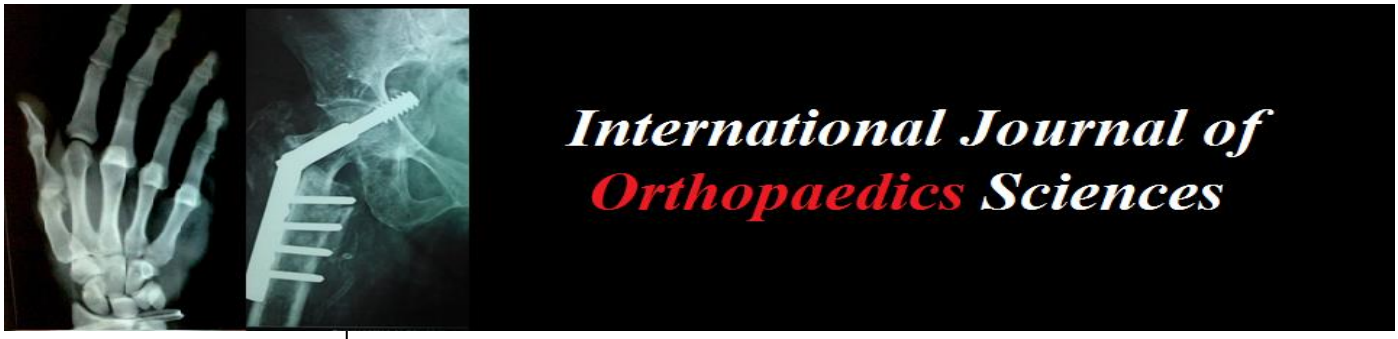

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Post-operative pain management using local infiltration analgesia (LIA) in total knee arthroplasty (TKA): A prospective study

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Abstract
Objectives: Post-operative pain management in Total Knee Arthroplasty (TKA) remains a challenging issue even though it is a commonly performed procedure today. Majority of the patients report severe pain following surgery due to which mobilization and early rehabilitation is hampered. Therefore, appropriate pain management is the need of the hour and Local Infiltration Analgesia (LIA) using periarticular cocktail injection is one of the preferred techniques. The objective of this study was to assess the functional outcome and patient satisfaction after using LIA in the form of periarticular Ranawat-cocktail among post-TKA patients.
Materials and Methods: This study was conducted at SGITO, Bangalore during the period between August 2017 to April 2018. In this study, we used LIA consisting of the Ranawat Regimen for TKA patients which contains (bupivacaine with adrenaline, morphine, methylprednisolone, cefazoline and normal saline) to manage postoperative pain in all 53 patients presenting to our institute for primary TKA. Functional outcome was assessed in terms of post-op VAS score, ROM, and SLRT at 12hrs, 24hrs, and 48hrs post-op. Opioid consumption, and patient satisfaction was recorded and statistical analysis was done.
Results: The mean age of patients in the study was 60.83. Mean VAS pain score at 12hrs, 24hrs, and 48hrs post-op were found to be 5, 3.5 and 2.79 respectively which indicated a highly significant (p<0.001) reduction in pain following TKA. Majority of the patients (71.7%) did not require any opioid rescue analgesia. Post-op ROM was satisfactory and all patients were able to do SLRT by day 1 and there was excellent patient satisfaction at time of discharge.
Conclusion: Local Infiltration Analgesia is a safe, simple and efficient method of reducing post-operative pain after total knee arthroplasty (TKA) which facilitates early rehabilitation among the patients and has an overall improvement in patient satisfaction with the procedure.

Keywords: Local infiltration analgesia, periarticular injection, total knee arthroplasty, visual analogue

1. Introduction
Total Knee Arthroplasty (TKA) is a routinely performed procedure today and is widely acknowledged for its success in patients suffering from severe grades of arthritis of the knee. However, post-operative pain management following TKA remains a challenging issue even today and is one of the main concerns among patients undergoing TKA [1, 2]. Majority of the patients report severe pain immediately following surgery due to which mobilization and early rehabilitation is hampered placing the patients at an increased risk for deep vein thrombosis, nosocomial infections and other complications due to prolonged hospital stay [3-5].
Different modalities commonly used for post-operative pain management after TKA include intravenous patient controlled analgesia (IV-PCA), epidural analgesia, femoral nerve blocks (peripheral nerve block), and local infiltration analgesia [6]. The major complications of epidural analgesia and iv analgesics are due to the systemic adverse effects caused by opioids such as headache, urinary retention, respiratory depression, nausea, vomiting, pruritis and orthostatic hypotension [6-8]. Peripheral nerve blocks are associated with motor blockade causing muscle weakness which hampers early mobilization and is also seen to have increased

