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Original Research Article

TO COMPARE PERIARTICULAR INFILTRATION COMBINED WITH ADDUCTOR CANAL BLOCK AND PERIARTICULAR INFILTRATION ALONE IN PROVIDING POSTOPERATIVE ANALGESIA IN ELECTIVE UNILATERAL TOTAL KNEE ARTHROPLASTY SURGERIES

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Abstract

Total knee arthroplasty (TKA) is associated with moderate to severe postoperative pain, delaying convalescence and prolonging hospital stay.Novel methods of postoperative analgesia for total knee arthroplasty have demonstrated improved functional outcomes and decreased narcotic consumption. These approaches include continuous adductor canal blocks (CACB) and periarticular infiltration(PAI). Periarticular infiltration has been shown to reduce postoperative pain without the motor blockade associated with epidural analgesia or femoral nerve block.The saphenous nerve is a sensory nerve innervating the anterior part of the knee capsule as well as the medial side of the lower leg and foot. It is found that a continuous saphenous nerve block reduced pain during knee flexion and reduced opioid onsumption during the first 24 hours after TKA.The saphenous nerve can be blocked at midthigh level with a single injection or through an indwelling perineural catheter placed in the adductor canal as a continuous block. The objective of this randomized control study was to compare periarticular infiltration combined with adductor canal block and periarticular infiltration alone on the post operative pain scores,duration of analgesia and the need for rescue analgesia after TKA.

METHODS:

A prospective, randomized control single centre study was conducted on 70 patients of ASA I and II physical status posted for elective unilateral total knee arthroplasty surgeries under subarachnoid block. They were randomized into 2 groups with 35 patients each. Group A received periarticular infiltration with adductor canal block. Group B received periarticular infiltration alone.

RESULTS:

Our study included 70 patients undergoing unilateral TKA with 35 receiving PAI+CACB and 35 patients receiving PAI only. In our study we found that continuous adductor canal block with periarticular infiltration provided better pain relief with better mean pain scores both at rest and on ambulation (2.72±0.60 and 2.92±0.62 respectively)on POD1 when compared to periarticular infiltration (3.3±0.55 and 3.3±0.52)alone which was statistically significant. ($p<0.0001$) There was no statistical significance found on POD0,2 and 3 with regards to pain scores between the groups .It was also observed that the duration for breakthrough pain was higher in group PAI+CACB compared to group PAI.The duration of analgesia was tested by

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student t test. The mean duration of analgesia in group CACB+PAI was 11.10±0.16 and group PAI was 7.26±0.11 (p=0.000174)which was statistically significant. In our study we found that the need for rescue analgesic was greater in PAI group compared to ACB+PAI group.There was a statistically significant difference noted between both the groups in terms of fentanyl requirement. Group ACB+PAI had less narcotic consumption on POD1 which was statistically significant whereas there was no significant difference noted in narcotic consumption on POD 0,2 and 3 between the two groups .There was no significant difference noted in mean heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure(MAP)between the two groups. Complications like nausea, vomiting and respiratory depression requiring airway management was not seen in both the groups.

CONCLUSION:

The addition of continuous adductor canal block to single shot periarticular infiltration improved subjective pain scores,prolonged the duration of breakthrough pain and reduced opioid consumption in patients undergoing unilateral TKA.

