THE EFFICACY OF LOCAL INFILTRATIVE ANALGESIA IN TOTAL KNEEARTHROPLASTY REGARDING PAIN AND MOVEMENT IN EARLY POSTOPERATIVE PERIOD

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ABSTRACT

Background: Total knee arthroplasty is a successful procedure for relieving pain and restoring function in cases with severe rheumatoid arthritis and osteoarthritis. Local infiltration analgesia is becoming more commonly used owing to the excellent pain relief, the low frequency of complications, and the anti-inflammatory effect.

Aim of study: To evaluate the efficacy of local infiltrative analgesia when it’s use in total knee arthroplasty patients for decrease the pain score and increase range of motion in early post-operative rehabilitation.

Methods: During the period from October 2016 to September 2018, a comparative prospective study was applied for 36 patients in Medical City, Hospital of Specialized Surgeries and Private Nursing Home Hospital. All patients were indicated for primary total knee arthroplasty which is done by the same surgical team and then followed-up to November 2018. They were divided into two groups, Group A included 16 patients managed with local infiltrative analgesia, while group B included 20 patients managed without local infiltrative analgesia. Patients with a history of deep venous thrombosis or pulmonary embolism or on long-term warfarin therapy, undergoing revision procedure, with a history of allergy or intolerance to 1 of the study drugs, with rheumatoid arthritis, and abnormal liver enzymes were excluded from this study. Assessment of clinical function was based on the range of motion score, straight leg raise pre and postoperatively, and VAS score scale postoperatively during rest and during movement.

Results: In group A, means of ROM score one day and two days postoperatively were decreased than that before operation (105.12 versus 89.37, P= 0.001 and 105.12 versus 87.37, P= 0.001 respectively). In group B, means of this score one day and two days postoperatively were decreased than that before operation (105.75 versus 88.50, P=0.001 and 105.75 versus 82.75, P= 0.001 respectively). During rest, means of VAS score four hours, 12 hours, one day, and two days after operation were significantly decreased in patients managed with LIA (group A) compared to means of patients in group B.(2.70 versus 1.87, P= 0.016; 3.45 versus 2.25, P=0.003; 3.90 versus 3.12, P=0.026; and 4.50 versus 3.50, P=0.002 respectively). During movement, statistically insignificant differences in means of VAS score between study groups four hours, 12 hours, and two days after operation (P= 0.258, 0.057, and 0.284 respectively). While mean of this score one day postoperatively was decreased in patients of group A compared to that inpatients of group B and this difference in means was statistically significant (P=0.016).

Conclusion: Local infiltration analgesia effectively reduces pain scores during rest and movement also reduces hospital stay in patients undergoing total knee arthroplasty, and better physiotherapy outcome.

Keyword: Total knee arthroplasty, ROM score, VAS score, local infiltration analgesia
I. INTRODUCTION

The knee joint is the largest and one of the most complex joints in the human body. A unique interaction of bones, muscles, menisci, and ligaments results in a compromise between stability and mobility\(^{(1)}\).

Basically, it consists of two condylar joints between the medial and lateral condyles of the femur and the corresponding condyles of the tibia, and a gliding joint, between the patella and the patellar surface of the femur. Above are the rounded condyles of the femur; below are the condyles of the tibia and their cartilaginous menisci; in front is the articulation between the lower end of the femur and the patella. The articular surfaces of the femur, tibia, and patella are covered with hyaline cartilage\(^{(2)}\).

The neural innervation of the knee joint is complex which innervated by the articular branches of the muscles which move the joint. The articular nerves are derived from the femoral, obturator, tibial, common peroneal, and recurrent peroneal nerves. The femoral nerve, through its saphenous branch and also via its branches to the vastus medialis, intermedius, and lateralis muscles, supplies the suprapatellar recess, the patellar periosseum, and the anteromedial and anterolateral portions of the joint capsule. The medial, lateral, and posterior aspects of the joint capsule, the infrapatellar fat pad, tibial periosseum, and the superior tibio-fibular joint are supplied by the tibial nerve. The common peroneal nerve supplies the anterolateral portion of the capsule, the infrapatellar fat pad, and the tibial periosseum. The obturator nerve supplies the superior part of the posteromedial capsule and the anteromedial aspect of the capsule. Cutaneous innervation of the anterior aspect of the knee is supplied by the femoral nerve\(^{(3)}\).

