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Research paper

Periarticular regional analgesia in total knee arthroplasty – Efficacy and outcome of single posterior capsular vs multiple site injections

Manish Diwakar [a, *], Dirk Baumann [b]

[a] Consultant Joint Replacement Surgeon, Shankus Medicity Hospital, Mehsana, India
[b] Trinity Hospital Lippstadt gem. GmbH, Klosterstraße 31, 59555 Lippstadt, Germany

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ABSTRACT

Objective: Total knee arthroplasty (TKA) is a frequently performed elective orthopedic intervention for painful arthritic knee with the purpose to improve postoperative quality of life. However, TKA is followed by intense pain in postoperative period. Postoperative pain after total knee arthroplasty (TKA) is a well-known clinical problem and prevents patients from sleeping, ambulating and participation in physical therapy. The infiltration of a cocktail in knee joint is a simple procedure performed by surgeon in soft tissue before component implantation. However, the technique and site of periarticular infiltration is still evolving, recent studies suggest that the proper technique of periarticular injection includes drug administration at eight sites around the knee. The purpose of this study was to compare the efficacy and outcome of single posterior capsule vs multiple site infiltration.

Methods: This was a prospective randomized control study. A total of forty patients were randomly assigned into two groups of twenty each. Group A was given a single periarticular injection of a fixed cocktail just before implantation of components while group B was given same cocktail at eight pre-determined sites around knee. Post operatively pain status was assessed by means of visual analogue scale.

Results: Comparison of the pain scores of the two group were not statistically significant.

Conclusion: The results of the study indicates that periarticular infiltration is a safe and effective means of postoperative pain control and that single posterior capsular infiltration is as effective as multiple infiltration.

Introduction

Total knee arthroplasty (TKA) is a frequently performed elective orthopedic intervention for painful arthritic knee with the purpose to improve postoperative quality of life[1,2]. However, TKA is followed by intense pain in postoperative period. Postoperative pain after TKA is a well-known clinical problem and prevents patients from sleeping, ambulating and participation in physical therapy.Early mobilization post TKA can prevent knee stiffness, lessens hospital stay and improves overall patient satisfaction and outcome of TKA[3]. Besides, early knee mobilization is associated with decreased risk of deep vein thrombosis and good long-term functional outcomes[4,5]. Adequate pain relief following TKA may facilitate early mobilization and thus the overall outcomes.

Multi-modal analgesic regimes are used to relieve pain in patients who have undergone TKA. Conventional postoperative analgesia is provided by either intravenous patient-controlled analgesia (PCA) or epidural analgesia. Recently several studies reported an upsurge in peripheral nerve block (PNB) use for Orthopedic patients[6,7]. Moreover, analgesic efficacy and surgical outcomes of PNB are comparable to PCA or epidural analgesia without the associated side-effects[7,8]. However, one of the challenges of treating post-operative pain after TKA with regional anesthetic techniques is to provide sufficient analgesia with preserved muscle function and minimal side effects.

Femoral nerve block (FNB) is often considered as the gold standard for pain alleviation after TKA[6,9–13]. However, FNB reduces quadriceps muscle strength thereby potentially compromising postoperative mobilization[14–18]. Furthermore, the FNB is associated with higher risks of fall due to quadriceps weakness

* Corresponding author.
E-mail address: manish.diwakar@gmail.com (M. Diwakar).

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following block[19–21]. Therefore, alternative analgesic techniques for effective pain treatment with preserved muscle function need to be evaluated.

With the aim to spare quadriceps motor function providing analgesia, periarticular infiltration (PAI) of a high volume of local anesthetic during TKA is gaining interest. In the late 1990s, Kerr and Kohan used ropivacaine, ketorolac, and adrenaline as a local infiltration after TKA, and the results have been promising, although not fully scientifically evaluated. Various papers have described the use of periarticular injections of anesthetic concoctions to relieve pain. These drug cocktails commonly include combinations of nonsteroidal anti-inflammatory drugs (NSAIDs), local anaesthetics and opioids such as morphine.

The infiltration of local anesthetic in knee joint is a simple procedure performed by surgeon in soft tissue before component implantation. Previous study demonstrated a low impact of PAI on quadriceps function during TKA[22], although several PAI methods have been proposed with different results depending on type of the solutions used; a classical PAI solution included high volume of local anesthetic, opioids (theoretically with low adverse-effects than systemic administration), and epinephrine to prolong analgesia.

However, the technique and site of periarticular infiltration is still evolving, recent studies suggest that the proper technique of periarticular injection includes drug administration at eight sites around the knee[23] We are not aware of any study comparing the efficacy and outcome of technique of periarticular analgesia.The purpose of this study was to compare the efficacy and outcome of single posterior capsule vs multiple site infiltration.