Keywords: TKA, Periarticular Infiltration,Analgesia

Introduction

Total knee arthroplasty (TKA) is one of the most successful surgical procedures to treat patients with end-stage knee osteoarthritis. However, TKA can be associated with moderate to severe pain in the early postoperative period affecting the quality of life and rehabilitation of patients.[1] An ideal analgesia regimen in TKA should reduce pain, preserve knee mobilisation ability, enable earlier physical therapy, hasten recovery, shorten hospital stay, lower the risk of postoperative complications and improve patient satisfaction.[2,3] The traditional analgesic techniques for TKA patients are patient controlled analgesia (PCA) opioids, epidural analgesia (EA) and femoral nerve block (FNB). Patients who received PCA often complained about nausea, vomiting and pruritus. The use of epidural analgesia is usually associated with side effects such as hypotension, urinary retention and pruritus.[4] Femoral nerve block has been part of the standard postoperative pain relief protocols following TKA in last decade, which has many advantages over patient controlled analgesia or epidural analgesia. However, femoral nerve block reduces the strength of the quadriceps muscle, which may increase the risk of postoperative falls and delay early postoperative mobilization, influencing patient satisfaction.[5] Thus, an option with preserved motor function and adequate analgesia for TKA patients still remains a challenge. Recently, there has been an increased interest in the ultrasound guided adductor canal block (ACB) for pain management after TKA. The adductor canal involves the vastus medialis nerve, medial femoral cutaneous nerve, articular branches from the obturator nerve, as well as the medial retinacular nerve in addition to saphenous nerve that innervate the medial, lateral, and anterior aspects of the knee. ACB is almost a pure sensory nerve block and thus may largely decrease the incidence of fall.[6] Moreover, multiple clinical studies and several meta-analysis[7,8] have reported that ACB could provide quadriceps muscle strength preservation, better ambulatory ability, and earlier functional recovery with similar analgesic effects as compared to FNB in patients after TKA. Periarticular infiltration (PAI) is an alternative regional anaesthesia technique with a combined administration of local anaesthetics, nonsteroidal anti-inflammatory drugs, opioids and epinephrine injected into the knee joint during the operation, which has quickly gained popularity in TKA patients for its simplicity, apparent safety and effectiveness over the last decade.[9] Studies demonstrate that both ACB and PAI have been shown to reduce pain after TKA without the motor blockade or impairing quadriceps function. The four active ingredients of the infiltration mixture are

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morphine, ketorolac, ropivacaine and epinephrine. Opioid receptors are present in peripheral inflamed tissues. These receptors are expressed within hours after surgical trauma and are thought to be responsible for afferent sensory input to the central nervous system. Nonsteroidal anti-inflammatory drugs reduce peripheral sensitization and activation of nociceptors by inhibiting the eicosanoid pathway that leads to production of inflammatory mediators. Ropivacaine is pharmacokinetically similar to bupivacaine, but it is longer acting and is associated with less cardiac and central nervous system toxicity, which allows patients to tolerate a larger dose.The maximum circulating level is reached twenty to thirty minutes after injection. The main action of ropivacaine is to block afferent peripheral nociceptive activity. The addition of epinephrine helps to reduce the toxicity of the local anaesthetic by keeping it localized to the area of injection.[9]

METHODS AND MATERIALS

A prospective randomized control single centre study was conducted in seventy patients undergoing elective total knee arthroplasty surgery under spinal anaesthesia at Fortis Hospitals Ltd, Bannerghatta road, Bengaluru. The study was conducted after institutional scientific and ethical committee clearance.

Inclusion Criteria

a) Age more than 18 years and less than 75years.
b) Body weight of 50-90kgs [BMI-18 to 28]
c) ASA 1 and 2
d) Posted for unilateral total knee arthroplasty surgery under spinal anaesthesia

Exclusion Criteria

a) Any hypersensitivity to local anaesthetics
b) Bleeding diathesis.
c) Infections at the injection site.
d) Known congenital abnormalities of lower spine or vertebral column.
e) Refusal by patient
f) Drug habituation
g) Conversion to general anaesthesia.
h) Any contraindications to study drugs

RESULTS

Table 1: Age wise distribution of Group A & B subjects

Age class	Group A (n=35)	Group B (n=35)	P-value
50-60 years	56±2.90(16)	56.41±2.92(14)	0.557
61-70 years	64.45±1.97(11)	63.92±2.08(14)	0.277
>70 years	72.12±1.45(8)	72±1.06(7)	0.693
Total	35	35	

Table 1 depicts the age wise distribution of cases. 35 cases each in group A and B were considered for the study .The age wise break up was determined based on the mean and standard deviation of the subject. 16 patients(45.71%) in group A were in between age 50-60 years,14 (40%)in case of group B. 11 (31.42%)patients in group A were aged between 61-70years, similarly group B had 14(40%) and 8 patients(22.8) in group A 7 patients(20%) in group B were above 70 years. Paired t test was used to test the hypothetical statements .There

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was no significant statistical difference between both the groups.