Total knee arthroplasty (TKA) is the surgical treatment of choice for advanced osteoarthritis after failure of other modes of conservative management in properly selected patients.

Postoperative Total knee arthroplasty (TKA) analgesia remains a challenging issue. It is reported that more than half of the patients undergoing knee replacement would experience severe pain in the early postoperative period. Considerable postoperative pain interferes with patients’ participation in physiotherapy, prolongs inpatient stay, lowers patient satisfaction, and leads to chronic pain and dysfunction. Thus, effective pain control in the immediate postoperative period is crucial for patients’ convalescence after TKA\(^{(4)}\).

Local infiltration analgesia (LIA) is becoming more commonly used owing to the excellent pain relief, the low frequency of complications, and the anti-inflammatory effect\(^{(5)}\).

The pain VAS is a one-dimensional measure of pain intensity, which has been widely used in diverse adult populations, including those with musculoskeletal diseases\(^{(6)}\). The scale consists of one horizontal or vertical line, usually 10 centimeters in length, which is anchored with verbal descriptors of “no pain” and “pain as shown in (Figure 1). The VAS is also available as a plastic slide ruler and on colored cards that can be given to the respondent\(^{(7)}\). The following cut points on the pain VAS have been recommended: no pain (0–4 mm), mild pain (5–44 mm), moderate pain (45–74 mm), and severe pain (75–100 mm). The VAS takes one minute to complete\(^{(6)}\).

II. PATIENTS AND METHODS

During the period from October 2016 to September 2018, comparative prospective study was applied for (36) patient in Medical City/ Hospital of Specialized Surgeries and Private Nursing Home Hospital do Total knee arthroplasty done by the same surgical team and then followed-up to November 2018, (11) of them were males and (25) were females (mean age, 64, 13 years). The objective is to evaluate the local infiltrative analgesia efficacy, patients of our study divided in to two groups, the interventional group (group A) and control group (group B), the first 32 patients were divided randomly into two groups, each patient assigned with a number, then

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patients with odd numbers were assigned as group A (16 patients) and patients with even numbers were assigned as group B and the last 4 patients were assigned as group B (20), informed consent was obtained from each patient involved in this study. Pre-operative preparation involved:

1. Detailed history including (age, gender, chief complaint, chronic diseases, back pain or hip pain, physiotherapy course, steroid injection, pain killer use, and history of drug allergy specially those used in our study).

2. Physical examination included examination of the hips, spine, and detailed knee examination (varus and valgus stress test, range of motion, and fixed flexion deformity).

3. Full laboratory investigations like complete blood count, Blood sugar, blood urea, serum creatinine, viral screen and general urine examination; other investigations are trailered to the specific condition.

4. Radiology: each patient should have the following knee x-ray views;

A. Full lower limb length x-ray with knee measures including (figure 2):

   i. Intramedullary angle: it is the angle between the anatomical axis and the mechanical axis of the femur.

   ii. Lateral distal femoral angle: it is the angle between the mechanical axis and the line drawn between the far distal ends of the condyles.

   iii. Medial proximal tibial angle: it is the angle between the mechanical axis of the tibia and a line drawn between the medial and lateral tibial platues, this angle is useful in detecting the tibial depression.

**Operative technique involved:** surgery was done under general anesthesia or spinal anesthesia according to the senior anesthetist opinion and patient condition and comorbidities. Intra-operative mid-thigh pneumatic tourniquet used with pressure setting (300-350 mm Hg) and assistive leg holder had been used for all the patients. Intravenous antibiotics infused half an hour before induction of anesthesia and continued for further two days, Then 1gm of tranxamic acid given i.v before starting the procedure.

