Section: Orthopedics

Original Research Article

EFFICACY OF PERICAPSULAR INFILTRATION WITH ADDUCTOR CANAL BLOCK FOR POST OPERATIVE PAIN MANAGEMENT AND POST OPERATIVE RECOVERY IN TOTAL KNEE ARTHROPLASTY

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ABSTRACT

Background: Total knee arthroplasty (TKA) is increasingly utilized in the elderly to alleviate chronic knee pain and enhance functional outcomes, demonstrating success in cases of advanced osteoarthritis. Post-operative pain hinders patient participation in physiotherapy, reduces satisfaction, extends hospital stay, and may result in chronic dysfunction. The objective is to assess the efficacy of pericapsular infiltration with adductor canal block for post-operative pain management in TKA.

Materials and Methods: An observational descriptive study was conducted among patients undergoing unilateral TKA for a period of two years. After selection of participants based on the inclusion and exclusion criteria, the patients receive pericapsular infiltration intraoperatively, which will include 20cc of 0.2% Ropivacaine + 30mg Ketorolac + 80mcg Clonidine + 5mg Morphine + 0.5mg Epinephrine + 20cc of normal saline. Following surgery, under ultrasound guidance adductor canal block is achieved and catheter is inserted and fixed and post operatively Bolus dose 6cc of 0.2% Ropivacaine and 4mg Dexamethasone given twice a day.

Results: The study comprised of 20 individuals with advanced osteoarthritis who had TKA. Most of our patients were women under 70 who had right knee surgery. The mean ROM was 39.50±11.91 on day 1, 61±18.32 on day 2, and 77.5±15.85 on day 3. The mean ROM difference between days 1 and 2, days 1 and 3, and days 2 and 3 was statistically significant ($p<0.001$). The mean VAS score was 4.67±2.082 on day 1, 6.07±1.77 on day 2, and 4.33±1.61 on day 3. The difference in mean VAS score from day 1 to day 2 was statistically significant ($p<0.001$), as was the difference from day 2 to day 3 ($p<0.001$). The difference in mean VAS score was not discovered between day 1 and day 3, which can be explained by reduced VAS score on day 1 due to the effects of analgesics given during surgery.

Conclusion: The current study's findings contribute to the conclusion that PENG block combined with ACB and LIA is useful for treating postoperative pain and hastening patients' functional recovery after TKA.

Keywords: Analgesis, Osteoarthitis, Total Knee Arthroplasty, Visual Analogue Scale.

INTRODUCTION

Osteoarthritis (OA) is a major source of pain and disability, resulting in considerable costs for individuals and society. Increased life expectancy will lead to a higher incidence and prevalence of OA, correlating with age (Yadav et al., 2022).[1] In the late stage of osteoarthritis, articular cartilage experiences softening, ulceration, and focal disintegration. Synovial inflammation may arise. Pain is the primary clinical sign, especially after prolonged activity and weight-bearing; stiffness, on the other hand, arises after periods of inactivity. It is probably not a single illness, but rather the outcome of various conditions leading to joint dysfunction. Also known as degenerative arthritis, it primarily affects the spine, hands, feet, and major weight-bearing joints like the hips and knees (Pal et al., 2016).[2]

The knee is one of the most commonly affected joints in osteoarthritis (OA). The knee, a crucial weight-bearing joint, often experiences heightened pain in individuals with osteoarthritis. Approximately 80% of worldwide osteoarthritis cases are due to knee osteoarthritis. It does not cause death but leads to disability, thus diminishing quality of life (QOL) (Jaiswal et al., 2021).[3] The global position of OA as a percentage of all age-standardized cases from 1990 to 2019. Years of healthy life lost due to disability (YLDs) were adjusted from the 17th to the 16th year. According to GBD 2017 estimates, OA ranks as the 24th most prevalent cause of YLDs in China. India's OA ranking improved from 23rd to 20th, reflecting a faster escalation in the country's OA burden. Symptomatic osteoarthritis (OA) prevalence in India increased 2.66-fold over the past thirty years, from 23.46 million in 1990 to 62.35 million in 2019 (Singh et al., 2022).[4]