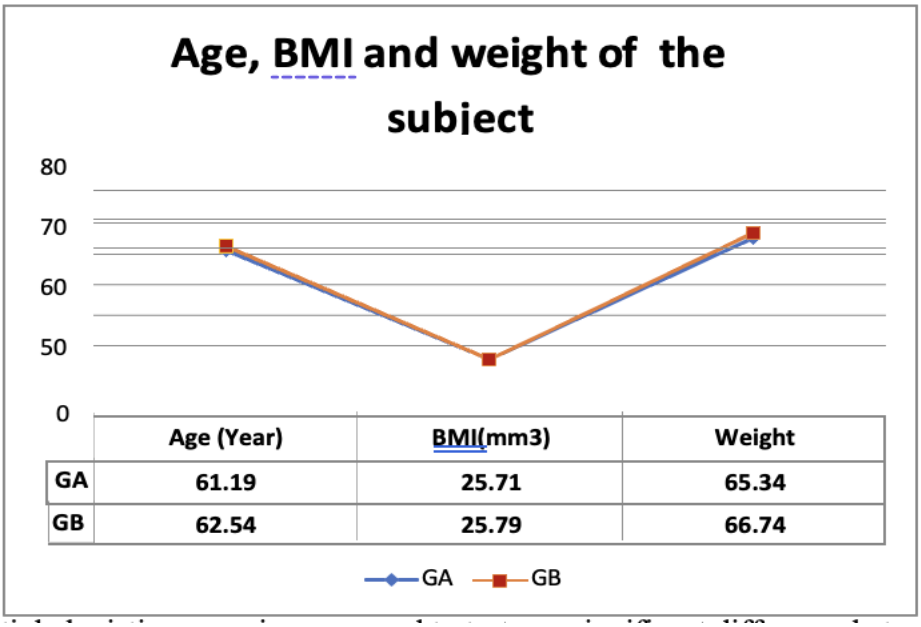
Table 2: Gender wise distribution of the cases

Gender	Group A (n=35)	Group B (n=35)
Male	20 (57.14%)	12(34.28%)
Female	15(42.85%)	23(65.71%)
Total	35(100%)	35(100%)

Gender wise distribution of the cases is represented in table 2. A total 35 cases in each group of which there were 20 male(57.14%) and 15 (42.58%)female in group A and group B had 12(34.28%)male and 23 (65.71%)females.The gender was found to statistically significant but clinically not relevant.

Table 3 : Mean BMI, Weight and ASA class

	Group A (n=35)	Group B (n=35)	P-value
BMI	25.71±0.63	25.79±0.75	0.630
Weight(kg)	65.34±5.42	66.74±7.42	0.370
ASA 1 ASA 2	14(40.0%) 21(60.0%)	15(42.85%) 20(57.14%)	



The multiple logistic regression was used to test any significant difference between the BMI, weight and ASA grading between group A and B .

The mean BMI in group A was 25.71±0.63 ; group B was 25.79±0.75.The mean weight in group A was 65.34±5.42 and group B was 66.74±7.42.

There was no statistical significance found between the variables in both the groups