Methods

Study design and subjects

This study was a prospective randomized control study. After obtaining institutional ethics committee approval, we assessed all 40 consecutive patients scheduled for unilateral primary TKA aged 50–80 years, from July 2017 to December 2017 for inclusion into the study. Written informed consent was obtained from all subjects prior to enrolment.

Eligibility criteria were.

Inclusion criteria:

- Primary, unilateral TKA under spinal anesthesia,
- American Society of Anesthesiologists physical status classification of I–III.

Exclusion criteria:

- Renal insufficiency,
- Contraindications to adductor canal block,
- History of arrhythmia or seizures,
- History of chronic pain unrelated to the knee,
- requiring treatment with long acting opioids,
- Alcohol or drug abuse,
- Allergy to either the components of the periarticular injection and
- Difficulties in comprehending visual analogue scale (VAS) pain scores.

40 patients were enrolled for the study and randomized into two groups (A-single or B-multiple injections), using computer generated randomization table. The patients and a clinical investigator who prospectively collected all clinical information were unaware of the group identities until the final data analysis. There were no significant differences in the demographic data, preoperative status and operative time among the two groups.

Anesthesia technique

Spinal anesthesia was induced with 3.0 ml 0.5% hyperbaric bupivacaine at the L3/4 interspaces (alternatively at the L2/3 or L4/5 interspaces).

Administration of adductor canal block(ACB)

In all patients, ACB was performed immediately postoperatively. All blocks were performed by the same senior anesthesiologist, with considerable experience in US-guided nerve blocks.All patients were given a single shot loading dose of 30 cc inj. Ropivacaine 0.75% followed by repeated boluses of inj. Ropivacaine 0.25%, 30 cc at an interval of 4 h till 8:00 am on the morning of the second day after surgery.

Surgical procedure and perioperative management

All surgeries were performed by the senior surgeon by the same approach and technique. Tourniquet was used in all of the patients, and the standard median parapatellar approach was used in all the cases. Posterior stabilised implants were used in all cases and patella was resurfaced in selected group of patients. After the bone cuts were taken and before cementing, 25 cc of single injection cocktail was delivered into the posteromedial capsule of the knee joint using a 21 gauge needle in group A and at eight standard sites (approx 2 cc cc each) in group B. The sites included.

1. Suprapatellar pouch and quadriceps tendon
2. Medial retinaculum
3. Patellar tendon and fat pad
4. Medial collateral ligament and medial meniscus capsular attachment
5. Posterior cruciate ligament tibial attachment
6. Anterior cruciate ligament femoral attachment
7. Lateral collateral ligament and lateral meniscus capsular attachment and,
8. Lateral retinaculum.

The cocktail contained a combination of ropivacaine (0.75%) 10 cc, cefuroxime 750 mg (5 cc), fentanyl (50mcg/ml) 2 cc and triamcinolone 40 mg (5 cc).

Patients were observed for side effects of Ropivacaine (i.e., perioral paraesthesia, visual disturbances, hearing problems, dizziness, uncontrolled muscle contraction, convulsion, hypertension, bradycardia, or headache every fifteen minutes in the recovery room, and every four hours for 48 h postoperatively.Side effects of narcotics were also noted in the chart (i.e.,nausea, vomiting, confusion, constipation, urinary retention, dizziness, sedation, respiratory depression or pruritus).

Below knee TED stockings for both lower limbs were utilized. Aspirin 75 mg OD for 6 weeks was used as a chemical prophylaxis for DVT. Perioperative intravenous antibiotics were given to all patients on first postoperative day. Additional analgesics consisted of oral acetaminophen 500 mg administered at 6 h intervals starting 6 h postoperatively. Ondansetron 4 mg i.v. was administered in case of moderate to severe nausea or vomiting, if needed. The adductor canal catheter was removed at 8:00 am on postoperative day (POD) 2 and site was inspected daily for signs of localized infection.

Patient's criteria for discharge were VAS $\leq$2, no signs of symptoms of surgical wound infection and adequate mobility around

with or without aids.

Outcome assessment

At the time of admission, patients were explained about the Visual Analogue pain scale and oxford knee scores. Patients were assessed for pain at 6, 12 and 24 h postoperatively at rest, pain after mobilization on POD1 and POD2. Secondary measures included Oxford Knee Score and length of stay. Oxford Knee Scores were calculated preoperatively and 6 weeks postoperatively.

Pain was evaluated on a VAS with 0 = no pain, and 10 = worst imaginable pain(Table 1).

Statistical analysis

Statistical analyses were performed using SPSS® for Windows® (version 20.0, IBM, Chicago, IL, USA). A P value of less than 0.05 was considered statistically significant, for all comparisons.

