

Periarticular Infiltration (Bupivacaine, Adrenaline, Magnesium Sulphate And Dexmedetomidine) For Postoperative Analgesia In Total Knee Arthroplasty- A Cases Series Study

Dr. Harsh Mehta*, Dr. Bansari Kantharia**

*Senior Resident, Department Of Anaesthesiology, Government Medical College, Bhavnagar, **Additional Professor, Department Of Anaesthesiology, Government Medical College, Surat

Abstract: Background: Total knee arthroplasty is a major surgery associated with severe pain and delayed rehabilitation. Good quality analgesia with minimum side effects is required for post-operative rehabilitation and influences overall outcome of patients. Material And Methods: All patients were given spinal anaesthesia. Intraoperatively, all patients received periarticular infiltration with solution of bupivacaine, adrenaline, dexmedetomidine and magnesium sulphate and normal saline. Post-operatively all patients received intravenous diclofenac sodium 75 mg 12 hourly. Postoperative pain using VAS score, sedation using Ramsay sedation score and hemodynamic parameters were observed. Result: The mean VAS score for pain was <2 during the first 48 hours and provided good analgesia to the patients. During the post-operative period hemodynamic parameters remained comparable to baseline and all patients were co-operative, oriented and tranquil. None of the patient developed any side effects. Conclusion: Local infiltration with bupivacaine, adrenaline, dexmedetomidine and magnesium sulphate can be used along with intravenous diclofenac sodium in patients undergoing total knee arthroplasty and is effective, safe and reliable multimodal pain regimen. [Mehta H Natl J Integr Res Med, 2022; 13(1): 123-128, Published on 26/01/2022]

Key Words: Total Knee Arthroplasty, Postoperative Analgesia, Local Infiltration, Dexmedetomidine, Magnesium Sulphate, Bupivacaine, Adrenaline

Author for correspondence: Dr. Harsh Mehta, Senior Resident, Department of Anaesthesiology, Government Medical College, Bhavnagar – 364001 E-Mail: harshmehta1307@gmail.com

Introduction: Adequate pain relief is very important for post-operative rehabilitation for total knee arthroplasty (TKA). Local infiltrative analgesia has recently gained attention for its minimal side effects and easy administration.

Infiltration with local anaesthetic agent decreases the requirement of intravenous analgesics for the patient. Addition of adjuvants along with the local anaesthetic agent increases its potency as well as duration of action. So far, steroids, opioids, ketoprofen, ketorolac, magnesium sulphate, etc. have been tried.

Infiltration with high potency long duration local anaesthetic agent like Bupivacaine in a diluted concentration provides good analgesia to patient. It acts by blocking the sodium-potassium pump which is responsible for generation of action potential¹. Addition of adrenaline causes local vasoconstriction thus decreasing the systemic absorption and increasing the duration of action of local anaesthetic agent¹. Adjuvant like dexmedetomidine (a central sympatholytic agent) helps in prolonging the action of local anaesthetic agent decreases the analgesic

consumption along with improving analgesia². Adding Magnesium Sulphate to drug mixture can increase the potency of this solution, decrease opioid consumption, provide analgesia and has anti-inflammatory action through NMDA receptors^{3,4}.

A steroid free infiltration solution needs to be looked upon which can be used safely in patients who are diabetic or more prone to develop local infection. Thus, we prepared a solution which does not contain steroids.

In this study, we decided to combine dexmedetomidine and magnesium sulphate with local anaesthetic agent bupivacaine and adrenaline for infiltration for enhanced postoperative analgesia in TKA thus avoiding steroids, opioids and other agents. We avoided parenteral opioids like morphine and preferred diclofenac sodium for additional intravenous analgesia as a part of multimodal pain protocol.

Material & Methods: After obtaining approval from the ethical committee of the institution and informed written consent of the patients, this

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material for any purpose, even commercially, provided the original work is properly cited and states its license.

prospective observational study was conducted at a tertiary care teaching hospital of south Gujarat from July 2018 to June 2019 in patients undergoing total knee arthroplasty. Post-operative analgesic effect of local infiltration done with combination of bupivacaine, adrenaline, dexmedetomidine and magnesium sulphate in and around the knee joint was studied in combination with intravenous diclofenac sodium given 12 hourly.

Inclusion Criteria: Patient belonging to American society of anaesthesiology physical status II and III. Age from 50 to 72 years of either sex. Patient undergoing unilateral knee arthroplasty under spinal anaesthesia. Patient giving informed consent.