Table 4: Mean value of heart rate and its significance with respect to Group A&B

	Group A		Group B		
		CI-95%		CI-95%	

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Time	Heart rate	Lower-Upper value	Heart rate	Lower-Upper value	P-value
Basal	84.8 3±15.14	[55.15-114.50]	83.54±13.84	[56.41-110.67]	0.711
3Min	86.00±15.42	[55.78-116.21]	82.29±13.96	[54.93-109.64]	0.291
6 Min	84.71±13.69	[57.88-111.54]	83.77±13.35	[57.6-109.94]	0.772
9 Min	82.26±15.48	[51.91-112.60]	81.40±14.47	[53.03-109.76]	0.811
12 Min	80.54±16.34	[48.52-112.56]	81.60±15.14	[51.91-111.28]	0.779
15 Min	79.09±13.91	[51.81-106.35]	78.91±14.20	[51.07-106.75]	0.957
18 Min	80.63±15.18	[50.88-110.37]	80.14±15.11	[50.52-109.75]	0.892
21 Min	77.46±13.74	[50.52-104.38]	78.14±12.34	[53.95-102.32]	0.828
24 Min	77.06±11.78	[53.96-100.15]	77.51±10.86	[56.22-98.80]	0.868
27 Min	77.09±11.65	[54.26-99.91]	77.43±9.88	[58.07-96.78]	0.895
30 Min	77.06±11.60	[54.31-99.79]	78.54±10.36	[58.23-98.85]	0.575
40 Min	74.06±16.94	[40.85-107.28]	77.71±10.52	[57.09-98.33]	0.282
50 Min	76.57±11.69	[53.65-99.48]	78.17±11.00	[56.61-99.72]	0.557
60 Min	77.51±11.26	[55.43-99.58]	77.51±10.29	[57.35-97.67]	0.896
70 Min	77.46±10.58	[56.71-98.20]	76.60±9.96	[57.08-96.11]	0.727
80 Min	78.17±11.06	[56.48-99.85	75.83±9.47	[57.26-94.39]	0.345
90 Min	78.51±10.94	[57.07-99.95]	76.97±9.51	[58.33-95.60]	0.531

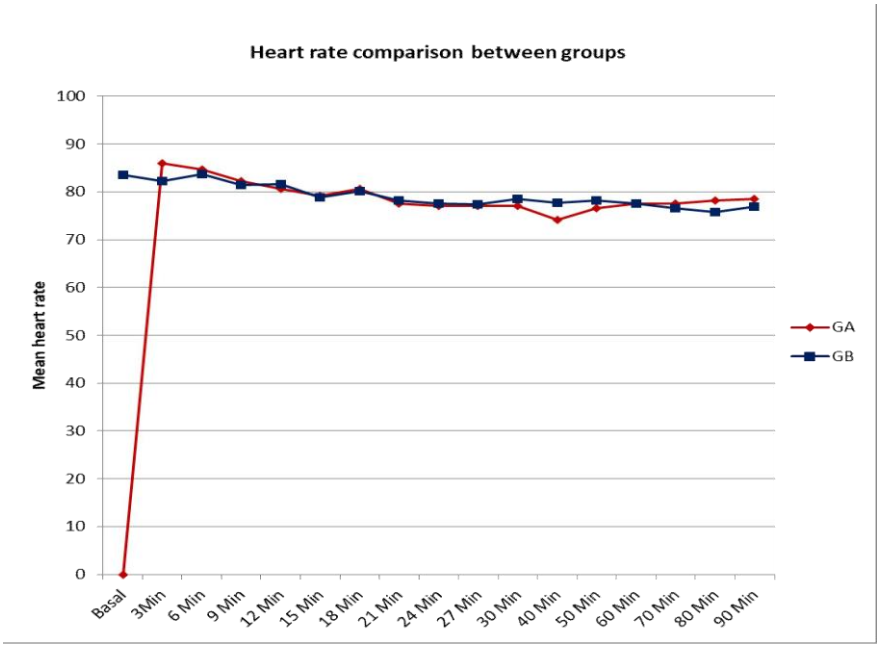

Table 4 shows the mean heart rate values of the two groups.Heart rate was monitored from time 0 and at different time intervals till the end of the surgery. Collected data was analysed by using Univariate analysis (t -test). The heart rates between group A and group B fall in the normal reference range.There is no statistically significant difference noted at any time interval between the two groups

Table 5: Mean value of Blood pressure and its significance with respect to Group A&B