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Figure 2: full lower limb length x-ray    Figure 3: lateral view in standing position
Anti-Thrombotic given 12 hours after surgery and continued for further 21 days in the form of subcutaneous low molecular weight heparin 4000 International units. The same surgical team performed the whole surgeries that eliminate technical differences and selection bias. In this study same implant design for all patients which were posterior- cruciate substitution. In this study the approach was for all patients, a Midline skin incision in slight knee flexion extended proximally about (3 cm) above the upper pole of patella and down to tibial tuberosity and then the arthrotomy done through medial Para patellar approach.

We used the femur first technique so we start femur first by setting the IM (intramedullary) angle according to the x-ray measurement and cutting 9 mm from the more distal condyle then start sizing and chamfering the distal femur. At this stage, do not cut the notch and then shift to finish the tibia bone cut. We used intramedullary guide for tibia cut.

The entry point near the base of the anterior tibial spine (anterior 1/3 of the tibial articular surface), reaming the entry hole, before resection confirm the amount of resection by using of stylus (2 mm) from the affected side and insure proper rotational alignment of the component After cutting the tibia 7-degree posterior slope and perpendicular to the mechanical axis, we used tibial tuberosity as marker to obtain proper rotational alignment of tibial component (medial 1/3).

After finishing the extension gap, we start to cut the flexion gap. Used posterior referencing in sizing of femur implant. To obtain rotational alignment of the femoral component we chose 3° external rotations. Then start anterior-posterior cut and then chamfering the distal femur. Then started soft tissue balancing, before started to any softtissue release, removed the osteophyte then carefully examine the flexion gap andextension gap by using spacer block and laminar spreaders, if obtain target (rectangular flexion and extension gap), so continued the procedure. In the LIA group a mixture of 150 mg (5 mg/ml) of Bupivacaine and 30 mg (1 ml) of Ketorolac and 0.5 mg epinephrine (0.5 ml), these were mixed with sterile normal saline solution to make up a combined volume of 150 mL in the operating room. Fifty ml of this solution where injected in the subcutaneous tissue in the line of skin incision prior to start the surgery (figure 5) together with infiltration of arthrotomy site before doing the arthrotomy (figure 6), another fifty ml of the solution was injected in flexed position (figure 7) into the posterior part of the capsule, the intercondylar area, and around the collateral in ligaments just before cementing the implants (figure 8) by using 50 ml 23- G needle, Special care was taken to avoid infiltration of the common peroneal nerve and popliteal fossa to avoid injury to vessels and sciatic nerve. The remainder was injected throughout the various soft tissue layers prior to wound closure (figure 9), in this way; all tissues that were traumatized received the analgesic solution.
Then intra articular (deep) drain was placed in the lateral gutter of the knee joint, another (superficial) drain was placed in the subcutaneous tissue. The wound was then closed in layers and adhesive dressings applied,
Compression bandages were then applied finally. Postoperatively, regular 1 gm of paracetamol was given three times daily to both groups together with celecoxib 200 mg orally was given twice daily unless contraindicated. First assessment of pain score was four hours after surgery, then 12 hours after surgery, then once daily until the discharge. The assessment of pain according the VAS score was done during the rest and movement. The range of motion measured once daily until discharge and the last measure done six weeks after the surgery by advise the patient to sit on the edge of the bed, the straight leg raising test done at time of discharge, the straight leg raising test was successful if the participant could hold the lower limb 10 cm from the bed with fully extended knee for 10 seconds. The time to fulfillment of discharge criteria was recorded by a physician who was unaware of the group randomization. The discharge criteria were: mild pain (VAS < 3 at rest) sufficiently controlled by oral analgesics, ability to walk with elbow crutches, ability to eat and drink, and no evidence of any surgical complications. Both groups of patients are involved in same rehabilitation protocol; involving range of motion exercise by using continuous passive motion machine in day one postoperative, then the patient can sit in the bed, get out of bed, and start to walk for many steps by using standard walker, then continue the rehabilitation program.