Total knee arthroplasty (TKA) is the preferred intervention for persistent pain or functional impairment following conservative treatment in cases of end-stage knee osteoarthritis, inflammatory arthritis, or osteonecrosis. TKA is a common orthopedic procedure, mainly indicated for primary knee osteoarthritis (Gränicher et al., 2022).[5]

The main limitation of the TKA procedure is postoperative pain, which can reduce compliance and hinder functional recovery, delaying rehabilitation (Kim et al., 2019).[6] Up to 34% of patients experience chronic pain following surgery, with the severity of early postoperative pain after total knee arthroplasty linked to a higher incidence of chronic pain (Wang et al., 2022).[7] Post-operative pain impedes patient engagement in physiotherapy, diminishes satisfaction, prolongs hospital stay, and may lead to chronic dysfunction. Multimodal analgesia manages pain effectively by reducing the risk of addiction to single agents and minimizing side effects linked to increased dosages (Wang et al., 2022).[8] Local infiltrative analgesia is a notable advancement. The adductor canal block creates a sensory blockade of the saphenous nerve, preserving quadriceps function and reducing the risk of falls. Patients receiving adductor canal block exhibit improved early rehabilitation, increased ambulation distances, reduced hospital stays, and greater quadriceps muscle strength relative to those undergoing femoral nerve block (Kim et al., 2019).[9] Regional anesthetic techniques, including local infiltration analgesia (LIA) and adductor canal block (ACB), effectively reduce pain and enhance postoperative outcomes in total knee arthroplasty (TKA) patients. ACB produces sensory blockade in the anteromedial knee area while preserving quadriceps muscle strength, thereby increasing its popularity. LIA involves the systematic application of local anesthetics around the surgical site. These techniques may insufficiently address the complex pain patterns associated with TKA. Recent studies have investigated the advantages of integrating different regional anesthesia methods to enhance postoperative pain relief and functional recovery. Incorporating the pericapsular nerve group (PENG) block with adductor canal block (ACB) and local infiltration analgesia (LIA) represents one strategy. The PENG block targets the sensory innervation of the posterior knee capsule, which may not be adequately addressed by ACB alone (Ferre et al., 2024).[10]

This study aimed to investigate the efficacy of combining PENG block with ACB and LIA in managing postoperative pain and accelerating functional recovery in patients undergoing TKA. The researchers hypothesized that this multimodal approach would provide superior pain relief, reduce opioid consumption, and enhance postoperative recovery compared to single modality techniques.

Objectives: To ascertain the effectiveness of adductor canal block combined with pericapsular infiltration for post-operative pain control following total knee arthroplasty in terms of:

- Pain assessment
- Mobilization period
- Range of motion of operated knee
- Use of opioid analgesia

MATERIALS AND METHODS

The present study was a prospective study which was conducted among the outpatients and inpatients reporting to the Department of Orthopedics in Father Muller Medical College Hospital, Mangalore, India with complaints of OA of the knee. The study was conducted after obtaining clearance from the Institutional Human Ethics Committee (IHEC) with reference number (FMMCIEC/CCM/550/2022) and informed consent from the patients included in the study. Patients were included into the present study if they were aged between 40 to 80 years, underwent TKA, and reported to the study center. Patients with bilateral TKA, revision of a previous TKA surgery and patients suffering from chronic kidney disease,

arrhythmia, and cardiac complication were excluded from the study.

Sample size: Sample size was calculated as 20 with a CI of 95% and 80% power

n= (Zα+Zp) 2σ2 / (Xpre-Xpost)2

Where Zα=1.96 at 95% CI, Zp = 0.841% at 80% power

(Xpre-Xpost) 2=0.14 σ2=+/-0.37

Calculated sample size: 20

Procedure: Data was collected from patients who have consulted in the Orthopedics department of Father Muller Medical College Hospital with OA of knee after written consent was taken from each patient enrolled in the study. After applying the inclusion and exclusion criteria to the study population, 20 patients were involved in the present study. The patients then received pericapsular infiltration intraoperatively, which included 20 cc of 0.2% Ropivacaine + 30 mg Ketorolac + 80 mcg Clonidine + 5 mg Morphine + 0.5 mg Epinephrine + 20 cc of normal saline. Following surgery, under ultrasound guidance adductor canal block was achieved and catheter inserted and fixed and post operatively bolus dose 6cc of 0.2% Ropivacaine and 4mg Dexamethasone was administered twice a day.