	Group A	Group B

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Time	Mean SBP/DBP	CI-95%	Mean SBP/DBP	CI-95%
Basal	138.34/81.71	[117.38/64.42-159.30/99.01]	138.29/84.34	117.19/159.38-68.65/100.04
3Min	126.94/72.09	[99.86/55.86-154.03/88.31]	122.60/71.62	105.28/139.92-57.55/85.71
6 Min	117.43/68.31	[90.67/45.51-144.19/91.12]	113.80/66	93.50/134.10-51.65/80.35
9 Min	116.86/67.97	[91.37/45.15-142.35/90.80]	112.86/65.05	92.97/132.74-53.90/76.22
12 Min	119.37/66.37	[98.64/48.14-140.10/84.60]	114.03/64.94	92.23/135.83-55.81/74.07
15 Min	119.57/68.93	[98.27/46.40-140.87/90.85]	112.88/65.62	89.36/136.40-51.50/79.76
18 Min	121.43/67.76	[100.29/49.39-142.57/86.09]	112.97/64.57	88.44/137.50-52.76/76.38
21 Min	123.66/68.97	[103.21/48.83-144.10/89.11]	112.29/64.37	88.39/136.18-51.26/77.49
24 Min	123.29/68.17	[105.05/50.19-141.52/86.16]	113.06/64.94	88.60/137.52-52.77/77.12
27 Min	122.17/69.11	[103.62/52.69-140.73/85.56]	113.83/81.91	90.98/136.68-63.75/71.24
30 Min	121.77/69.34	[102.36/52.27-141.18/86.12]	113.49/65.37	93.00/133.97-52.70/78.05
40 Min	122.34/69.0	[103.50/53.60-141.19/84.40]	113.26/66.22	92.67/133.84-53.84/78.62
50 Min	120.66/69.54	[101.61/51.58-139.70/87.51]	114.60/22.640	94.47/134.73-54.54/78.26
60 Min	**119.89/69.77**	[99.66/53.59-140.11/85.59]	**114.40/66.97**	94.70/134.10-54.69/79.25
70 Min	**122.97/70.29**	[106.32/54.88-139.63/85.69]	**114.23/66.88**	94.03/134.43-53.86/79.91
80 Min	**121.54/70.23**	[100.59/55.26-142.50/85.19]	**113.74/67.51**	93.66/133.82-53.48/81.55
90 Min	**120.66/69.347**	[101.40/52.16-139.91/86.58]	**112.11/67.57**	94.16/130.07-52.06/83.08

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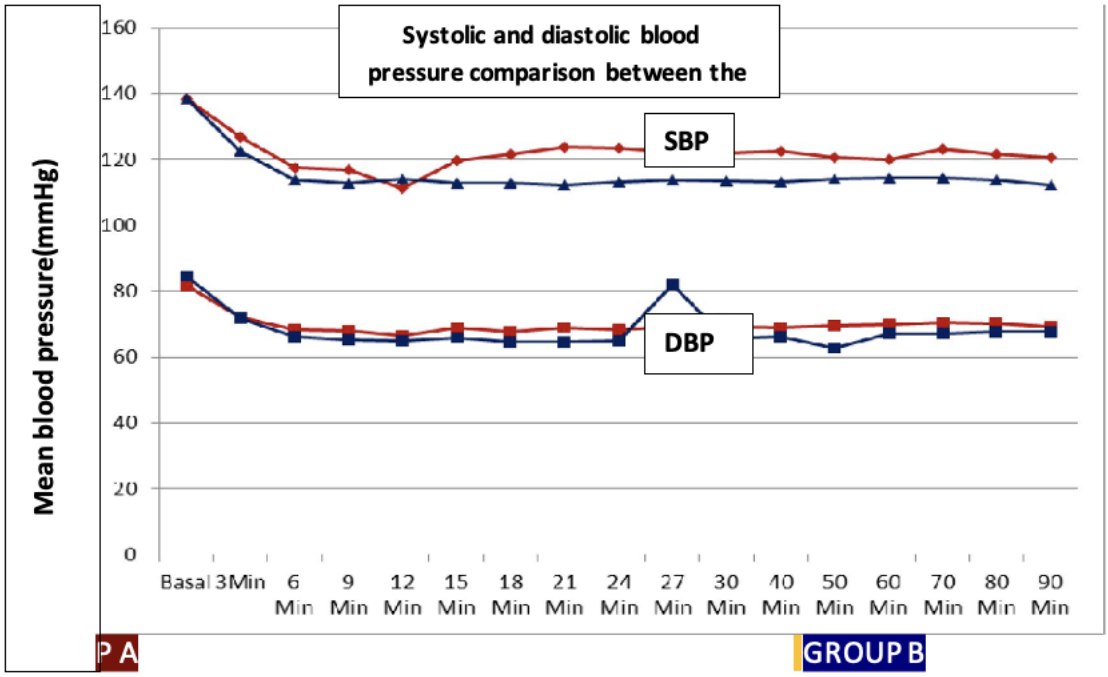

Table 5 shows mean systolic and diastolic blood pressure of both the groups. Both diastolic and systolic blood pressure were monitored at different time intervals starting from induction to the completion of surgery. The collected data was analysed by using multivariate analysis .The mean systolic and diastolic blood pressure fall in the normal reference range ($p<0.01$) and there is no significant difference noticed among both the groups statistically.