Statistical analysis

The data analyzed using Statistical Package for Social Sciences (SPSS) version 25. Categorical data presented by frequencies and percentages. Independent t-test (two-tailed) was used to compare the continuous variables among study groups accordingly. Paired t-test was used to compare means of ROM scores pre and postoperatively. Pearson’s Chi–square test was used to assess statistical association between study group and straight leg raise test. A level of P – value less than 0.05 was considered significant.

III. RESULTS

The total number of patients in this study was 36. Total knee arthroplasty was done for all of them. They were divided into two groups. Group A included 16 patients managed with local infiltrative analgesia (LIA), while group B included 20 patients managed without LIA.

General characteristics

The distribution of study patients and comparison between study groups by general characteristics is shown in figures (10, 11, and 12) and table (1). The age of patients was ranging from 46 to 78 years with a mean of 64.13 and standard deviation of ± 8.06 years. In both groups (A and B) the highest proportions of patients were aged ≥ 60 years (56.2% in group A and 85% in group B). Concerning gender, the highest proportion of patients in both groups was female (68.7% and 65% respectively). Regarding BMI level, 65.3% of patients in group A and 70% in group B were overweighted.

There was no statistically significant difference (P ≥ 0.05) between means of study groups regarding age (P= 0.341), and BMI level (P=0.150).
Figure 1: Distribution of study patients by gender

Figure 2: Distribution of study patients according to BMI level

| Variable          | Group A Mean ± SD | Group B Mean ± SD | P - Value |
|-------------------|-------------------|-------------------|-----------|
| Age (Years)       | 62.68 ± 10.07     | 65.3 ± 6.04       | 0.341     |
| BMI (kg/m²)       | 28.76 ± 2.33      | 27.65 ± 2.17      | 0.15      |

Table 1: Comparison in mean of participant’s demographic data between study groups

**Stay in Hospital**

The distribution of study patients and comparison between study groups according to the duration of staying in hospital is shown in figure (13) and table (2). 60% of patients were hospitalized for four days. In this study, there was statistically insignificant difference (P ≥ 0.907) between mean of study groups regarding hospitalized duration.

Table 2: Comparison in means of study groups by hospitalized duration

| Variable       | Group A Mean ± SD | Group B Mean ± SD | P - Value |
|----------------|-------------------|-------------------|-----------|
| Stay in Hospital | 3.87 ± 0.61       | 3.90 ± 0.64       | 0.907     |

**Group A**

The comparison in means of ROM score among patients of (group A) is shown in table (3). We found that means of this score one day and two days postoperatively were significantly decreased than that before operation (105.12 versus 89.37, P= 0.001 and 105.12 versus 87.37, P= 0.001 respectively). Statistically insignificant difference was seen between mean of this score preoperatively and after six weeks of operation (P= 0.127).

Table 3: Comparison in means of ROM preoperatively with one day, two days, and six weeks postoperatively by group A
Table 4: Comparison in means of ROM preoperatively with one day, two days, and six weeks postoperatively by group B

| Variable               | ROM Score Mean ± Std. Dev | P-Value |
|------------------------|---------------------------|---------|
| Preoperatively         | 105.75 ± 10.03            | 0.001   |
| One Day Postoperatively| 88.50 ± 7.27              |         |
| Two Days Postoperatively| 82.75 ± 8.18             | 0.001   |
| Six Weeks Postoperatively| 105 ± 5.61               | 0.107   |

As shown in table (5), statistically insignificant differences were seen in means of ROM score between study groups preoperatively, one day, two days, and six weeks after operation (P= 0.141, 0.329, 0.80 respectively). While statistically significant difference was seen in means of this score on discharge from hospital (P=0.001).

Table 5: Comparison in means of ROM score preoperatively, one day, two days, after discharge, and six weeks postoperatively between study groups Association between LIA and straight leg raise after operation
Table (6) shows the association between LIA injection and ability to performing straight leg raises after knee arthroplasty. It was clear that there was no statistically significant association between administration of LIA and ability for raising leg straightly after operation ($P > 0.069$).