Exclusion Criteria: Known allergy to any of the study drug. Any major hepatic disease, renal insufficiency, respiratory disease, cardiac failure, organ transplant, morbid obesity, neuropathic pain, history of stroke or major neurological deficit, sensory or motor disorder in operated limb. Any contraindication to spinal anaesthesia. Inability to walk independently. Inability to comprehend pain assessment.

All patients underwent a thorough preanesthesia checkup. A detailed history was elicited and thorough general and systemic examination was done and investigation like complete blood count, random blood sugar, serum creatinine level, baseline ECG and urine analysis were done.

Pre-operatively, on day of surgery, overnight fasting of patients was confirmed. An intravenous route was established and patients were preloaded with 10-15ml/kg of ringer lactate infusion. All patients were premedicated with 1 mg of intravenous midazolam 15 minutes prior to shifting the patients to operative room.

Antibiotic and tranexamic acid were given as per choice of surgeon. Baseline temperature, pulse, blood pressure, respiratory rate and oxygen saturation of patients were recorded. In the operation theatre, non-invasive blood pressure, pulseoximetry and ECG monitoring was done.

All patients were given spinal anaesthesia in either sitting or lateral position with a 23G or 25G quincke's spinal needle in L₃-L₄ intervertebral space with 3-4 ml of intrathecal heavy

bupivacaine (0.5%) under strict aseptic precautions. Intraoperatively, all patients received local periarticular infiltration of solution made up of 20 ml (0.5%) Bupivacaine, 0.3ml (1:1000) Adrenaline, 50 µg of Dexmedetomidine and 1 gm Magnesium Sulphate diluted upto 100 ml with Normal Saline.

30 ml of this was infiltrated in posterior capsule, medial and lateral collateral ligament before placing the component, 40 ml infiltrated in the remainder capsule, synovium, retinaculum, periosteum, iliotibial band, periarticular tissue (quadriceps tendon, patella tendon and peripatellar tissue), soft tissue surrounding knee joint after placing the component and 30 ml in the deeper subcutaneous tissue and fat pad before wound closure.

Postoperatively, all patients received injection diclofenac sodium 75 mg intravenously 12 hourly.

If patient complained of pain or VAS > 3 rescue analgesic was given with injection paracetamol 1gm intravenously (maximum 3 doses 8 hourly).

If pain still persisted and VAS > 3 additional rescue analgesia was given with injection tramadol 100 mg intravenously (maximum 3 doses 8 hourly) along with injection ondansetron 4 mg intravenously.

Post-operatively, pulse rate, systolic and diastolic blood pressure, respiratory rate, oxygen saturation, sedation and pain was monitored every hourly for first 2 hours then at 6th hour and thereafter 6 hourly upto 24 hours and then 12 hourly upto 48 hours. Ease of mobilization was assessed at 24 hours by assessing pain on sitting, standing and on walking for atleast 3 metres.

Method Of Assessment: Pain was assessed on a visual analog scale of 0-10 where 0 is no pain and 10 is worst pain. Sedation was assessed using Ramsay sedation score.

Parameters Studied: Post-operative pain on Visual analogue scale. Sedation as per Ramsay sedation score. Requirement of additional analgesia. Total additional analgesia required in 48 hours. All patients were observed for side effects like hypotension, hypertension, bradycardia, tachycardia, nausea and vomiting sedation and respiratory depression.

Statistical Analysis: The data collected was entered into a database Microsoft excel sheet. The results were expressed as mean \pm standard deviation. The statistical analysis was done using EPI 2000 software using the “two tailed student’s t test”. The difference was considered to be statistically significant when P value $<$ 0.05.

Results: A total of 27 patients were observed. The mean age for TKA in our study was 59.9 ± 6.7 years with 59.3% female and 40.7% male. Male: female ratio being 1:1.45. Mean VAS score during the post-operative period was less than 2 in the first 48 hours at various time intervals which suggested mild pain. Mean VAS scores increased at 24th hour on standing and walking to 3 which also suggested mild pain.

Out of 27 patient observed in this study, 19 (70%) patients were comfortable and did not require rescue analgesia for 48 hours post-operatively. 8 patients required rescue analgesia with injection acetaminophen 1gm intravenously, 1 at 2nd hour, 2 at 6th hour, 1 at 12th hour , 5 at 24th hour and 1 at 30th hour. Of these, 2 patients required rescue analgesia twice, once at 6th hour and again at 24th hour. None of the patients required additional tramadol supplementation during the post-operative period.