opioid consumption post-op [9, 10]. Therefore, good post-op pain relief which facilitates rehabilitation is the need of the hour for better patient and surgeon satisfaction and a multimodal approach is preferred nowadays [11, 12]. Local Infiltration Analgesia (LIA) in the form of periarticular cocktail injection is one of the preferred techniques [13, 14].

The objective of this study was to assess the functional outcome, opioid consumption, and patient satisfaction rate after using LIA in the form of perioperative Ranawat cocktail among post-TKA patients.

2. Materials and Methods

2.1 Study design

This was a prospective study that was conducted at Sanjay Gandhi Institute of Trauma and Orthopaedics, Bangalore during the period between August 2017 to April 2018 after obtaining approval from the institution ethical committee.

2.2 Inclusion criteria

1. Age >45 years
2. Patients of both sex having Grade III and Grade IV Osteoarthritis knee (Kellgren-Lawrence grading) [15]

2.3 Exclusion criteria

1. Age < 45 years
2. Patients suffering from rheumatoid and other secondary arthritis.
3. Patients with connective tissue disorders.
4. Patients who are medically unfit for surgery.
5. Patients with previous history of cardiac disease, coagulopathies or hypersensitivity to any of the cocktail constituents.
6. Revision TKA patients.

2.4 Procedure

All the surgeries were performed by the same surgeon and assistant. Total knee arthroplasty was carried out among 53 patients under spinal anaesthesia after placing a thigh tourniquet set to 350mmHg pressure. The standard midline incision and medial parapatellar approach was used. Femur and tibial cuts were taken followed by patellar resurfacing. The ranawat cocktail (ROC) consists of 2 sets of injections: deep and superficial (Table 1). The deep injection consists of bupivacaine with epinephrine, morphine, methylprednisolone, cefazoline and normal saline and the superficial injection consists of bupivacaine and normal saline [11].

3-4 ml of the deep injection was injected around 6 specific sites identified to have concentration of nerve endings which are medial meniscus capsular attachment (Fig 1), lateral meniscus capsular attachment (Fig 2), posteromedial capsule (Fig 3), posterolateral capsule (Fig 4), medial retinaculum and lateral retinaculum (Fig 5). The superficial injection was injected around the suprapatellar fat pad (Fig 6), and around the quadriceps tendon (Fig 7) [16]. Infiltration was done before cementing using 19G spinal needle using “moving needle technique” to allow even spread of the cocktail.

Table 1: Ranawat Cocktail Constituents

Roc Cocktail	Strength/dose	Amount
1. Deep injection		
Bupivacaine	0.5% (200–400 mg)	24 cc
Morphine sulphate	8 mg	0.8 cc
Epinephrine (1:1000)	300 mcg	0.3 cc
Methylprednisolone acetate	40 mg	1 cc
Cefuroxime	750 mg	10 cc (reconstituted in normal saline)
Sodium chloride	0.9%	22 cc
2. Superficial injection		
Bupivacaine	0.5%	20 cc
Sodium chloride	0.9%	20 cc

This was followed by inserting the femoral and tibial inserts after trial of implants; followed by placing a drain and doing a 3- layered closure. Drain was released 4 hours after surgery.

