ORIGINAL ARTICLE

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Effect and Outcomes of Timing of Tourniquet Release in Total Knee Arthroplasty: A prospective Clinical Trial

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Summary

In total knee arthroplasty procedures, use of tourniquet is a universally accepted, however, there still a controversy about the most appropriate timing of the tourniquet release and its impact on outcome. We aimed in this clinical trial to compare the outcome of intraoperative tourniquet release with haemostasis before the quadriceps muscle and wound are closed with the postoperative release with regard to overall blood loss, pain, duration of surgery, hospital stay, complications and knee movement. Hence, a total of 100 patients were enrolled in this study for whom total knee arthroplasty was performed during the period 2018-2020. We found that patients with early tourniquet release had less postoperative pain, achieved earlier straight-leg raising, and had fewer wound complications. There were no significant differences between the two groups in time of operation, or 48 hours postoperative haemoglobin concentration. In conclusion. Some adverse effect of tourniquets use in knee surgery can be significantly reduced by early tourniquet release, with haemostasis before the quadriceps mechanism and the wound are closed.

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1 INTRODUCTION

Total knee arthroplasty (TKA) is one of the most frequently performed surgeries worldwide, with significant growth in recent years, due to the increased life expectancy of the population and, therefore, to further joint deterioration. Total knee arthroplasty is a surgical procedure that consists of replacing the damaged joint by placing an artificial internal implant. The primary reason for placing a knee replacement is joint wear that causes pain and disability due to the significant destruction that the joint presents and which can be caused by advanced osteoarthritis and rheumatoid arthritis (1). This surgical procedure is aimed at patients who suffer continuous pain in one or both knees in cases where conservative treatment did not show favorable results. The primary objectives of total knee replacement are to improve the quality of life of patients by reducing or eliminating pain, restoring functionality and consequently improving the action of the muscles, ligaments and other soft tissues that help balance movement. of this joint. Surgical treatment is indicated when the patient is limited in his activities of daily life due to pain or when he needs to take medication permanently to maintain an acceptable functional state. This reconstructive joint surgery offers individuals with limited functional capacity for ambulation, the opportunity to obtain an independent, pain-free and highly functional lifestyle (2–5).

Different indications are found for TKA (6–9) involve one or more of the following when

- Continuous and limiting pain (to a greater or lesser degree)
- Pain restricts activities of daily living
- Pain returns after stopping anti-inflammatories, chondroprotectors or other specific treatments
- A significant deformity and / or stiffness
- No improvement on rehabilitation therapy
- Walking shows constant instability
- Advanced osteoarthritis

It is now recognized that in optimal conditions total knee replacement can last from 15 to 20 years (10). Routine activities that are authorized to perform after surgery will depend

on patient's age and physical capacity. However, to achieve a full recovery and maximize the benefit of this surgery, it is recommended that patients receive an institutional rehabilitation program after surgery(11,12).

Although a variety of complications are described for the use of tourniquet, such as neuromuscular injuries, increased postoperative pain, delayed wound healing, increased thrombotic events, the tourniquet is routinely employed for better visualization, less blood loss, and easier cementation in total knee arthroplasty (TKA). Pneumatic tourniquets are used in an estimated 15,000 orthopaedic and non- orthopaedic surgical procedures daily in the United States and elsewhere, facilitating operations by reliably establishing a bloodless surgical field with a high level of safety (13). To reduce the tourniquet time and the incidence rate of complications, some surgeons suggested to release tourniquet intraoperatively, which has been reported to have less blood loss, lighter postoperative pain, lower incidence rate of complication, better evaluation of patellar tracking, and faster functional recovery. Although many studies involving randomized controlled trials (RCTs), retrospective studies, and systematic review have investigated whether releasing tourniquet before wound closure is more effective in reducing blood loss than releasing tourniquet after wound closure in TKA without an increased risk of complications, it is still highly debatable . Some authors have described advantages without use of tourniquets in TKA. Nevertheless, the use of tourniquets will continue because it is a long established practice and most of the surgeons rely on this technique. Many surgeons prefer a tourniquet release before wound closure for hemostasis to minimize postoperative blood loss. Other authors report conflicting results of this procedure . There are some prospective randomized and nonrandomized studies that compare the effect of tourniquet release timing in cementless or cemented unilateral TKA. However, many of these studies show an inadequate reporting and methodology (14–20). Therefore, we tried to compare the effect of timing of release of tourniquet with regard to overall blood loss, pain, duration of surgery, hospital stay, complications and knee movement