The highest VAS score was observed at 6th hour (1.85 ± 1.13). However, during the post-operative

period of 48 hours, the VAS score remained less than 2 which imply mild pain. Patients were also assessed for pain at 24th hour while sitting, standing and on walking. VAS score at sitting was 1.63 which increased to 2.78 on standing and 3.07 while walking. Though VAS score increased in standing and on walking, patients were able to mobilise with mild pain.

Maximum number of patients required rescue analgesia at 24th hour during standing or on walking which may be due to movement of knee joint. However, mean VAS score at 24th hour was 3 which signifies mild pain and shows that adequate mobilization can be achieved with this multimodal pain protocol for total knee arthroplasty.

During the post-operative period, pulse rate, systolic blood pressure, diastolic blood pressure, respiratory rate and oxygen saturation remain comparable to baseline and no statistical difference was observed.

None of the patients during the post-operative period were sedated and had Ramsay sedation score of 2 and were co-operative, oriented and tranquil.

None of the patients observed during the study period developed hypotension, hypertension, tachycardia, bradycardia, nausea, vomiting, respiratory depression or any other side effect.

Figure 1: Mean VAS Score At Rest

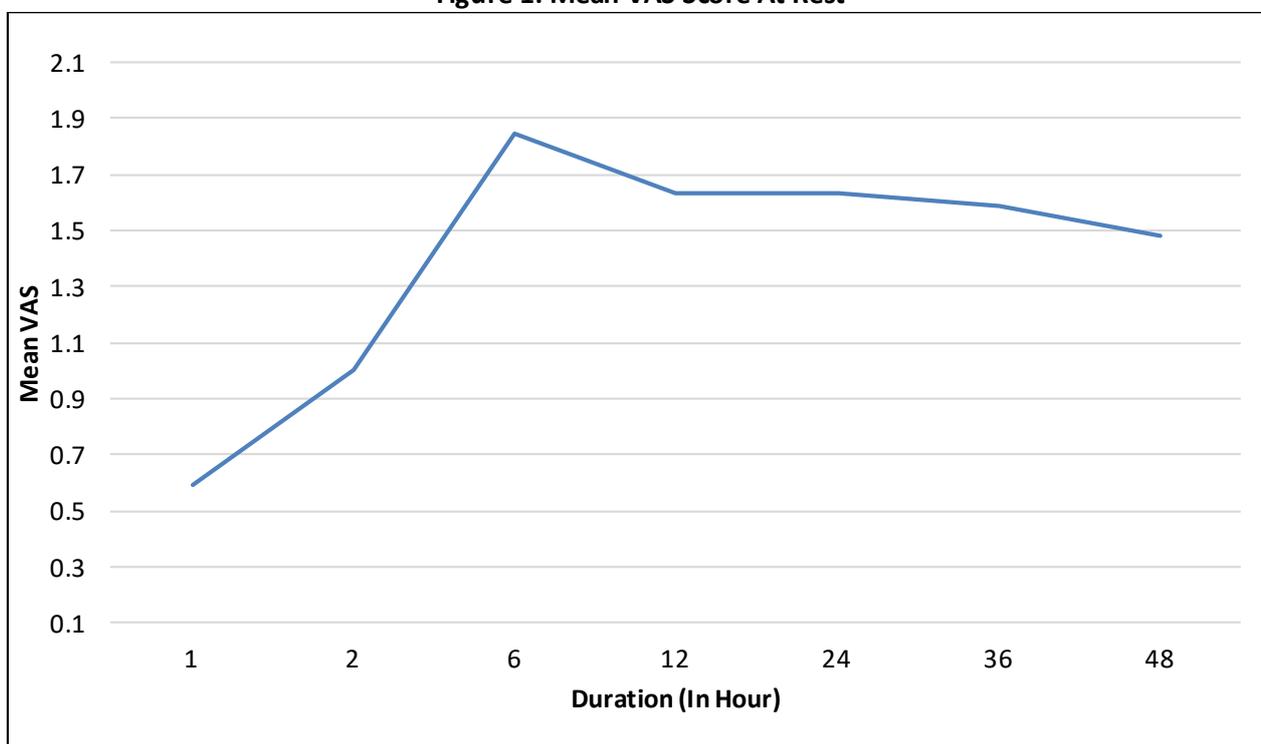


Figure 2: Rescue Analgesia Required In 48 Hours

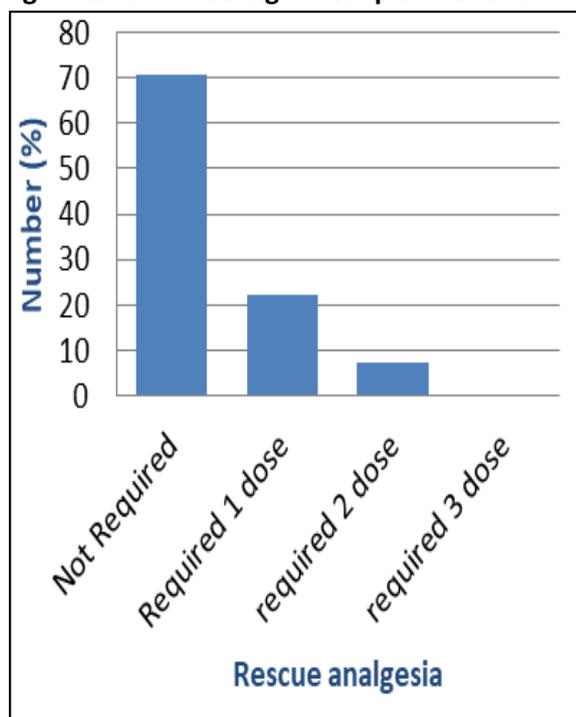
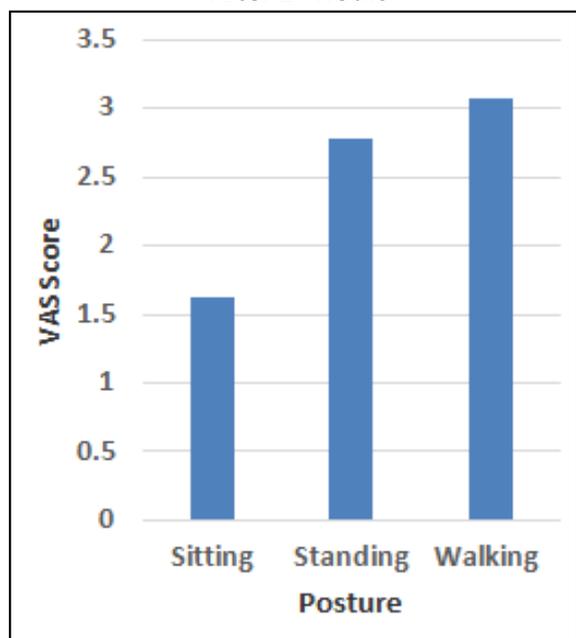


Figure 3: Mean VAS Score In Different Positions After 24 Hours