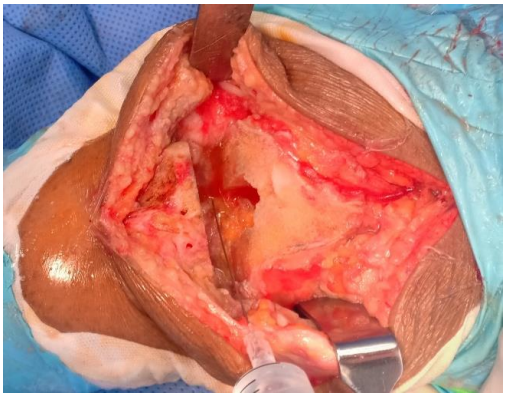

Fig 1: Medial Meniscus Capsular attachment

Fig 2: Lateral Meniscus Capsular attachment

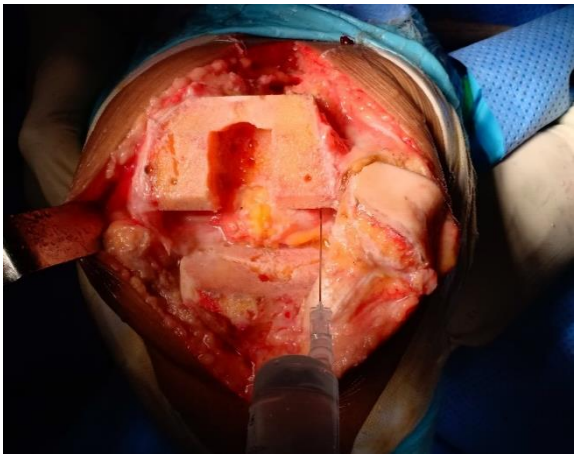

Fig 3: Posteromedial Capsule

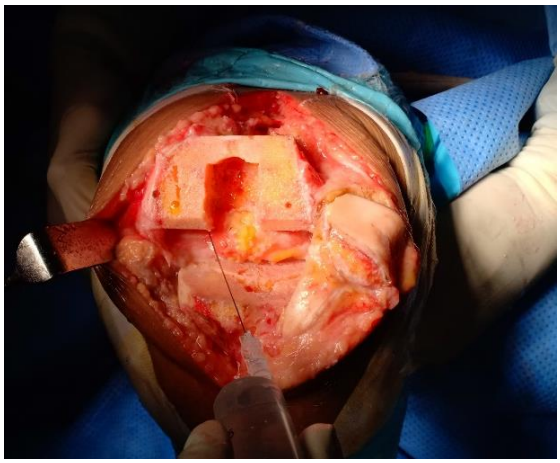

Fig 4: Posterolateral Capsule

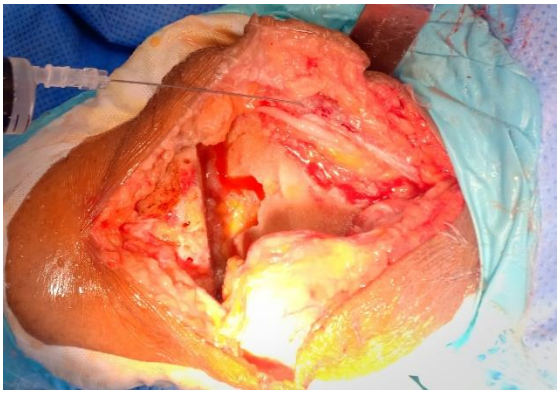

Fig 5: Medial and Lateral Retinaculum

Fig 6: Suprapatellar fat pad

Fig 7: Quadriceps tendon

All patients were put on post-operative analgesia in the form of Inj. Paracetamol 1g TID, and opioid analgesic Inj. Tramadol 50mg IV was used only if the pain was intolerable to the patients as rescue analgesia.

Passive knee mobilization was started once the spinal anaesthesia had weaned off and active mobilization was started the next morning following surgery. Static quadriceps, Active SLRT, Range of movements of the knee were recorded using a goniometer and weight bearing was advised as tolerated by the patients. Pain was measured using the VAS scale (0-10 with 0 being pain free and 10 being most excruciating severe pain). VAS score and ROM were documented pre-op and at 12hrs, 24hrs, 48hrs post-op.

Patient satisfaction with the procedure was assessed using likert 4 point scale with categories including very satisfied(4), somewhat satisfied (3), somewhat dissatisfied (2), and not satisfied (1) at the time of discharge and analgesic and opioid consumption of the patients were documented and the data was subjected to statistical analysis with p (<0.05) set as statistically significant.

3. Results

Demographic variables of the patients; mean age of the patients in the study was 60.83 years with 31 males (58.5%) and 22 females (41.5%) (Fig 8). Majority of the patients were between 51-60 years of age (45.3%) (Table 2).