Table 6. Association between LIA and straight leg raises following knee arthroplasty

| Variable            | Study Groups | Total (%$\times$36) | P- value |
|---------------------|--------------|---------------------|----------|
|                     | Group A (%)  | Group B (%)         |          |
|                     | n= 16        | n= 20               |          |
| Straight leg raise  | Yes          | 12 (57.9)           | 9 (42.1) | 21 (58.3) | 0.069 |
|                     | No           | 4 (26.7)            | 11 (73.3)| 15 (41.7) |          |

Distribution of study groups by VAS score results

The distribution of VAS score scale among study patients is shown in table (7). During rest, we found that after four hours and 12 hours of operation, the highest proportion of patients in both groups were complaining from mild pain (93.8% in group A, and 80% in group B after four hours of operation) and (87.5% in group A, and 60% in group B after 12 hours of operation). After one day of operation, mild pain was reported by 62.5% of patients in group A, while three quarters of patients in group B complained from moderate pain. The highest proportion of patients in group A and group B complained from moderate pain two days postoperatively (56.2% and 95% respectively).

During movement, it was clear that, after four hours of operation the highest prevalent score that reported by study patients in both groups was mild pain (75% of patients in group A and 65% of patients in group B). Concerning the scoring 12 hours postoperatively, we noticed that highest proportion of patients in group A were complained from mild pain (62.5), while 70% of patients in group B suffered from moderate pain.

Regarding VAS score one day after total knee arthroplasty, we found that 56.2% of patients in group A and 95% of those in other group were complained from moderate pain after this time of operation. As in scoring of one day postoperatively, the highest proportion of patients in both groups was suffered from moderate pain two days postoperatively (75% and 95% respectively).

Table 7: Distribution of study groups according to VAS score results during rest and movement

| VAS Score                  | Group A (%) | Group B (%) | Total (%)$\times$36 |
|----------------------------|-------------|-------------|---------------------|
| Variable                   | n= 16       | n= 20       |                     |
| During Rest                |             |             |                     |
| Four Hours Postoperatively |             |             |                     |
| Mild                       | 15 (93.8)   | 16 (80.0)   | 31 (86.1)           |
| Moderate                   | 1 (6.2)     | 4 (20.0)    | 5 (13.9)            |
| 12 Hours Postoperatively   |             |             |                     |
| Mild                       | 14 (87.5)   | 12 (60.0)   | 26 (72.2)           |
| Moderate                   | 2 (12.5)    | 8 (40.0)    | 10 (27.8)           |
| One Day Postoperatively    |             |             |                     |
| Mild                       | 10 (62.5)   | 5 (25.0)    | 15 (41.7)           |
| Moderate                   | 6 (37.5)    | 15 (75.0)   | 21 (58.3)           |
| Two Days Postoperatively   |             |             |                     |
| Mild                       | 7 (43.8)    | 1 (5.0)     | 8 (22.2)            |
| Moderate                   | 9 (56.2)    | 19 (95.0)   | 28 (77.8)           |
| During Movement            |             |             |                     |
| Four Hours Postoperatively |             |             |                     |
Comparison in means of VAS score between study groups four hours, 12 hours, one day, and two days, following total knee arthroplasty. During rest, we found that means of this score four hours, 12 hours, one day, and two days after operation were significantly decreased in patients managed with LIA (group A) compared to means of patients in group B. (2.70 versus 1.87, \( P = 0.016 \); 3.45 versus 2.25, \( P = 0.003 \); 3.90 versus 3.12, \( P = 0.026 \); and 4.50 versus 3.50, \( P = 0.002 \) respectively). During movement, statistically insignificant differences in means of VAS score between study groups four hours, 12 hours, and two days after operation (\( P = 0.258, 0.057, \) and 0.284 Respectively). While mean of this score one day postoperatively was decreased in patients of group A compared to that in patients of group B and this difference in means was statistically significant (\( P = 0.016 \)).

