e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(2); 521-529

Original Research Article

Efficacy of a Local Anaesthetic Cocktail Injection with and Without Posterior Capsular Infiltration for Post-Operative Pain Control in Patients Undergoing Simultaneous Bilateral Tka: A Prospective Comparative Study

Parimal Bhaskar[1], Manish Kumar[2]

[1]Senior Resident, Department of Orthopaedics, Patna Medical College and Hospital, Patna, Bihar, India

[2]Senior Resident, Department of Orthopaedics, Maulana Azad Medical College, New Delhi, India

Received: 21-12-2022 / Revised: 04-01-2023 / Accepted: 03-02-2023

Corresponding author: Dr. Manish Kumar

Conflict of interest: Nil

Abstract

Aim: This comparative study was aimed to evaluate the efficacy of a local anaesthetic cocktail injection with and without posterior capsular infiltration for post-operative pain control in patients undergoing simultaneous bilateral TKA.

Methods: This was a prospective comparative study including 60 patients undergoing simultaneous bilateral TKA. The study took place at Patna Medical College and Hospital, Patna, Bihar, India for the period of one year.

Results: Results of the study were analyzed in 60 patients (120 knees). Females were found to be more in number who were diagnosed with primary knee OA and underwent simultaneous bilateral TKA compared to males. Male to female ratio was 0.56:1, mean age at which the patients underwent the procedure was found to be 61.62±7.7 years and mean BMI of the patients who underwent TKA was found to be 25.74±3.01 kg/m^2. There were no significant differences in pre-operative parameters such as VAS scores, knee flexion, extensor lag and KSS between the two groups.

Conclusion: The study successfully demonstrates that posterior capsular infiltration when included in LIA technique provides a better pain control and also early functional recovery after TKA.

Keywords: Local Infiltration Analgesia, Total Knee Arthroplasty, Posterior Capsular Infiltration, Knee Society Score, Visual Analogue Scale, Straight Leg Raise, Range Of Motion.

Introduction

According to the World Health Organization (WHO), 9.6% of men and 18% of women older than 60 years of age worldwide have symptomatic OA, making this condition one of the most prevalent chronic conditions. [1] Total knee arthroplasty (TKA) is one of the most common elective orthopaedic procedures which has been proven and established to be a highly successful procedure in patients with severe knee osteoarthritis,

being able to reduce pain and improve function and quality of life. [2]

Pain is the primary indication for THR and TKR and many preparatory, surgical and rehabilitation strategies target reduction in pain. However, both short- and long-term pain after THR and TKR are common. [3-5] Perioperative pain is managed with multi-modal analgesia with additive or synergistic effects. [6] Regimens aim to achieve good pain relief immediately after surgery while allowing for early mobilisation and hospital discharge. Other methods such as spinal and epidural anaesthetics and the use of opioids may preclude early mobilization and rehabilitation. [7,8] Pain management by infusion of local anaesthetic into wounds has been evaluated in diverse surgical procedures. In their systematic review, Liu and colleagues noted improved pain, reduced opioid use and side effects, increased patient satisfaction, and shorter hospital stay in patients receiving local anaesthetic infiltration. [9] Only one study included patients with THR or TKR [10], but further evaluations have been reported. [11] More recent meta-analyses in abdominal surgery [12], and lumbar spine surgery [13], have questioned the clinical value of local anaesthetic wound infiltration.

In order to resolve this issue, various approaches have been designed, such pre-emptive analgesia, opioids medications, COX-2 inhibitor drugs, epidural anaesthesia, peripheral nerve blockade, local infiltration analgesia, PCA and multimodal analgesia.2 Kerr et al from Sydney, Australia developed a wound infiltration procedure for tackling post-op pain after TKA/THA known as local infiltration analgesia (LIA). [14] Principle of this technique is using multiple agents which target the pain pathway and receptors within the knee. But there is still shortage of literature depicting the importance of inclusion of posterior capsule during infiltration procedure and additional benefits of posterior capsular infiltration. The cocktail mixture considered for our study comprises of 0.5% bupivacaine, 40 mg methyl prednisolone, 1.5 gm cefuroxime and 0.9% normal saline. The main action of local anaesthetics is reversible block of voltage gated Na channels in noci-ceptors, thus resulting to decreased transmission of pain signals to the brain. [15] Intermediate acting corticosteroid like methyl prednisolone has been used by many surgeons due to its anti-inflammatory properties. [16] The prophylactic use of antibiotic drug cefuroxime in the anaesthetic cocktail was to aid in the prevention of deep wound infections.