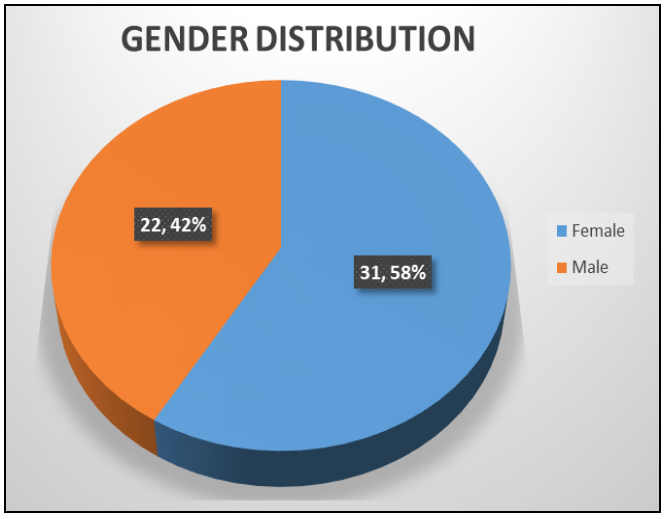

Fig 8: Gender Distribution

Table 2: Distribution of study subjects based on Age group

Age Group	Frequency	Percent
Less than 50 Years	5	9.4
51 to 60 Years	24	45.3
61 to 70 years	21	39.6
More than 70 Years	3	5.7

Majority of the patients suffered from chronic knee pain in the range of 6-10 years (32.1%) and less than 5 years (30.2%) (Table 3). The average duration for which patients were suffering from chronic knee pain was 8.17 years. 7 patients (13.2%) in the study were diabetics on regular treatment (Fig 9).

Table 3: Duration of Symptoms (Knee Pain)

		Frequency	Percent
Duration of Knee Pain	**Less than 5 yrs**	16	30.2
	6-10 Years	17	32.1
	11-15 Years	9	17.0
	More Than 15	11	20.8

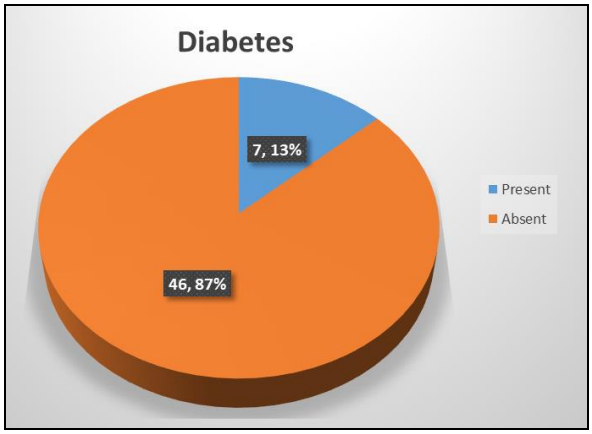

Fig 9: Diabetics in the Study

The visual analogue scale (VAS) showed an average score of 5, 3.5 and 2.79 at 12 hours, 24 hours and 48 hours post-op respectively; while the average Pre-op VAS pain score among the patients was 7.5 (Table 4).

Table 4: Visual Analogue Score at 12 hours, 24 hours and 48 hours Post-op.

		VAS at 12 hours		VAS at 24 hours		VAS at 48 hours	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
VAS Scale	2	0	0	1	1.9	20	37.7
	3	0	0	29	54.7	27	50.9
	4	16	30.2	19	35.8	4	7.5
	5	25	47.2	2	3.8	1	1.9
	6	9	17.0	2	3.8	1	1.9
	7	2	3.8	0	0	0	0
	8	1	1.9	0	0	0	0
	Mean VAS	5		3.5		2.79	

There was found to be no significant association between diabetes and VAS score among the patients in the study indicating that the cocktail was found to be effective in both diabetic and non-diabetic patients (Table 5) and also no significant association between gender and VAS score among patients (Table 6).

Table 5: Association between Diabetes and Visual Analogue Scale

VAS	Diabetes						P value
	Absent			Present			
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation	
12 hours	4	4	0	4	4	0	0.827
24 hours	3	3	0	3	3	0	0.653
48 hours	2	2	1	3	3	1	0.126

#Mann Whitney U test

Table 6: Association between Gender and Visual Analogue Scale

VAS	Gender						P value
	Female			Male			
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation	
12 hours	4	4	0	4	4	0	0.808
24 hours	3	3	0	3	3	0	0.685
48 hours	2	2	1	3	3	1	0.215

#Mann Whitney U test

On applying Wilcoxon Signed Rank test for comparison of the Visual Analogue Scale at 12, 24 and 48 hours post-op; it was found that VAS score between 12 hours and 24 hours post-op; 24 hours and 48 hours post-op and between at 12 hours and 48 hours post-op was found to be statistically Significant (Table 7). Overall from the study, it was found that pain of the patients gradually reduced from 12 hours to 48 hours post-op and the reduction in pain was found to be highly significant (p<0.001).