Discussion: Local infiltrative analgesia has been studied recently for providing effective post-operative analgesia and minimizing side effects by delivering a drug mixture having either local anaesthetic (diluted to increase volume) alone or with adjuvants to improve analgesia. This decreases narcotic consumption and increases the duration of analgesia by local anaesthetic agent. Ours is the first study using this combination of drugs to the best of our knowledge. However, there are a few studies where magnesium sulphate has been used for

knee infiltration with a different combination of drugs. A few authors have used dexmedetomidine for wound infiltration in other surgeries. We could not find any study where dexmedetomidine was used for knee infiltration⁴.

NMDA receptors play a major role in central nociceptive transmission modulation and sensitization of acute pain states. They are located centrally as well as peripherally in skin, muscles and knee joints. They play a role in sensory transmission of noxious signals. In inactive form, NMDA receptor is blocked by central magnesium ion.

Thus, magnesium can be considered as physiological blocker of NMDA receptors. Recently, magnesium has been demonstrated to reduce post-operative analgesic and/or opioid requirement³ and reduce post-operative pain scores and total dose of rescue analgesia⁵.

Addition of magnesium sulphate to local anaesthetic has shown to have beneficial effect in prolonging duration of analgesia⁵.

Analgesic effect of dexmedetomidine is due to α_2 receptor stimulation at the spinal cord level and at supraspinal sites. It also provides antinociception through non-spinal mechanism by activation of α_{2a} receptors and inhibition of conduction of nerve signals through C and A δ fibers. As an adjuvant, it has been proven that it reduces the post-operative analgesic requirement and prolongs the action of local anaesthetic agent.

