Table 2: Comparison of visual analogue score at activity in the studied groups

Time	Group I (CSEA) (30)	Group II (SSFNB) (30)	Mann- Whitney U test	P Value
0 h	0.3±0.65	0.3±0.65	450	>0.05
6 h	1.77±0.50*	3.8±0.40**	3	<0.05
12 h	2.63±0.49*	2.73±0.74**	436	>0.05
24 h	2.7±0.46*	2.8±0.6**	365	>0.05
36 h	3.03±0.32*	2.97±0.41**	422	>0.05
48 h	2.97±0.49*	3.1±0.5**	410	>0.05

*p value within group I as compared to VAS at o h using Wilcoxon sign rank test
**p value within group II as compared to VAS at o h using Wilcoxon sign rank test

However, significant difference in the variation of pulse rate was observed within the groups.

Table 4 compares the blood pressure (BP) between the studied groups. The systolic blood pressure (SBP) at 0h and 48h the SBP were matched for both the groups. While significant difference in mean SBP was observed between the two groups at 6h, 12h, 24 and 36h. The subjects in group II were found to have higher mean SBP. Statistically significant difference was observed between the two groups regarding Diastolic BP (DBP) at 0h, 6h, 24h and 48h. While, the groups were found to be matched for DBP at 12h and 36h. Mean arterial blood pressures (MAP) at 0h, 6h,24h and 36h was found to be significantly different while, MAP of subjects at 12h and 48 were found to be matched for the groups.

DISCUSSION

TKR is a common surgery which improves mobility and quality of life. The pain after TKR is severe and persists for 48–72 hours after the surgery.[4] Effective analgesia allows for earlier ambulation and initiation of physiotherapy, which hastens functional recuperation, reduces the length of stay in the hospital, and lowers the risk of postoperative complications, such as thromboembolic disease or nosocomial infections.[8]

PCA (opioids) and EA and FNB are commonly used analgesic options for TKR. PCA morphine or other opioids

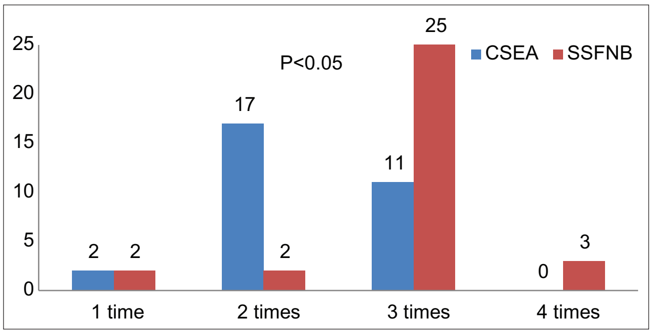

Figure 1: Comparison of rescue analgesia needed in two groups

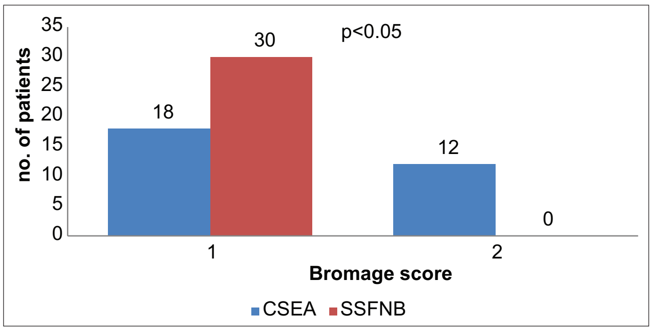

Figure 2: Comparison of Bromage score of Motor blockade on POD 1

Table 3: Comparison of the mean pulse rate between the study groups

Time	Group I (CSEA) (30)	Group II (SSFNB) (30)	t- Test	P Value
0 h	78.87±12	78.1±11.56	0.85	>0.05
6 h	89.26±13*	88.1±12.5**	0.92	>0.05
12 h	89.9±14.9*	86.26±12.12**	1.46	>0.05
24 h	90.43±13.4*	86.4±11.3**	1.66	>0.05
36 h	87.25±9.1*	83.43±8.9**	2.01	0.05
48 h	85.1±7.84*	82.7±8.8**	1.53	>0.05