Table 7: Comparison of Mean, Median and Standard Deviation of VAS using Wilcoxon Signed Rank test

Wilcoxon Signed Rank test	Mean	Median	Standard Deviation
VAS 12 hours	5	4	0
VAS 24 hours	3.5	3	0
VAS 48 hours	2.79	2	1
12 hours vs 24 hours, p <0.001* 24 hours vs 48 hours, p <0.001* 12 hours vs 48 hours, p <0.001*			

All patients were encouraged to start physiotherapy the next morning after surgery, and all patients were able to do active SLRT with acceptable ROM by post-op day 1.

Rescue analgesia given in the form of tramadol infusion was used in 15 patients among whom 4 patients were given the infusion on day 1 and day 2; and 11 patients were given tramadol infusion only on day 1. Majority of the patients (71.7%) did not require rescue analgesics and were only given Inj. Paracetamol 1g TID. (Table 8)

Table 8: Rescue analgesia used by patients

Rescue analgesia	Tramadol infusion
Day 0	11
Day 1	11
Day 2	4
Total	15/53 (28.3%)

In the entire study, 3 (5.7%) of the patients were found to have complications which were superficial wound infections managed using higher antibiotics and regular dressings which did not affect final outcome.

Overall satisfaction of the procedure among the patients was which was assessed by likert scale showed that majority of the patients 37(69.8%) were fully satisfied with the procedure and 16(30.2%) were somewhat satisfied with the outcome of the procedure. None of the patients found the procedure to be somewhat dissatisfactory or non-satisfactory (Fig 10).