This comparative study was aimed to evaluate the efficacy of a local anaesthetic cocktail injection with and without posterior capsular infiltration for post-operative pain control and early functional recovery in patients undergoing simultaneous bilateral TKA.

Materials and Methods

This was a prospective comparative study including 60 patients undergoing simultaneous bilateral TKA. The study took place at Patna Medical College and Hospital, Patna, Bihar, India for the period of one year.

Inclusion criteria

The inclusion criteria were patients diagnosed with bilateral knee primary osteoarthritis undergoing simultaneous bilateral total knee arthroplasty, patients with ASA grade 1 and 2 and patients undergoing surgery with spinal anaesthesia being given.

Exclusion criteria

The exclusion criteria were patients with known h/o allergy to the drugs used in the study, ≥ASA grade 3, poorly controlled diabetes mellitus or h/o recent cardiac disorders and arrhythmia, rheumatoid arthritis/neuromuscular deficits, h/o previous trauma or previous surgical

intervention in the same sided knee, treated previously with high tibial osteotomy and patients admitted for revision TKR.

Procedure

In all the study participants, one knee, received LIA in anterior, medial and lateral structures of the knee as well as posterior capsule (group A) and contralateral knee received LIA in anterior, medial and lateral structures, identical to the former knee, but excluding posterior capsule region (group B). To determine the side of knee (right/left) to be infiltrated with LIA with PCI in all 50 patients, we used alternating allocation method based on the date of admission of the patients, where if the first patient received LIA with PCI in the right knee and LIA without PCI in left knee, the next patient admitted in the sequence received LIA with PCI in the left knee and LIA without PCI in right knee, thus alternation was used in the sequential sequence for all the subjects to determine the side of knee receiving posterior capsular infiltration (PCI). The intention of alternation process was to make the comparison between two groups with as many as similar characteristics as possible. Pre-operatively clinical history and relevant data such as pain scores, knee society score and knee range of motion in both knees of all the patients were collected as per the pre-designed proforma. It showed no statistically significant differences between both the groups. All patients received spinal anaesthesia with 0.5% bupivacaine and 0.5 ml (25 mg) fentanyl. The antibiotic prophylaxis was provided with 1.5 gm of cefuroxime, half an hour before the TKA incision. All TKAs were done by a single senior surgeon, and standard anterior midline incision with medial parapatellar arthrotomy was taken. Tourniquet was used in all the patients. Cemented posterior stabilized total knee components (Meril, Stryker, Depuy and Smith and nephew) were used in all the patients. The cocktail was infiltrated after giving a thorough wash before cementing and final implantation. Cocktail injection was prepared by the assistant which included 100 mg bupivacaine (0.5%, 20 ml), 40 mg methyl prednisolone acetate, and 1.5 gm cefuroxime. The contents were mixed with sterile normal saline 0.9% to a total mixture of 60 ml. We divided the posterior capsule into following zones for better understanding and to maintain identical protocol of injection in all the participants: zone 1: postero-medial capsular area on femoral aspect, zone 2: postero-lateral capsular area on femoral aspect, zone 3: postero-medial capsular area on tibial aspect and zone 4: postero-lateral capsular area on tibial aspect. We avoided infiltrating the central portion of the posterior capsular area to escape the damage to neuro-vascular structures as it has a well-established close proximity to the midline structures such as popliteal artery and tibial nerve. If damage occurs to these structures while injecting in the central area of the posterior capsule, it might result into dangerous complications intra-operatively. We also avoided injecting the cocktail mixture into Zone 4 (postero-lateral capsular area on tibial aspect) to avoid damage to the common peroneal nerve in that area. Thus, we injected cocktail mixture to zone 1, zone 2 and zone 3 in all our patients.

In one knee (Group A) LIA with posterior capsule area infiltration was administered, where after tibial and femoral cuts and before placement of implant, the 1st 20 ml of the cocktail preparation was injected into the posterior capsule in a flexed knee position, in equal proportions, into zones 1, 2 and 3 each, respectively.