2 PATIENTS AND METHODS

Prospective study was conducted between October 2018 to February 2020 included 100 patients undergoing primary total knee replacement suffering from tricompartmental arthritis of the knee joint, having severe pain during walking & even at rest. All the patients operated on in governmental or private hospital.

Diabetic patients or those who had previous open knee surgery or have any contraindication for surgery or tourniquet were excluded. Then patients were assigned into two groups randomly , (group A and B) with 50 patient in each group. In group A the quadriceps mechanism and skin were closed, and bandages were applied before tourniquet release. In group B the tourniquet was released and hemostasis achieved before closure and bandaging.

Before operation, all patients were weighed and graded for knee pain and function using the Knee Society Scoring System (21). The radiographs were assessed according to the classification of Holden et al (22). The patient Knee Society Scoring System and radiographic grade were similar.

Study protocol:

Half of patients in each group had spinal anesthesia, the other half did have general anesthesia because of the preference of their anesthetist. Targocid vial 400 mg was given intravenously at induction of anesthesia and three further doses of 200 mg postoperatively.

A pneumatic tourniquet was placed around the thigh, and inflated pressure is calculated automatically and inflated after elevation of the limb for two minutes after skin incision. The prostheses used is LPS-Flex Fixed Bearing Knee, the tourniquet used is A.T.S.® Automatic Tourniquet System.

These were implanted using a standard technique through a midline incision Intramedullary femoral resection guides and (extra and intra) medullary tibial resection guides were used to make cuts in all cases. Proper ligament balancing through all classical steps done, and proper limb alignment is checked. Autogenous bone-graft was used to fill in the holes for intra-medullary guides. Cut bone surfaces were cleaned by pulsed irrigation before the prostheses were fixed with cement.

On the completion of this stage the patient was randomized for grouping In both groups.

In group A the quadriceps mechanism and skin were closed, and bandages were applied before tourniquet release.

In group B the tourniquet was released and hemostasis achieved before closure and bandaging.

The quadriceps mechanism was closed with absorbable sutures over two suction drains.

Clips and nylon suture material were used for the skin. A wool and crepe bandage was then applied and retained for 48 hours.

The total operating time was recorded from the skin incision to the time of application of wool and crepe bandage.

Anticoagulant therapy was started in the evening after surgery and continued until the patient was fully mobile. Postoperative pain control was by 50 mg of pethedine given intravenously following by a standard protocol with 200 mg celebrax twice daily,50m tramadol twice daily, panadol 1000mg three time daily. Postoperative pain was measured for all patients which were on the standard analgesia regime by using a Wong-Baker faces pain rating scale at six hours after operation. The decrease in haemoglobin concentration from before operation to 48 hours after was calculated, as was information regarding requirements for blood transfusion.

We followed up the patient during hospital stay and after discharge for 6 weeks.

Standard post-operative rehabilitation regime for all patient done, with no use of continuous passive motion device .

The time to achieve straight-leg raising with less than 10° extension lag, and the range of active knee flexion at four days, 14 days and six weeks were documented by total knee arthroplasty team. The wound was inspected at four and at 14 days postoperatively. Any excessive swelling of the knee was also reported.