To measure pain, a visual analogue scale was used on postoperative day 0, 1, 2 and 3 and number of subjects who could ambulate comfortably. The range of motion of the knee was checked to ensure the viability of the treatment and the use of opioid analgesics were noted and the duration of hospital stay were taken into consideration. Rescue analgesia (Tramadol) was administered if the visual analogue scale score exceeded 5.

Statistical Analysis: The data was analyzed using SPSS v 23 for Windows [IBM Corp., Armonk, NY]. The data was assessed for normal distribution Categorical data was summarized by means of frequency and percentages. Quantitative normal data was summarized by mean and standard deviation. Comparison across the follow ups of quantitative data was performed by using Repeated Measures ANOVA and Bonferroni post hoc analysis. The level of significance was set at $p<0.05$.

RESULTS

The demographic data obtained from [Table 1] revealed that most of the participants included were aged below 70 years (65%) followed by 35% who were aged above 70 years. The gender distribution of the participants revealed that most of the participants were female (75%). The distribution of location of side of TKA showed that most patients underwent TKA of the right knee (50%) followed by left (40%) and bilateral TKA (10%). The initiation of ROM was seen in 85% participants with the remaining 15% not showing any movement on 60% of the participants day 0. Rescue analgesia was administered to while the remaining 40% did not receive any rescue analgesia.

Table 1: Demographic and clinical features

Variable	Sub category	Percentage
Age distribution	70 and below	65%
	70 and above	35%
Gender distribution	Male	25%
	Female	75%
Location of surgery	Left	40%
	Right	50%
	Bilateral	10%
Initiation of ROM on day 0	Initiated	15%
	Not initiated	85%
Need for rescue analgesia	Yes	60%
	No	40%

Table 2: Comparison of mean ROM of the participants on the first three days after surgery

				Change and p-value		
ROM	N	Mean	Std. Deviation	Day 1 - Day 2	Day 1 - Day 3	Day 2 - Day 3
Day 1	20	39.50	11.910	21.50 p=0.000*, HS	38.00 p=0.000*, HS	16.50 p=0.000*, HS
Day 2	20	61.00	18.325			
Day 3	20	77.50	15.853			

*: highly significant difference ($p<0.001$)

Table 3: Comparison of the mean VAS score on the first three days after surgery

Day of scoring		Change and p-value					
	Mean	Day 0 -Day 1	Day 0 - Day 2	Day 0 -Day 3	Day 1 - Day 2	Day 1 - Day 3	Day 2 - Day 3
Day 0	1.90±0.912	-2.6, p=0.000*, HS	-0.8, p=0.001*, HS	-0.45, p=0.070, NS	1.8, p=0.000*, HS	2.15, p=0.000*, HS	0.35, p=0.110, NS
Day 1 at rest	4.50±2.090						
Day 2 at rest	2.70±1.174						
Day 3 at rest	2.35±1.040						
Day 3 at rest	2.35±1.040						

*: highly significant difference ($p<0.001$)

[Table 2] depicted the mean ROM of the participants on the first three days postoperatively and the results showed that the mean ROM on day 1 was 39.50±11.91, 61±18.32 on day 2 and 77.5±15.85 on day 3. The difference in mean ROM between day 1 and day 2 was found to be statistically highly significant ($p<0.001$), similarly the difference between day 1 and day 3 along with day 2 and day 3 was also found to statistically highly significant ($p<0.001$).