Magnesium sulphate by blocking calcium channels has depressant effect on myocardium vascular smooth muscles which results in decreased cardiac output and hypotension. It also relaxes smooth muscles in respiratory tract by decreasing cytosolic calcium.

Dexmedetomidine acts on α_2 receptors in central nervous system and provides anxiolysis and tranquility. It also helps in maintaining cardiovascular stability in patients by decreasing the sympathetic flow. It does not cause respiratory depression in patients and provides conscious sedation.

Busch A et al (2006) found that patients infiltrated with ropivacaine, ketorolac and epinephrine had significantly lower VAS score for

pain during activity in postanesthesia care unit ($p=0.04$) than in patients who did not receive infiltration while all patients received PCA with morphine in total knee arthroplasty⁶.

Venditelli Pascal et al (2006) infiltrated 100 ml solution having ropivacaine, ketorolac and adrenaline along with oral celecoxib and acetaminophen with patient controlled anaesthesia pump with morphine as a multimodal analgesia protocol for total knee arthroplasty and observed that local analgesic group had significantly lower mean VAS for pain during exercise than control group on POD 1 as well as significantly lower score for pain at rest and during exercise for 1st 48 hours after surgery⁷.

Chen Y et al (2009) used solution with ropivacaine and magnesium sulphate for intra-operative intra-articular injection and PCA with morphine post operatively. They found that post-operative VAS score was significantly lower in infiltration group. Morphine consumption in infiltrated group was significantly less and found no side effects related to local administration of magnesium sulphate in total knee arthroplasty³.

Bondok R et al in (2006) injected solution having magnesium sulphate intra-articularly in arthroscopic knee surgery and observed significantly lower pain scores in patients who received intraarticular infiltration than control group for initial 8 hours. Also, time required for rescue analgesic with diclofenac was longer in infiltration group. Total diclofenac consumption was also lower in infiltration group than control group with no change in arterial pressure, heart rate and sedation⁸.

Mullaji Arun et al (2006) gave periarticular injection of bupivacaine, fentanyl, methylprednisolone, cefuroxime with normal saline in one knee and only normal saline in another knee in patients undergoing bilateral total knee arthroplasty. Post-operatively all patients received epidural infusion with bupivacaine and fentanyl along with intravenous tramadol 8 hourly and diclofenac suppository at night and found that pain scores were less on infiltrated side⁹.

Anderson L et al (2007) used ropivacaine and epinephrine for infiltration in one knee with oral celecoxib, acetaminophen, gabapentin and

patient controlled analgesia with intravenous morphine and observed that in bilateral total knee arthroplasty, pain scores were significantly lower in infiltrated knee at rest, on 45° knee flexion, straight leg test and 45° elevation. No major side effects were observed¹⁰.

Toftdahl Karen et al (2007) used infiltrative solution containing ropivacaine, ketorolac and adrenaline for intra-articular analgesia in one group and femoral nerve block in another group with analgesic regimen comprising of paracetamol, ibuprofen and oxycodone and reported that the patients in infiltration group had significantly lower pain scores during physiotherapy than patients in femoral nerve block group. Mobilisation also improved significantly in intraarticular infiltration group¹¹.

Tsakade Sachiyuki et al (2014) used ropivacaine, morphine, epinephrine, methylprednisolone and ketoprofen for infiltration in one group and epidural infusion in another group along with flurbiprofen and loxoprofen orally post operatively. They concluded that VAS at rest was significantly lower in periarticular infiltration group as compared to epidural supplement and did not observe any cardiac or central nervous system toxicity in any study patient¹².

Pazoki Shirin et al (2015) used magnesium sulphate for wound infiltration in cesarean section and observed that, mean VAS score was significantly lower than control group. The cumulative Diclofenac (rescue analgesic) requirement was much lower than control group without any side effects¹³.

Ahmed M Abd El Hamid (2016) used dexmedetomidine in wound infiltration with bupivacaine in cesarean section and observed that morphine consumption was less in patients receiving wound infiltration than the control group¹⁴.

Due to limited availability of patients, this study was conducted on a small group without a comparative control group. Hence, a study with a larger sample size is required.