Statistical analysis performed using the statistical package for social sciences and all tests applied under assumption of P. value of 0.05 or less to be significant

3 | RESULTS

Society Scoring System, radiographic grade, diagnosis, and the operating time was similar for both groups (Table 1).

The Wong-Baker faces pain rating scores for patients in group B were significantly lower than those of group A (median scores 1 and 4 respectively; $p < 0.001$). (Figure 1).

Patients in group B were able to perform straight-leg raising significantly earlier than those in group A (mean 2.8 days and 5 days, respectively; $p < 0.001$), (Figure 2).

At four days, the mean range of flexion in patients in group B was 60° vs. 55° for group A, but this difference was not statistically significant (Figure 3). At 14 days and at six weeks the mean ranges of flexion were similar in both groups.

At 48 hours, the median decrease in hemoglobin concentration was similar in both groups which was 3 g/dL.

Regarding complications; in group A , 8 (16%) patients suffered minor wound complications such as continued oozing after ten days, erythema, cellulitis, or minor dehiscence, as opposed to 7 (14%) in group B. (Figure 4). No patient in group B had to return to theatre. In group A, one patient needed secondary suture under anesthesia for a major wound dehiscence.

Table 1. Baseline characteristics of the studied groups

Variable	Group A	Group B
Mean age in years (range)	70 (55 to 83)	69 (48 to 72)
Male: female	22:28	19:31
Mean weight in kg (range)	75 (47 to 100)	77 (50 to 115)
Median Knee Society Scoring System (range)	53 (10 to 91)	51 (18 to 91)
Median radiographic grade (range)	2 (1 to 4)	2 (1 to 4)

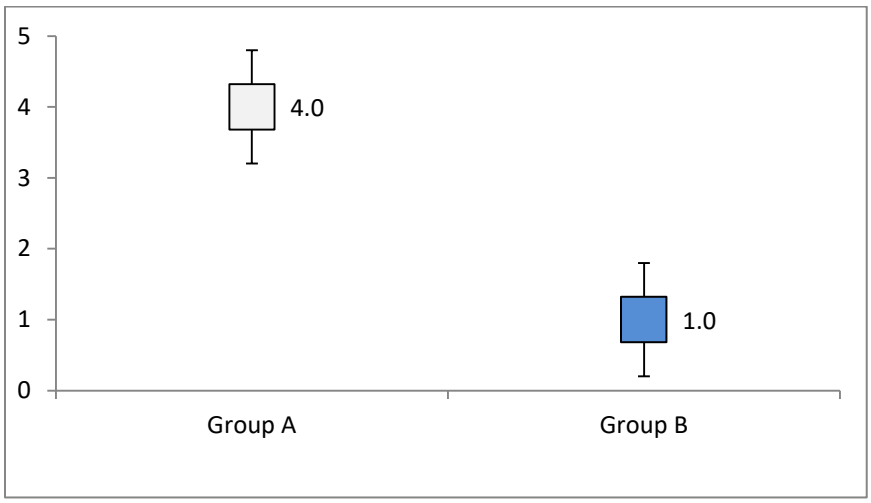

Figure 1. Comparison of median Wong-Baker faces pain rating scores of the studied group (P<0.001)