Results

Demographics

There was no significant difference in the demographic profile of the two groups (Table 2). The mean average age of patients included in the study was 67.4 years. Female preponderance was seen with a total of twenty three female patients (57.5%).

Pain scores

The pain scores were observed to be high in the immediate post operative period and then declined gradually over next forty eight hours. Same trend was observed in both the groups.The difference in pain scores in both the groups were not significant (Table 3).

Length of stay

The average length of stay in both the groups was more than three days (Table 4).

Oxford scores

At six weeks follow up both the groups reported almost identical increase in oxford scores (Table 5).

Discussion

Total knee arthroplasty can be associated with severe, early post-operative pain. Thus, optimal analgesia after surgery is prerequisite to facilitate early rehabilitation and mobilization, enhance functional recovery and to minimize post-operative morbidity.

Femoral nerve blocks are commonly used to decrease preoperative pain from total knee arthroplasty, despite the 1–2.5% incidence of femoral motor blockade with quadriceps weakness, nerve damage, and infection[24–28]. Furthermore, 15% of femoral nerve blocks are unsuccessful[29] and do not provide any analgesia to the posterior portion of the knee supplied by the sciatic nerve.

Introducing an analgesic into the site of surgical trauma modifies the nervous system in 2 ways: (1) peripheral sensitization occurs by reducing the threshold for afferent nociceptive neurons, and (2) central sensitization occurs by increasing the excitability of spinal neurons.

LIA allows for pain control at the source, maximizes muscle control, facilitates rehabilitation, and prevents venous stasis.We injected a combination of ropivacaine, fentanyl, triamcinolone and cefuroxime. Ropivacaine has a pharmacokinetic profile similar to bupivacaine with a longer half-life and lower cardiac and systemic toxicity; patients can therefore tolerate a higher dose.The techniques for LIA and in particular the target tissues vary in the literature. It is still unclear which tissues are responsible for generating pain in the setting of total knee arthroplasty. Periarticular infiltration techniques target the joint capsule, deep tissues surrounding the collateral ligaments, and the subcutaneous tissues and wound edges[30].

Anderson et al[31] found that ropivacaine infiltrated into the subcutaneous tissues intraoperatively was a key component in postoperative pain control. It has been observed in the literature[31–35] that periarticular infiltration is effective in reducing opioid consumption postoperatively. This would suggest that the tissues responsible for generating pain in the setting of total knee arthroplasty may be better targeted by a periarticular technique. The authors of a systematic review of the literature in 2012[36] advocated delivery by systematic infiltration of all exposed tissues, including the posterior capsule.

Intraoperative cocktail injection of analgesia facilitates direct visualization and precise placement of the needle into the

Table 1
Visual analogue scale.

1	Mild pain that you are aware of but not bothered by
2	Moderate pain that you can tolerate without medication
3	Moderate pain that is discomforting and requires medication
4–5	More severe and you began to feel anti social
6	severe pain
7–9	Intensely severe pain
10	Most severe pain, you might contemplate suicide over it

Table 2
Demographic variables between the study group.

	Group A	Group B	Total
No. of patients (n)	20	20	40
Gender (M/F)	9/11	8/12	17/23
Avg. age (years)	68.6	66.2	67.4
Body mass index	26.3	25.7	26

Table 3
VAS pain scores.

	Group A	Group B	P value
Preoperative	3.00	3.53	.10
6 h	5.51	5.00	.21
12 h	4.42	5.32	.11
24 h	3.56	3.30	.32
48 h	3.37	3.24	.09

Table 4
Length of stay.

	Group A	Group B	P value
Avg. LOS(days)	3.30	3.44	.21

Table 5
Oxford knee scores and ROM.

	Group A	Group B	P value
Oxford (pre)	22.9	24.2	.16
Oxford (6 weeks post)	40.9	41.3	.22

traumatized tissues and nerve endings. The local concentration of the cocktail agents within the soft tissue improved and prolonged the analgesic blockade and decreased the seepage from the wound.Also injection of the cocktail into different sites compared to a single site was equally effective in pain control.

Conclusion

The results of the current study successfully demonstrate that intraoperative cocktail injection safely provides excellent post-operative pain control and can be substituted for conventional pain control alternatives and also that single posterior capsule injection is as effective as multiple site injections.

Limitations

Several limitations of the study should be noted. First, regarding the study patient population, 57.5% (23/40) of our patients were females. Furthermore, our patients tended to be elderly (mean age >66 years old). Moreover, because factors, such as, age, gender, and ethnicity probably influence pain perception, these cohort-related characteristics should be considered before foreseeing our findings to patient populations in different part of the world.

Small sample size and short follow-up period limit the generalization of the findings. Owing to low risk rate we have used spinal anesthesia for TKR; authors speculated that it could mask the pain score in postoperative period.

Conflicts of interests

None.

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