Conclusion: We could provide adequate analgesia using a combination of bupivacaine, adrenaline, magnesium sulphate and dexmedetomidine for intra operative knee infiltration along with intravenous diclofenac

sodium in most of our patients undergoing total knee arthroplasty thus avoiding use of opioids or other regional analgesia techniques.

Only 30% of our patients demanded additional analgesic which was effectively provided with 1 gm paracetamol infusion.

Thus, we could avoid opioids and their side effects like respiratory depression and pruritus and could achieve other benefits of magnesium sulphate and dexmedetomidine like anxiolysis, tranquility, anti-emesis, and maintenance of hemodynamic stability. Thus, it is effective, safe and reliable multimodal pain regimen without any adverse events.

References:

1. Morgan & Mikhail's clinical anaesthesiology, 5th edition 2014: 246, 288, 263-276, 331, 1023-1086
2. Miller's anaesthesia, 8th edition 2015: 821-863, 1028-1057
3. Chen Y, Zhang Y, Zhu Y L, Fu P L. Efficacy and safety of an intra-operative intra-articular magnesium/ropivacaine injection for pain control following total knee arthroplasty. The journal of international medical research 2009;37:1733-1741
4. Donadi P, Moningi S, Gopinath R. Comparison of bupivacaine and bupivacaine plus magnesium sulphate infiltration for postoperative analgesia in patients undergoing lumbar laminectomy: a prospective randomized double-blinded controlled study. J Neuroanaesthesiol Crit Care 2014;1:183-7
5. Stoelting's pharmacology and physiology in anaesthetic practice, 5th edition 2015:194-195, 258-259, 278, 282-313, 476, 505
6. Busch A, Shore B, Bhandari Rakesh, Ganpathy Su, McDonald S, Bourne R et al. Efficacy of periarticular multimodal drug injection in total knee arthroplasty a randomized trial. The journal of bone & joint surgery 2006;volume 88-A(5):959-963
7. Vendittoli Pascal, Makinen Patrice, Drolet Pierre, Lavigne Martin, Fallaha Michel, Guertin Marie et al. A multimodal analgesia protocol for total knee arthroplasty. The journal of bone & joint surgery 2006 february; volume 88-A(2):282-289
8. Bondok R, Abd El-Hady A. Intra-articular magnesium is effective for postoperative analgesia in arthroscopic knee surgery. British

- journal of anaesthesia 2006; volume 97(3):389-392
9. Mullaji A, Kanna Raj, Shetty Gautam, Chavda Vipul, Singh D. Efficacy of periarticular injection of bupivacaine, fentanyl and methylprednisolone in total knee arthroplasty: a prospective, randomized trial. The journal of Arthroplasty 2010; volume 25(6). 851-857
10. Anderson L, Husted H, Otte K, Kristensen B, Kehlet H. High-volume infiltration analgesia in total knee arthroplasty: a randomized, double blind, placebo-controlled trial. Acta Anaesthesiol Scand 2008;52:1331-1335
11. Toftdahl K, Nikolajsen L, Haraldsted V, Madsen F, Tonnesen E, Soballe K. Comparison of peri- and intraarticular analgesia with femoral nerve block after total knee arthroplasty A randomized clinical trial. Acta Orthopaedica 2007; 78(2):172-179
12. Tsukada Sachi-yuki, Wakui Motohiro, Hoshino Akiho. Postoperative epidural analgesia compared with intraoperative periarticular injection for pain control following total knee arthroplasty under spinal anaesthesia a randomized controlled trial. The journal of bone & joint surgery 2014 september; volume 98-A(17):1433-1438
13. Pazoki S, Golestani Eraghi M, Jamilian M. Incisional injection of magnesium sulphate for post-cesarean section pain management, Arch Crit care Med. 2015;1(1):e524
14. Abd El-Hamid AM, Alrabiey MI, Abd El-Fattah MH. A comparison of the postoperative analgesic effects of intravenous dexmedetomidine with a combination of dexmedetomidine and bupivacaine wound infiltration for lower segment cesarean section: A prospective, randomized study. Ain-Shams J Anaesthesiol 2016;9:235-9

Conflict of interest: None
Funding: None
Cite this Article as: Mehta H, Kantharia B. Periarticular Infiltration (Bupivacaine, Adrenaline, Magnesium Sulphate And Dexmedetomidine) For Postoperative Analgesia In Total Knee Arthroplasty- A Cases Series Study. Natl J Integr Res Med 2022; Vol.13(1): 123-128