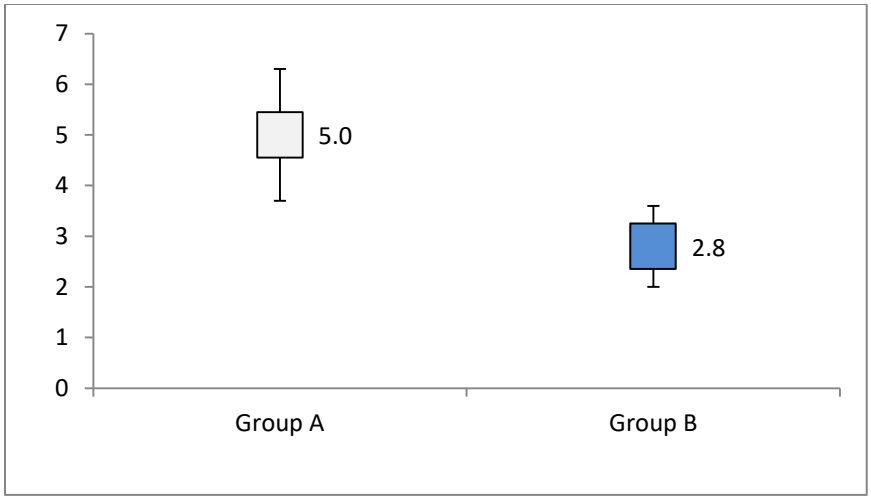

Figure 2. Comparison of mean duration in days to perform straight-leg raising among the studied group (P<0.001)

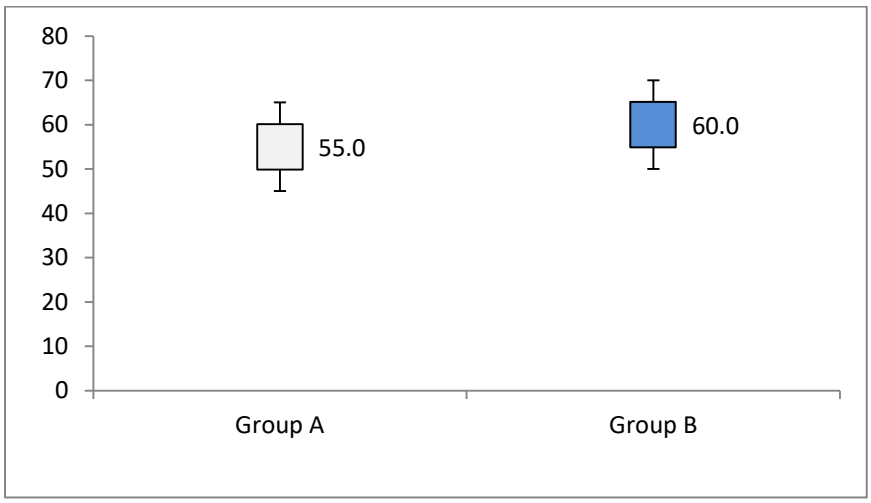

Figure 3. Comparison of mean range of flexion at fourth day among the studied group (the difference was statistically insignificant, P > 0.05)