[Table 3] compared the mean VAS scores between the first three days postoperatively at rest and the results show that the mean VAS score on day 0 was 1.90±0.912, 4.50±2.090 on day 1, 2.70±1.174 on day 2 and 2.35±1.040 on day 3. This mean was compared between the days and it was revealed that the difference in means between day 0 and day 1 was statistically highly significant ($p<0.001$), similarly highly significant difference was observed between day 0 and day 2 ($p<0.001$), day 1 and day 2 ($p<0.001$) along with day 1 and day 3 ($p<0.001$). The difference in means between day 0 and day 3 ($p>0.05$) along with day 2 and day 3 ($p>0.05$) did not show a statistically significant difference.

Table 4: Distribution of number of participants who could walk on the first three days after surgery

	Initiated		Not initiated		Total	
	Count	Row N%	Count	Row N%	Count	Row N%
Day 1	3	15.0%	17	85.0%	20	100.0%
Day 2	14	70.0%	6	30.0%	20	100.0%
Day 3	18	90.0%	2	10.0%	20	100.0%

Results from [Table 4] reported that 15% of the participants could walk on day 1, 70% could walk on day 2 and 90% could walk on day 3.

Table 5: Comparison in VAS score for between the first three days after surgery

	N	Mean	Std. Deviation	Day 1 - Day 2	Day 1 - Day 3	Day 2 - Day 3
Day 1 on walking	3	4.67	2.082	p=0.000*, HS	p=0.0740, NS	p=0.000*, HS
Day 2 on walking	14	6.07	1.774			
Day 3 on walking	18	4.33	1.609			

*: highly significant difference ($p<0.001$)

The results from [Table 5] shows that the mean VAS score was 4.67±2.082 on day 1, 6.07±1.77 on day 2 and 4.33±1.61 on day 3. The difference in mean VAS score from day 1 to day 2 was found to be statistically highly significantly ($p<0.001$), the difference in mean VAS score between day 2 and day 3 was also found to be statistically highly significant ($p<0.001$). The difference in mean VAS score was not found between day 1 and day 3; this can be explained by reduced VAS score on day 1 due to the effects of analgesics given during surgery.

DISCUSSION

The obesity pandemic and an aging population are elevating the incidence of knee osteoarthritis. Osteoarthritis adversely affects quality of life, leading to pain, functional limitations, sleep disturbances, and additional complications (Lunn et al., 2011).[11] Total knee arthroplasty is the definitive treatment for advanced knee osteoarthritis. TKA is a widely performed surgical procedure globally, significantly impacting the healthcare system (Wu & Raja, 2011).[12] Long-term functional outcomes and quality of life improvements are observed; however, significant pain in the early postoperative days may impede recovery (Wu & Raja, 2011).[13] Post-TKA pain is common and affects long-term outcomes and rehabilitation via effective pain management. Many articles offer general guidance on pain management after TKA, but they frequently lack a comprehensive evaluation of the underlying research (Lavand'homme et al., 2022).[14] Adductor canal catheter insertion effectively provides postoperative analgesia following TKA. This technique effectively reduces pain while maintaining quadriceps strength, essential for prompt mobilization and post-operative rehabilitation. This study sought to improve evidence on the efficacy of adductor canal catheters for pain management and recovery after TKA.

The demographic findings indicated that most participants were female and under 70 years of age. This conclusion aligns with Rames RD et al.'s study, where most of the 624 participants were female, with a mean age of 64.5 years (Rames et al., 2019). Previous research projects also identified the gender gap (Parsley et al., 2010; Liebs at al., 2011).[15,16] Research indicates that women have a higher likelihood than men of developing knee osteoarthritis, particularly with advancing age. Various factors, including hormonal influences and genetic predispositions, contribute to the increased incidence of knee problems in women. Consequently, by the time women pursue surgery, their joint deterioration is often more advanced. Women typically pursue TKA later than males in the progression of their condition. Research shows that women exhibit reduced knee function and increased functional impairment during knee surgery. Several variables may contribute to this delay, including elevated pain tolerance, increased stoicism, and possible bias among medical professionals who may minimize the severity of women's symptoms. Consequently, women often exhibit greater knee deterioration by the time they undergo TKA, necessitating surgical intervention (Parsley et al., 2010; Liebs at al., 2011).[17,18]