*p value<0.01 within Vs 0h mean pulse rate
**p value<0.05 within Vs 0h mean pulse rate

Table 4: Comparison of the mean blood pressures between the study groups

Time	Group I (CSEA) (30)	Group II (SSFNB) (30)	t- Test	P Value
		Systolic blood pressure		
0 h	117.73±20.9	124.03±16	1.69	>0.05
6 h	125.0±24.4*	140.3±17.9**	3.14	<0.05
12 h	126.13±23.5*	135.9±18**	2.17	<0.05
24 h	119.8±20.94*	133.1±21.7**	2.77	<0.05
36 h	125.57±20.4*	134.2±14.1**	2.38	<0.05
48 h	125±57*	131.93±15.16**	1.85	>0.05
		Diastolic blood pressure		
0 h	65.8±12.15	72.4±12.15	2.68	<0.05
6 h	67.83±12.8*	76.26±8.3$	3.40	<0.05
12 h	72.36±14.7*$	75.5±11.66$	1.36	>0.05
24 h	69.13±16.22*	77.5±9.78$	2.76	<0.05
36 h	70.9±14.4*	75.83±12.2$	1.81	>0.05
48 h	73.1±12.3*	77.0±9.33$	2.07	<0.05
		Mean arterial pressure		
0 h	83.11±14.5	89.3±11.5	2.19	<0.05
6 h	86.88±15.59*	99.43±9.85**	4.16	<0.05
12 h	90.28±16.36*	95.36±12.6**	1.74	>0.05
24 h	86.02 17.46*	95.76 12.04**	2.87	<0.05
36 h	88.93±14.7*	95.03±10.88**	2.19	<0.05
48 h	90.5±13.5*	95.6±11**	1.94	>0.05

*p value>0.05 within group I Vs 0Hr
**p value<0.01 within group II Vs 0Hr
$p value>0.05 within group II Vs 0 Hr

are frequently used as the primary analgesic for TKR. EA is associated with the risk of neuraxial haematomas, unwanted hypotension and bilateral lower limb motor block. Systemic opioids are a popular postoperative analgesic regimen, but these are associated with side effects of nausea, vomiting, pruritus and sedation.

Most of the studies available in literature have compared analgesia outcomes after continuous EA and continuous FNB. There are very few studies which used SSFNB as a post analgesia plan. The pain after TKR surgeries is moderate to severe. SSFNB may not be sufficient for analgesia, so it can be part of multimodal analgesia regime either it can be use concomitantly with Continuous epidural infusion (CEI) or IV PCA. With advances in technology and introduction of ultrasound in regional anaesthesia one can be assure of action of femoral block. In our study both the group epidural was placed in situ, because mean surgical time for TKR in our institute was 3 - 3.5 hours both groups started epidural after two hours of surgery to maintain adequate sensory and motor level. In SSFNB group epidural infusion was concluded immediately at the end of surgery and ultrasound guided SSFNB was given and patient shifted to PACU for monitoring.

We found that demographic parameters like age, sex, weight, height and ASA grade were comparable in both the study groups. In a study done by Shanthanna H, Huilgol M, and *et al* in 2012 comparative study of ultrasound-guided continuous FNB with continuous EA for pain relief following TKR found no difference in demographic profile of both the groups.[9] In study done by LEE AR *et al* in 2011, effect of combined single-injection FNB and patient-controlled EA in patients undergoing TKR they found no difference in demographic data.[10] Our study can be compared with study done by Lee *et al* as there was no significant differences in demographic data.[2]

We found that the peak of mean VAS score in CSEA group was around 12 hours period 2.6±0.49, hence we came to know that CSEA group patients were more comfortable with lower pain scores in initial post op hours. VAS score rises slowly to peak around 24 hours after that it remains at that level. Whereas in SSFNB group mean VAS score was significantly high at 6 hours 3.8±0.04 (peak) after that at 12, 24, 36 and 48 hours VAS score shows decreasing trend which was apparently higher than CSEA group. It could be managed with rescue analgesia. In both the groups mean VAS score remained in low bearable range 3 -4.