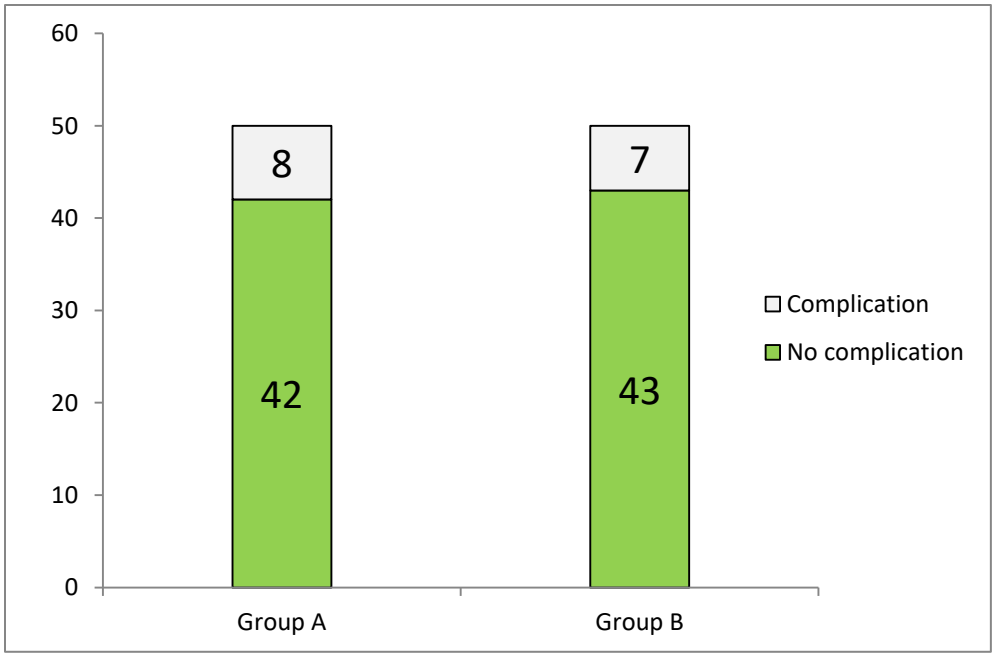

Figure 4. Frequency distribution of postoperative complications in both studied groups

4 | DISCUSSION

The use of tourniquet is a common practice in most orthopedic procedures. It provides a clear visualization of the operative field which helps in dissection and prevents iatrogenic injuries of important structures. Careful homeostasis has long been a tenet of sound surgery and this applies equally when operating in a bloodless field. In this way, hematomas can be prevented, which may subsequently lead to complications related to wound, such as infection or dehiscence and in case of flaps (13,20).

Nevertheless, their use is still associated with potentially serious morbidity and even mortality (23,24). However, there is a paucity of information regarding the incidence of individual complications . The tissues at greatest risk from tourniquet use are the nerves and muscles where soft tissue damage and tourniquet paralysis could be reported (25–28)

Abdel-Salam and Eyres (29) reviewed 80 patients with a total knee arthroplasty who were randomly selected to have the operation under a tourniquet which was released after wound closure and compression bandaging, or without its use from the beginning.

Patients operated on without a tourniquet had no increase in overall blood loss, suffered less postoperative pain, achieved earlier straight-leg raising and flexion, and also had fewer wound and thrombotic complications.

We found a reduction in complication rate in our early release group, which was similar to that reported by Abdel-Salam and Eyres using no tourniquet. Our results showing reduction in postoperative pain and earlier straight-leg raising after early tourniquet release and control of bleeding also seemed to mirror their findings for tourniquet-free surgery.

It is difficult for physiotherapists to mobilize patients safely before they have achieved straight-leg raising (30), and this therefore was an advantage over the late release group.

We did not find a significant improvement, however, in early range of movement.

Two previous studies have shown that release of the tourniquet does not affect overall blood loss during total knee arthroplasty (17,20).

We did not formally assess this aspect, but the similar decrease in haemoglobin concentration in both groups tends to support this view. Our study has extended the findings of Abdel-Salam and Eyres (29).

A reduction of the tissue tension after operation is achieved by releasing the tourniquet and achieving haemostasis before closure, but reactive hyperaemia and continued bleeding until tamponed will have occurred in the patients in both our groups and in Abdel-Salam and Eyres' groups. The removal of one of the causes for excessive increase in tension has been shown to achieve some of the benefits of tourniquet-free surgery without losing its benefits during the implantation of the prosthesis.

Anesthetists prefer to be able to estimate the total blood loss before the patient leaves theatre, and a further advantage of early tourniquet release is that most of the loss occurs before wound closure, while the patient is still under the direct control of the anesthetist, and not at a later stage during recovery(31,32).

5 | CONCLUSIONS

Our results showing reduction in postoperative pain and good functional outcome regarding earlier straight-leg raising that mimic the findings for tourniquet-free surgery. Early straight-leg raising make the physiotherapists able to mobilize patients safely and early. Anesthetists prefer to be able to estimate the total blood loss before the patient leaves theatre, which is an advantage of early tourniquet release and occurs before wound closure. Intra-operative tourniquet release and securing homeostasis does not increase overall blood loss. Reduction in complication rate in early release of tourniquet is observed.

Ethical Issue:

All ethical issues were approved by the author, in accordance with Ethical Principles of Declaration of Helsinki of the world Medical Association, 2013, for research involving human subjects

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