The distribution of TKA sites indicates that 50% of patients underwent the procedure on the right knee, 40% on the left knee, and 10% bilaterally. Teo I et al,[20] (2017) examined the correlation between limb volume increase and the dominant leg. Of the participants, 86% exhibited right leg dominance, and 93% demonstrated an average volume increase of 349 ml in the dominant leg, which was statistically significant ($p<0.001$) (Teo et al., 2017).[21] Sixty percent of participants received rescue analgesia, while forty percent did not. A study by Xie Y et al. found that the group receiving adductor canal block (ACB) plus local infiltration analgesics (LIA) used significantly fewer analgesics (remifentanil and sufentanil) compared to the LIA group ($p=0.006$), aligning with the current investigation's findings (Xie et al., 2023).[22] Simsek F et al. found that the analgesic intake among ACB, IPACK, and EA groups was comparable in a separate study (Simsek et al., 2023).[23] Khan MJ et al conducted a study indicating that ACB was superior to LIA in terms of rescue analgesic doses within the first 24 hours postoperatively ($p=0.046$) (Khan et al., 2024).[24] Reduced postoperative opioid consumption is associated with the multimodal approach of integrating ACB and pericapsular infiltration. This is significant as it provides effective pain relief while minimizing the risk of opioid-related adverse effects such as nausea, constipation, and sedation (Luo et al., 2022).[25]

The mean VAS scores at rest were evaluated, revealing scores of 1.90±0.912 on day 0, 4.50±2.090 on day 1, 2.70±1.174 on day 2, and 2.35±1.040 on day 3. The differences between day 0 and day 1, as well as day 2, were statistically significant ($p<0.001$). A similarly significant difference was noted between day 1 and day 2, as well as day 3 ($p<0.001$). The mean differences between day 0 and day 3 ($p>0.05$) and between day 2 and day 3 ($p>0.05$) were not statistically significant. The mean VAS score for walking during rehabilitation was 4.67±2.082 on day 1, 6.07±1.77 on day 2, and 4.33±1.61 on day 3. The difference between day 1 and day 2 was statistically significant ($p<0.001$), as was the difference in mean VAS score between day 2 and day 3 ($p<0.001$). No significant difference in mean VAS score was observed between day 1 and day 3, likely due to the reduced VAS score on day 1 resulting from analgesics administered during surgery. A prior study by Xie Y et al. found that the ACB + LIA group had a lower incidence of postoperative pain 24 hours post-surgery ($p=0.028$) compared to the LIA group (Xie et al., 2023). A previous study by Luo ZY indicated that at 72 hours postoperatively, ACB combined with LIA significantly reduced both resting and active VAS pain levels, improved sleep quality, and increased satisfaction rates ($p<0.05$) (Luo et al., 2022). Goytizolo EA et al. investigated the efficacy of ACB combined with periarticular injection in TKA patients. At 24 hours post-anesthesia, patients receiving both treatments reported reduced pain severity ($p=0.041$) and increased pain relief ($p=0.048$). Other secondary outcome measures, including opioid use, opioid-related side effects, and pain levels on a numerical rating scale, exhibited no differences (Goytizolo et al., 2019). Simsek F et al.'s study compared ACB to epidural analgesia (EA) alone after TKA, also incorporating infiltration between the popliteal artery and the posterior knee capsule (IPACK). The findings indicated no significant difference in VAS scores on post-operative days 1 and 2; however, the ACB + IPACK group exhibited a significantly higher VAS score at 8 hours post-operation ($p=0.038$) (Simsek et al., 2023). Khan MJ et al. previously measured the time interval from block administration to the patient's initial report of post-operative pain. ACB was found to be superior to LIA ($p=0.001$). There was no significant difference in the mean sedation levels of the groups as measured by the Ramsay score (Khan et al., 2024). Kampitak W et al. investigated the results and effectiveness of LIA versus ACB in TKA patients. The ACB group exhibited significantly lower VAS scores at 6, 12, and 18 hours, as well as at one, two, and three days, along with reduced postoperative morphine use ($p<0.05$) (Kampitak et al., 2018). Recent meta-analyses indicate that continuous adductor canal blocks (ACBs) are more effective for pain relief compared to single-shot procedures. In patients undergoing TKA, continuous analgesia delivery through an adductor canal catheter significantly reduces pain scores and the requirement for rescue analgesia. Continuous ACB demonstrated reduced VAS scores and overall rescue analgesia dosage compared to single-shot techniques in a systematic analysis of 828 individuals. No significant differences were observed in hospital stay length (Jabur et al., 2023). A randomized controlled trial by Lyngeraa TS et al assessed the analgesic effects of ACB versus a single injection procedure using catheter-based repeated boluses, employing either a standard perineural catheter or a novel suture-method catheter. The results indicated no differences between the catheter groups; however, the single-injection group showed improvements in muscle strength and ambulation (Lyngeraa et al., 2019).[26,27]