Placement of the final implants was done and the next 20 ml were injected into quadriceps, patellar tendon, medial and lateral retinaculum and subcutaneous tissue (approx.4 ml each) sequentially with a 21-gauge needle and syringe. In the contralateral knee (Group B), 20 ml of

cocktail preparation was injected identically as the first knee and into the same sites as above, quadriceps, medial and lateral retinaculum, patellar tendon and subcutaneous tissue but without posterior capsular infiltration. Tourniquet was released and hemostasis was achieved. Thorough wash was given in all the surgeries followed by wound closure in layers and sterile dressing. Post-operatively, primary parameter VAS score for pain at rest and on movement was noted at 6, 12, 24, 48, 72 hours and on the discharge day. Knee flexion and extensor lag were recorded by goniometer and compared on both the sides at 6, 12, 24, 48, 72 hours and on the discharge day. Knee society score was assessed for both knees in all the study participants at 15 days and 1 month post-operatively. Time taken for active SLR was noted for both the knees post-operatively.

Statistical analysis

The data entry was done in the Microsoft EXCEL spreadsheet and the final analysis was done with the use of statistical package for social sciences (SPSS) software, IBM manufacturer, Chicago, USA, version 21.0. The presentation of the Categorical variables was done in the form of number and percentage (%). On the other hand, the quantitative data were presented as the means ± SD and as median with 25th and 75th percentiles (interquartile range). The data normality was checked by using Kolmogorov-Smirnov test. The cases in which the data was not normal, we used non parametric tests. The comparison of the variables which were quantitative and not normally distributed in nature were analyzed using Wilcoxon signed rank test and variables which were quantitative and normally distributed in nature were analyzed using paired t test. For statistical significance, p value of less than 0.05 was considered statistically significant.

Results

Table 1: Age and BMI of the study subjects

Parameters	
Age (years)	
Mean±SD	61.62±7.7
Median (25th-75th percentile)	61.5 (57.25-68)
Range	32-76
BMI-body mass index (kg/m²)	
Mean±SD	25.74±3.01
Median (25th-75th percentile)	25.8 (23.66-27.534)
Range	19.33-33.06

Results of the study were analyzed in 60 patients (120 knees). Females were found to be more in number who were diagnosed with primary knee OA and underwent simultaneous bilateral TKA compared to males. Male to female ratio was 0.56:1, mean age at which the patients underwent the procedure was found to be 61.62±7.7 years and mean BMI of the patients who underwent TKA was found to be 25.74±3.01 kg/$m^{2.}$

Table 2: Pre-operative parameters of the study subjects

Pre-operative parameters	**Group A (N=60)**	**Group B (N=60)**	**P value**
VAS			
Mean±SD	4.9±0.93	4.9±0.91	0.920
Median (25th-75th percentile)	5 (4-5.75)	5 (4-5)	
Range	4-7	3-7	

Knee flexion			
Mean±SD	97.3±8.22	98.5±9.22	0.270
Median (25th-75th percentile)	95 (90-105)	100 (90-110)	
Range	80-115	80-115	
Extensor lag			
Mean±SD	1.32±2.82	1.42±2.68	0.450
Median (25th-75th percentile)	0 (0-0)	0 (0-0)	
Range	0-10	0-10	
KSS			
Mean±SD	43.46±3.47	43.68±3.5	0.700
Median (25th-75th percentile)	43 (41-45)	44 (41-45)	
Range	39-52	39-52	

There were no significant differences in pre-operative parameters such as VAS scores, knee flexion, extensor lag and KSS between the two groups.

Table 3: Comparison of trend of post-operative VAS at rest, on movement and knee flexion at different time intervals between group A and B

Time intervals at rest	Group A (Median)	Group B (Median)
Post-operative at 6 hours	2.00	4.00
Post-operative at 12 hours	2.00	3.00
Post-operative at 24 hours	2.00	3.00
Post-operative at 48 hours	2.00	3.00
Post-operative at 72 hours	1.00	3.00
Post-operative at discharge	1.00	1.00
Time intervals on movement		
Post-operative at 6 hours	4.00	5.00
Post-operative at 12 hours	3.00	5.00
Post-operative at 24 hours	2.00	5.00
Post-operative at 48 hours	2.00	4.00
Post-operative at 72 hours	1.00	3.00
Post-operative at discharge	1.00	2.00
Time intervals at Knee Flexion		
Pre-operative	97.30	98.40
Post-operative at 6 hours	36.80	44.80
Post-operative at 12 hours	46.44	51.44
Post-operative at 24 hours	56.10	59.20
Post-operative at 48 hours	65.66	67.86
Post-operative at 72 hours	74.56	76.96
Post-operative at discharge	82.92	85.15

The VAS scores at rest were lower in Group A knees compared to contralateral knees (Group B) at 6, 12, 24, 48 and 72 hours with $p<0.0001$. The difference between VAS values at rest at the time of discharge was not found to be significant. The VAS scores on movement were significantly lower in knees where LIA included posterior capsular area (Group A) compared to contralateral knees (Group B), at all the given time frames. Post-operatively, comparison of mean values of knee flexion range between Group A and Group B at 6, 12, 24, 48, 72 hours and at the time of discharge, showed a significant difference, with Group A demonstrating

higher knee flexion range of motion compared to Group B.