Table 6: Mean arterial pressure between two groups

Time	Group A		Group B		P-value
	Mean±SD	CI-95%	Mean±SD	CI-95%	
Basal	95.57±9.07	[95.57-95.57]	95.26±9.39	[95.26-95.26]	0.888
3Min	84.14±11.85	[84.14-84.14]	84.91±9.18	[84.91-84.91]	0.762
6 Min	78.20±11.99	[78.20-78.20]	78.80±8.02	[78.80-78.80]	0.806
9 Min	76.40±12.61	[76.40-76.40]	76.09±6.52	[76.09-76.09]	0.897
12 Min	75.03±9.89	[75.03-75.03]	75.80±5.98	[75.80-75.80]	0.694
15 Min	75.74±11.81	[75.74-75.74]	75.29±8.08	[75.29-75.29]	0.853
18 Min	76.49±10.01	[76.49-76.69]	74.66±7.01	[74.66-74.66]	0.378
21 Min	77.31±10.79	[77.31-77.34]	77.06±8.40	[74.06-74.06]	0.595
24 Min	77.83±10.16	[77.83-77.83]	75.37±9.23	[72.37-72.37]	0.292
27 Min	78.14±9.18	[78.14-78.14]	76.31±7.41	[74.31-74.31]	0.362
30 Min	77.69±10.11	[77.69-77.69]	78.77±9.45	[74.77-74.77]	0.645
40 Min	77.89±8.49	[77.89-77.89]	77.54±7.42	[74.54-74.54]	0.854
50 Min	77.57±10.16	[77.57-77.57]	75.86±8.90	[74.86-74.86]	0.456
60 Min	76.51±9.60	[77.51-77.51]	75.46±8.9	[75.46-75.46]	0.636
70 Min	76.66±9.52	[77.66-77.66]	76.97±8.40	[74.97-74.97]	0.885
80 Min	77.97±9.43	[77.97-77.97]	75.34±9.00	[75.34-75.34]	0.462
90 Min	78.57±9.99	[78.57-78.57]	76.77±8.50	[75.77-75.77]	0.440