Recent studies have examined the optimal location for the continuous catheter. Research comparing catheter insertion sites in the femoral triangle, proximal ACB, and distal ACB has shown that total pain levels were similar among the groups; however, the distal ACB may provide better pain control in the early postoperative period. The block's continuous nature is essential for effective pain management, despite the necessity of placement (Lee et al., 2022). Studies indicate that patients receiving ACB alongside pericapsular infiltration experience reduced discomfort during movement and at rest, as measured by the Visual Analog Scale (VAS), compared to those receiving only pericapsular infiltration. Early mobilization and rehabilitation are essential for recovery following total knee arthroscopy, facilitated by enhanced pain

management. Enhanced pain management results in improved functional outcomes, as patients can participate in physical therapy and daily activities more easily (Chen et al., 2021). PAI administers local anesthetics at the surgical site, whereas ACB specifically targets the saphenous nerve innervating the anteromedial region of the knee. This dual approach more effectively addresses pain from surgical trauma and surrounding tissues than either treatment alone, resulting in improved overall analgesia. The combined analgesic effects of ACB and PAI can synergistically enhance their efficacy. Reducing opioid requirements post-surgery and allowing for lower doses of local anesthetics can enhance pain relief. Improved pain management and potentially reduced adverse effects associated with heightened opioid use are the results (Hussain et al., 2023).

During the initial three days postoperatively, 85% of participants exhibited a mean range of motion (ROM), with values recorded as 39.50±11.91 on day 1, 61±18.32 on day 2, and 77.5±15.85 on day 3. The mean ROM difference between day 1 and day 2 was statistically significant ($p<0.001$), as was the difference between day 2 and day 3 ($p<0.001$). ACB with LIA demonstrated significantly improved range of motion (ROM) compared to LIA alone within 72 hours postoperatively ($p<0.05$), as reported in a prior study (Luo et al., 2022). Findings indicated that 15% of individuals walked three steps, 70% walked fourteen steps on day two, and 90% walked eighteen steps on day three. Post-surgery, patients should mobilize promptly with ACB and IA to optimize pain management. Enhancing joint mobility necessitates circulation and stiffness prevention, achievable solely through early mobilization. Post-surgery, physical therapy and rehabilitation exercises significantly enhance joint mobility and overall functionality (Luo et al., 2022; Marya et al., 2020).

CONCLUSION

The results of the present study help conclude that combining pericapsular infiltration block with ACB is effective at managing postoperative pain and accelerating functional recovery in patients undergoing TKA. Surgeons can use the procedure to avoid post operative pain and discomfort among their patients while also ensuring better outcomes.

The ACB approach aims to mitigate adverse impacts on muscle strength, particularly in the quadriceps. Patients retain greater functional capacity during the healing process due to this preservation. Studies indicate that patients receiving both ACB and IA exhibit greater range of motion and functional recovery compared to those receiving IA alone. The combination of the two treatments preserves quadriceps strength, facilitating more efficient rehabilitation (Hussain et al., 2023). Effective pain management provides psychological benefits. Reduced discomfort increases patient optimism regarding recovery, potentially enhancing participation in rehabilitation activities. The psychological component is crucial, as a positive outlook can enhance outcomes and improve adherence to rehabilitation treatments (Luo et al., 2022).

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