In the study by Sundarathiti N *et al.*[11] 31 patients received a CSEA; 30 patients received SA and CFNB. They found that there were no significant differences in the VAS scores for the first hour and at postoperative12-72 hr between the two groups. At postoperative6-12 hr, the VAS scores were significantly greater in the CFNB compared with the CEI. Shanthana *et al* in 2012 did a comparative study of ultrasound-guided continuous FNB with continuous EA for pain relief following total knee replacement and found that mean VAS score was significantly high in CFNB group than CEI at 6 hours and after that mean VAS scores did not show significant difference between the groups and also requirement of rescue analgesic was more in SSFNB group.[9] Our study shows almost consistent results with this study hence our study can be compared with study of Sundarathiti N *et al.*[11] and shanthana and *et al* in 2012.[9]

Our study is further can be supported by meta-analysis of randomized controlled trials by Fowler and *et al*[4],which showed that peripheral nerve blocks provides equal analgesia except for first 6 hours .also common side effects were more common in CSEA group.

Barrington MJ *et al*[12] found patients in CFNB group received more Oxycodone (13 / 12 mg) and Rofecoxib (70/ 60 mg) than did CEA group. There were no differences between groups in the number of patients requiring IV morphine. In their study CFNB group had a infusion of plain bupivacaine 0.2 % at 0.1 ml /kg/hr with a PCA in contrast to epidural group where infusion of ropivacaine 0.2% plus Fentanyl l4 mcg/ml commenced at 6-10 ml /hr this may the reason to for increased analgesic consumption in CFNB group. In our study Fentanyl was not added to both groups, rescue analgesic requirement was more in SSFNB group because of pain in posteromedial aspect of knee which was not blocked by SSFNB.

Looking at the trends over a period of time the hemodynamic parameters viz. Pulse rate, SBP, DBP, MAP had shown peaks and troughs coinciding with mean VAS score in both groups. As compared to CSEA group, in SSFNB group all hemodynamic parameter are increased after 6 hours and remained at that level then slowly decreased to be equal with CSEA at around 48 hours, this was because sympathetic stimulation due to pain. Whereas in CSEA group patients had sympathetic blockade due to CEI which lead to relatively stable hemodynamic parameters and lower VAS scores. All hemodynamic parameters were compared with '0' hours (that is at the end of surgery) as a baseline when FNB was given. If this could have been compared with preoperative values the difference (rise) in hemodynamic parameters SSFNB group may not have been significant as many of these patients were hypertensive and diabetic. In a study by Dauri M *et al*.[13] author did not find significant differences in MAP, HR and RR.

Limitations of the study

Though the study followed a robust research model, our study was limited by a small sample size. Replication of study in larger population and at multiple centres will be helpful in generalising the results of study.

CONCLUSION

We conclude that patients of CSEA group had better analgesia and hemodynamic stability, but at the cost of more motor blockade on non-operative limb and delayed recovery. This study shows that ultrasound guided single shot femoral nerve block with bupivacaine 0.25% 30 ml, can provide adequate post-operative analgesia in addition to oral analgesics postoperatively in TKR patients. A PNB technique which includes femoral block represents the best balance between analgesia and side-effects as a choice of postoperative analgesic technique for major knee surgery such as TKR, especially as the risk of injury to the neuraxis is negligible. Data are urgently required comparing efficacy and morbidity of single-shot blocks compared with perineural catheter techniques, preferably with a large randomized controlled trial so that a meaningful comparison of less common complications can be undertaken. More work is also needed to prove that newer techniques offer important advantages such as faster return to normal daily activities, decreased morbidity, and improved patient satisfaction. As with all aesthetic and the risk of system error, it is important to consider risk–benefit on a patient-by-patient basis and tailor the analgesic technique accordingly.

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Author's contribution:
SM - Prepared first draft of manuscript; **RC -** Data collection; **KD -** Concept, coordination of study review of manuscript preparation;
DA - Statistically analysed and interpreted, preparation of manuscript and revision of the manuscript.

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