Table 4: Comparison of trend of extensor lag at different time intervals between group A and B

Time intervals	Group A (Median)	Group B (Median)
Pre-operative	0.00	0.00
Post-operative at 6 hours	50.00	60.00
Post-operative at 12 hours	47.50	50.00
Post-operative at 24 hours	40.00	50.00
Post-operative at 48 hours	40.00	40.00
Post-operative at 72 hours	25.00	30.00
Post-operative at discharge	5.00	5.00

The extensor lag was significantly lesser in Group A when compared to Group B at 6, 12, 24, 48 and 72 hours. However, there was no significant difference between the two groups at the time of discharge.

Discussion

There is an emphasis on postoperative analgesia and an ideal analgesia technique is required to provide adequate pain-free postoperative period, with knee mobility preserved, allow early return to activity, have lower rate of postoperative complications, lead to shorter hospital stay time and achieve better patient satisfaction. [17,18] The various modalities of postoperative analgesia work by inhibiting pain receptors with different drugs acting in different modes. Patient-controlled analgesia (PCA), continuous epidural analgesia, peripheral nerve blocks, and local infiltration analgesia (LIA) are the usual pain management regimens. [19,20]

According to a survey done by ISHKS joint registry in 2013, which included data of 34,478 TKAs, it was observed that OA knee was the indication for TKA in 33,444 patients, which makes around 95% of the study population considered. [21] With regard to a survey conducted, the number of total knee joint replacement procedures in India are on a rise every year and estimated surgeries in 2020 were around 2,00,000. [22] TKA might usually be accompanied with post-operative pain which affects the patients ability to mobilise, satisfaction ratio and rehabilitation program. Several methods have been devised to tackle the problem of post-operative pain after TKA such as pre-emptive analgesia, opioids, COX-2 inhibitors, peripheral nerve blockade, LIA and patients controlled analgesia. Each method carries its own benefits and side effects. [23,24] LIA is one such method which has proven to be beneficial for post-operative pain but there is not much definitive literature that specifically isolates the advantages of the posterior capsular infiltration when included as a component of LIA. Diwakar et al conducted a prospective study to compare the effectiveness of a single posterior capsule versus multiple site injection in controlling post-operative pain. Authors concluded that a single posterior capsular injection is as satisfactory as multiple infiltration. [25] Garg et al did a study to assess the effectiveness of LIA (bupivacaine) given into the posterior capsule along with FNB and concluded that posterior capsular infiltration aided in relieving the post-operative pain after TKA. [26] In our study, it was observed that values of VAS were significantly lower in Group A when compared to Group B at rest and on movement, at different time frames. It depicts improved and better pain control with posterior capsular infiltration.

In a randomized, double-blind, placebo, research done by Fu et al 80 participants with OA knee who were posted for TKA were assigned to 2 groups: trial, who

received intraarticular LIA including PCI, and Control, who received NS. [27] The authors found out that Knee ROM at 15th post-op day, was better in trial group when compared to the control group. In our study, knee flexion range of motion was higher in Group A than Group B and the extensor lag was lesser in Group A than Group B at all the observed time frames, which shows improved functional range of movements in the posterior capsule infiltrated knees. In a study conducted by Esswing in authors evaluated the efficacy of LIA for post-operative pain in patients undergoing TKA and found LIA group had reduced morphine consumption when compared to the placebo group, though knee scores at 14 days and 3 months follow-up were not significantly different than the placebo group. [28] In our study, comparison of KSS at 15th day and at 1 month showed significant difference and was found to be higher in Group A compared to Group B. The difference shows the impact of PCI in patient satisfaction factors and early functional outcome in post-operative phase. [29]

Conclusion

The results of the study and comparison of the post-operative parameters such as VAS, knee range of motion, KSS and time taken to perform active SLR between both groups successfully demonstrate that posterior capsular infiltration when included in local infiltration analgesia technique provides a better post-operative pain control and early functional recovery after TKA.

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