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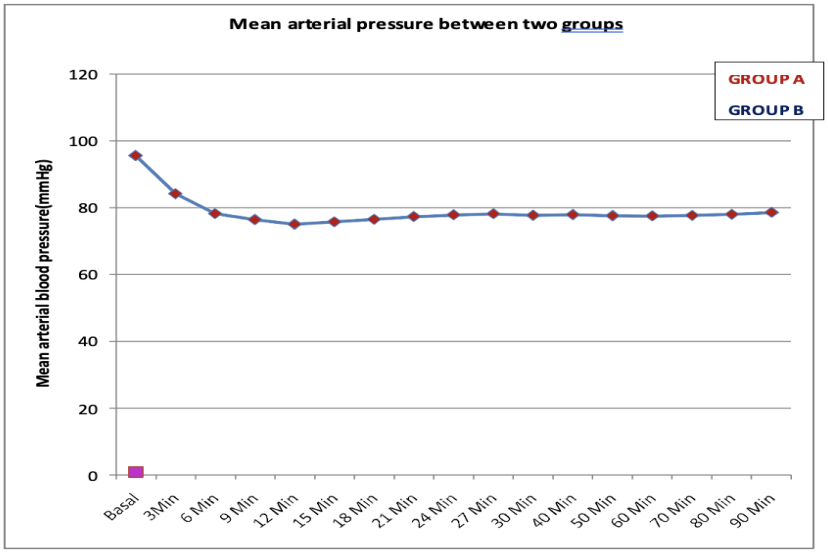
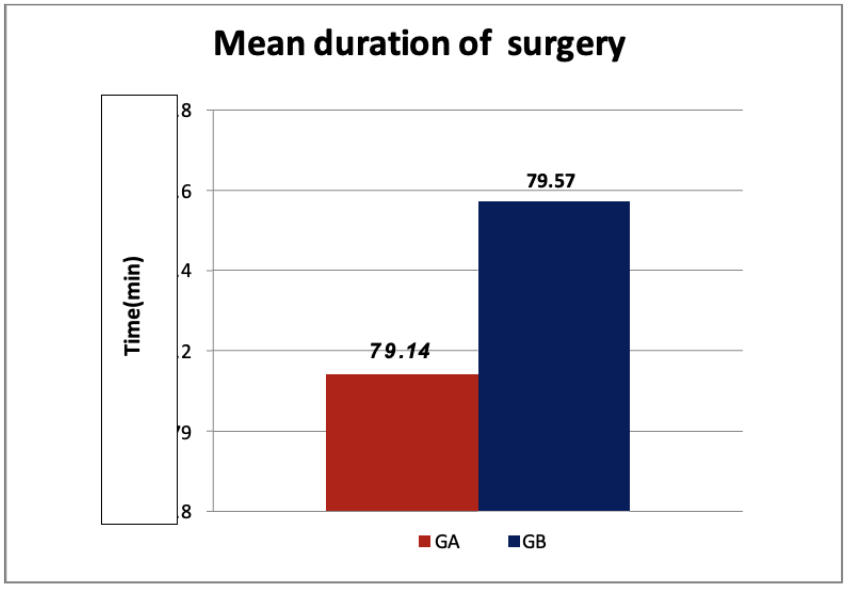


Table 6 shows mean arterial blood pressure between the two groups. Mean arterial pressure was documented throughout different time intervals during the surgery.The collected data was analysed by using multivariate analysis(t test) . As per the analysis the mean arterial pressure recorded in group A was 78.57±9.99 and in case of group B it was 77.77±8.50 .The mean arterial pressure falls in the normal reference range and there is no any statistically significant difference noted between both the groups

Table 7. Duration of surgery(in min)

Group A		Group B		P-value
Mean±SD	ci-95%	Mean±SD	ci-95%	
79.1429±7.42	64.59-95.74	79.57±6.78	66.25-92.88	0.801
Adverse event -Nil		Adverse event -Nil		



As per the analysis , the mean duration of surgery was 79.1429±7.42 minutes with [CI95%; 64.59-95.74] in group A and 79.57±6.78 with confidence interval [CI 95 % ; 66.25-92.88] in group B. The hypothesis was tested by paired t test . The duration of surgery was found to be not statistically significant between the groups.

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DISCUSSION

A study entitled Comparison of periarticular infiltration combined with adductor canal block and periarticular infiltration alone in providing postoperative analgesia in elective unilateral total knee arthroplasty surgeries was undertaken at Fortis Hospitals Bannerghatta Road Bangalore, to evaluate the duration of analgesia,pain scores,need for rescue analgesia, hemodynamic variations, and side effects if any. Sample size calculation is based on the study by Evan Green et al considering a variance for numerical pain scale between the two groups as 2 and a maximum variance within any group as 0.5.With an effect size of 1, at 95% confidence limit and 80% power, a sample size of 70 was obtained with 35 in each group[10].

Hypothesis made before starting the study: We hypothesized that periarticular infiltration combined with adductor canal block improved subjective pain scores,duration of breakthrough pain and reduced opioid consumption when compared to periarticular infiltration alone

Demographic data: Demographic data comparing age, sex showed no statistically significant difference among both the groups.