Table 8: Comparison in means of VAS score between study groups four hours, 12 hours, one day, and two days, after operation

| Variable                  | VAS Score                      | Variable |
|---------------------------|--------------------------------|----------|
|                           | Group A Mean ± SD   | Group B Mean ± SD   |   |
| **During Rest**           |                               |                       |   |
| 4 Hours Postoperatively   | 1.87 ± 0.95           | 2.70 ± 0.97           | 0.016   |
| 12 Hours Postoperatively  | 2.25 ± 1.23           | 3.45 ± 1.05           | 0.003   |
| One Day Postoperatively   | 3.12 ± 1.2            | 3.90 ± 0.78           | 0.026   |
| Two Days Postoperatively  | 3.5 ± 1.09            | 4.50 ± 0.68           | 0.002   |
| **During Movement**       |                               |                       |   |
| 4 Hours Postoperatively   | 2.75 ± 1.48           | 3.20 ± 0.83           | 0.258   |
| 12 Hours Postoperatively  | 3.31 ± 1.30           | 4.05 ± 0.94           | 0.057   |
| One Day Postoperatively   | 3.81 ± 1.16           | 4.65 ± 0.81           | 0.016   |
| Two Days Postoperatively  | 4.65 ± 1.20           | 4.95 ± 0.75           | 0.284   |

**IV. DISCUSSION**

Total knee arthroplasty (TKA) is used to treat degenerative joint disease in a variety of patient populations. It’s a promising treatment for end-stage osteoarthritis (OA) of the knee for alleviating pain and restoring the function (8). In 2002, approximately 381,000 TKA were performed in USA (9). In many patients, OA or rheumatoid arthritis affects both joint, causing deformity and pain to both joints; and without bilateral TKA, functional recovery and pain relief are unlikely (10). Local infiltration analgesia (LIA) applies the concept of surgical wound infiltration with local anaesthetics to joint surgery (11). Traditional methods of pain management such as opioids provide inadequate pain relief and excessive adverse effects (12). The use of LIA has become relatively common for a number of surgical procedures and has the advantage of relative simplicity compared with other regional anesthesia techniques (13).
In the current study, thirty-six patients participated; TKA was done for all of them. They were divided into two groups. Group A included 16 patients managed with local infiltrative analgesia (LIA), while group B included 20 patients managed without LIA.

In group A and group B in the current study, at one and two days postoperatively, means of this score were significantly decreased than pre-operatively (P<0.05). While non-significant difference was seen after six weeks of operation (P>0.05), no significant differences observed in means of ROM score between study groups preoperatively, one day, two days, and six weeks after operation (P= 0.141, 0.329, 0.80 respectively), with only significant difference was seen in means on discharge from hospital (P=0.001). Also, no significant association between LIA and ability for raising leg straightly after operation observed (P > 0.069).

Visual analogue scale (VAS) score results among study groups, after four hours of operation, mild pain found in 93.8% in group A, and in 80% in group B. After 12 hours, it is observed in 87.5% in group A, and 60% in group B. After one day, mild pain in 62.5% of group A, while moderate pain in 75% of group B. Two days postoperatively, moderate pain found in 56.2% of group A and 95% of group B. The means of this score during rest were significantly decreased in group A than in group B in all periods.

On the other hand, during movement after four hours post-operatively, mild pain found in 75% and 65% of group A and B respectively. After 12 hours, mild pain found in 62.5%, and 70% of group B had moderate pain. At one day post-operatively, 56.2% of group A and 95% of group B had moderate pain, while in two days both groups were suffered from moderate pain (75% for group A and 95% for group B). No significant differences in means of score between study groups four hours, 12 hours, and two days after operation (P<0.05). While significantly decreased in one day in group A compared to B (P=0.016).

V. CONCLUSION

LIA is a simple effective method to reduce pain and improve physiotherapy outcome also reduces hospital stay in patients undergoing TKA.

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