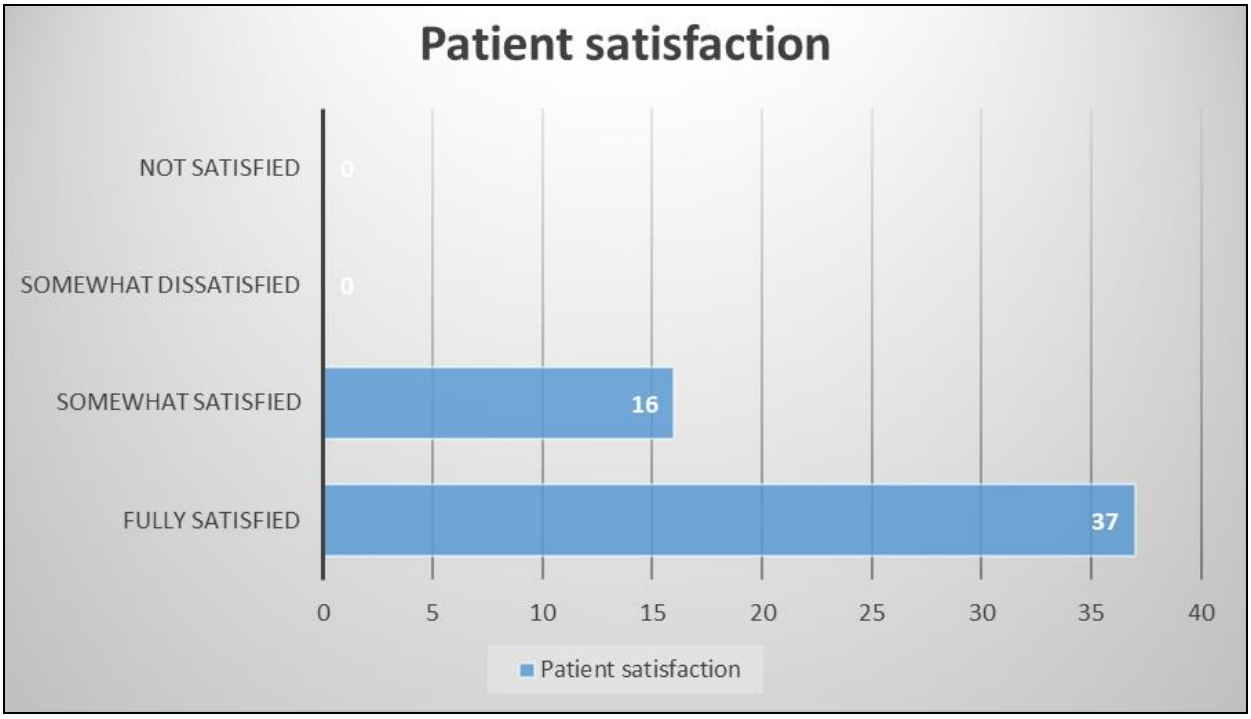

Fig 10: Patient Satisfaction

4. Discussion

The main goal of performing Total Knee Arthroplasty (TKA) in patients is to alleviate pain and increase the quality of life among patients by facilitating early mobilization. But after performing TKA it is found that due to inadequate post-operative pain management there is a delay in the mobilization time among patients and a high rate of dissatisfaction with the procedure [17]. Patients are also found to have increased stress and disturbed sleep following TKA thereby affecting their quality of life [5, 18, 19]. Therefore, an adequate and efficient post-operative analgesia protocol is the need of the hour and one of the most efficacious methods is found to be multimodal approach using Local Infiltration Analgesia (LIA) [14].

LIA has the upper hand over Epidural analgesia in terms of reduced opioid consumption and its associated systemic adverse effects which include nausea, vomiting, pruritis and orthostatic hypotension [20]. LIA also avoids the muscle weakness that is usually seen in peripheral nerve blocks such as Femoral nerve block. Therefore, by facilitating early mobilization, it reduces the risk of Deep Vein Thrombosis and pulmonary congestion among post-TKA patients.

The main advantages of LIA over other methods of analgesia are the easily targeted delivery of the cocktail to specific sites where nerve endings are located at one's own discretion [16]. The contents of the cocktail such as epinephrine are also found to increase the period of analgesia and reduce post-operative soakage by constricting the surrounding blood vessels. Morphine acts on opiate receptors and reduces transmission of pain signals and cefuroxime acts as an antibiotic cover reducing chances of post-op infection. Methylprednisolone acts by attenuating the neuroendocrine stress response, inhibiting pro inflammatory pathways and by counteracting vasodilatory effects of prostaglandins [21-23]. Usage of LIA is also found to reduce opioid utilization and its systemic adverse effects to patients by the long lasting effects of bupivacaine which is one of the components in the Ranawat Cocktail (ROC) regimen. All these beneficial effects of LIA cocktail ensures that the TKA patients have a reduced hospital stay thereby reducing their chances of nosocomial

infections due to signicant reduction in post-op pain and also early and adequate mobilization [24]. The use of LIA has also been linked with better patient satisfaction, decreased opioid consumption and reduced operative site complications [14, 22, 25].

The main disadvantages of LIA is usually seen due to the high doses of local anaesthetic used in the cocktail and is associated with cardiotoxicity and CNS toxicity in some elderly patients which may be lethal and are thus relative contraindications in such patients [26].

These results were similar and in agreement with other studies on LIA for post- TKA pain management conducted by others studies worldwide [12, 14, 27].

Hence, we recommend a multimodal approach for pain management in TKA patients with starts with good pre-op counselling and physiotherapy to acclimatize the patients to the procedure and understand expected outcomes following surgery. This should be followed intra-operatively with good surgical technique and correct size of implants to restore knee biomechanics along with administration of LIA. Acute pot-op, pain management should be adequate to facilitate early mobilization with proper physiotherapy protocols. Following discharge, patients should be asked to continue physiotherapy with the target of gradually increasing their walking distance using a walker on a daily basis [18].

The main limitations of this study include small sample size, short follow up period, and no control group to compare the outcome. Long term outcome of LIA could not be assessed and the effects of individual constituents of the cocktail and their benefits and complications need to be further analysed.

5. Conclusion

Local Infiltration Analgesia in the form of periarticular injection is a safe, simple and efficient method of reducing post-operative pain after total knee arthroplasty (TKA) which facilitates early rehabilitation among the patients and has an overall improvement in patient satisfaction with the procedure.

Conflict of Interest: None

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