Pain scores

In our study we found that continuous adductor canal block with periarticular infiltration provided better pain relief with better pain scores both at rest and on ambulation on POD1 (2.72±0.62 and 2.92±0.62 respectively)when compared to periarticular infiltration alone(3.30±0.55 and 3.34±0.51 respectively) which was statistically significant. ($p<0.001$)There was no statistical difference noted on POD0,2 and 3 in regards to pain scores The study conducted by Evan Green et al determined that patients in the PAI + continuous ACB group reported significantly less pain only on POD 0 for both pain at rest ($p = 0.009$) and pain with activity ($p = 0.02$). Differences in patient reported pain scales were not significantly different on POD 1, POD 2, or POD 3.They identified an additive effect when utilizing both PAI and continuous ACB for postoperative TKA analgesia compared to PAI alone[10]

Fei Lan et al conducted a study in which they found that the primary end point of pain scores with active knee flexion in the operated knee at 24 h after surgery was significantly reduced in PAI+ACB group compared with PAI+Group saline 2.75–4.25 vs 4–6, ($P<0.001$) .In addition, NRS pain scores at rest and with movement at 8, 12, 24 and 48 h after surgery and rate of patients with NRS>3 with movement within 24 and 48 h postoperatively were significantly lower in PAI+CACB than in PAI+saline($P < 0.05$)[11]

In our study we concluded that the NRS pain scores were statistically and significantly lesser in PAI+CACB group on POD1 compared to PAI group.There was not much difference noted in pain scores on POD0,2 and 3 which was similar to the studies conducted by Evan Green and colleagues and Fei Lan et al.

Duration of analgesia

In our study we found that the duration of analgesia was significantly greater in the combined adductor canal and periarticular infiltration group(11.10±0.16) compared to periarticular infiltration alone(7.26±0.11) with a statistical difference of $p<0.001$ Evan green et al concluded in their study that compared to periarticular group, breakthrough pain occurred later in the combined group which is similar to our study

Fei et al in their study found that time until breakthrough pain (NRS > 3) was significantly longer in Group RP than that in Group Con (18.5[IQR, 4–46] hours vs 10.0 [IQR, 3– 24] hours, $P=0.002$)

The results mentioned in both the above studies show that the duration for breakthrough pain was more in ACB+PAI group compared to PAI alone which was similar to our study

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Opioid consumption(Rescue analgesia)

In our study we found that the need for rescue analgesic was greater on POD1 in PAI group(group B) compared to ACB+PAI group. Fentanyl requirement was higher in PAI group on POD1 compared to ACB+PAI group. Group ACB+PAI had less narcotic consumption (less by 190mcg) on POD1 which was statistically significant whereas there was no significant difference in narcotic consumption on POD0,2 and 3The study conducted by Evan green et al determined that the narcotic consumption was found to be to be significantly less for the PAI + CACB group compared to PAI alone on POD 0 (17.25 mg less), POD 1(20.01 mg less), and POD 3 (18.77 mg less), ($p < 0.05$). On POD 2, on average, the PAI + CACB received 12.34 mg less of morphine equivalents than the PAI only, but this difference was not significant ($p = 0.171$) When total narcotic consumption in morphine equivalents from POD 0 to POD3 was compared, PAI + CACB patients on average received significantly less medication (66.07 mg) than the PAI only group ($p = 0.009$) Fei Lan et al in their study found that the consumption of IV morphine was not significant between groups 0–24 h after surgery. However, Group ACB+PAI consumed significantly less IV morphine at 24–48 h postoperatively compared to Group Con (15.64 ± 10.53mg vs 27.15 ± 21.46 mg, p=0.039)

In contrast to the above studies we observed that the overall fentanyl consumption was more in PAI group compared to PAI+CACB group and that it was statistically significant. Howeever the fentanyl consumed on POD1 was statistically significant in PAI group with no difference noted on POD0,2 and 3.[10-11]

Changes in the perioperative haemodynamic parameters:

There were no significant differences between the study groups with respect to changes in heart rate, systolic blood pressure, diastolic blood pressure and mean arterial blood pressure preoperatively

The studies conducted by Evan Green et al and Fei et al showed similar findings as ours with no significant changes in hemodynamic parameters such as heart rate,systolic,diastolic and mean arterial blood pressure

Adverse events: We didn't observe any side effects such as nausea,vomiting and respiratory depression Evan Green et al and Fei et al too in their studies did not find any significant adverse events between the two groups which was similar to our study.

CONCLUSION

To conclude our study demonstrates that a combination of periarticular infiltration and adductor canal block after unilateral total knee arthroplasty surgeries provides better pain relief prolonging the duration of analgesia as well as reducing the need of narcotic consumption with mimimal or no side effects or complications.

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