Original article

Short term outcomes of long duration versus short duration tourniquet in primary total knee arthroplasty: A randomized controlled trial

Raju Vaishya, Amit Kumar Agarwal*, Vipul Vijay, Manish Kumar Tiwari

Department of Orthopaedics & Joint Replacement Surgery, Indraprastha Apollo Hospitals, Sarita Vihar, New Delhi 110076, India

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ABSTRACT

Introduction: A tourniquet is used during the total knee replacement surgery to improve the visibility, to reduce the blood loss and for better cementation. Indirectly it decreases the duration of surgery and enhances the recovery of the patient. Their use however is controversial due to some side effects associated with the use of tourniquet. They may increase the risk of deep vein thrombosis and pulmonary embolism by causing venous stasis, endothelial damage and increased platelet adhesion secondary to distal limb ischemia.

Material and Methods: We conducted a randomized controlled trial (RCT) to examine the benefits and risks associated with the use of long duration over short duration tourniquets during TKA. The study was a prospective randomised control trial with a total of 80 knees (40 knees in each group) included in the study. The knees selected for surgery were randomly allocated to one of the two groups: Group A - long duration tourniquet (LT-group) or Group B - short duration tourniquet (ST-group).

Result: The average operating time in Group A (43.53 ± 3.11 minutes) was statistically less significant than that of Group B (51.7 ± 2.56 minutes). Intra-operative blood loss in Group B, was significantly more than that of Group A. Post-operative blood loss in the drain was more in long duration tourniquet group. Total blood loss (intra-operative + post-operative) was more in short duration tourniquet group. Pain score (using VAS scale) was comparable in both the groups at the end of the second and sixth week. At sixth weeks there was no significant difference in the range of motion in both the groups. The KSS score was not significantly different in both the groups in post operative period at first, second, and six weeks. There were no events of thrombo-embolism and deep vein thrombosis in either groups. In 11 patients (27.5%) of long duration tourniquet group, swelling, and redness of knee was seen post operatively as compared to three patients (7.5%) of short duration tourniquet group.

Conclusion: The use of a short duration tourniquet during TKA gives better symptomatic pain relief in the early postoperative period as compared to long duration use of tourniquet. However, this is associated with increased blood loss, more operating time and not having a clear operative field. We suggest that a rational thinking and reconsidering the practice of routine use of long duration tourniquet in each and every case of TKA is required.

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1. Introduction

With the advent of technology and instruments, Total Knee Arthroplasty (TKA) has now become one of the most commonly performed Orthopaedic surgery.^{1,2} Although recent advances in surgical materials and techniques have increased the efficacy of

this procedure, still the patients remain concerned about the pain and length of recovery associated with TKA.

During TKA, an intraoperative tourniquet is often placed on the upper thigh to reduce blood flow to the extremity.^{3,4} The tourniquets seemingly have various benefits that can enhance procedural speed and patient recovery. These advantages include minimizing the amount of both intra-operative and post-operative blood loss, producing an intra-operative 'bloodless' visual field, improving the cement-bone inter-digitations and reducing the operation time.^{5,6} However, the reported disadvantages of

* Corresponding author.

E-mail address: amitorthopgi@yahoo.co.in (A.K. Agarwal).

Table 1

The inclusion and exclusion criteria of the study.

INCLUSION CRITERIA	EXCLUSION CRITERIA
<ul style="list-style-type: none"> - Symptomatic grade IV bilateral knee OA - Patients who have signed written informed consent for the procedure. 	<ul style="list-style-type: none"> - Patient with any hematological diseases (coagulopathy). - Patient with any infective foci in the body. - Patient with history of immune-suppression. - Patient with the peripheral neuro-vascular disease. - Inflammatory arthritis like rheumatoid arthritis.

tourniquet application include an increased risk of nerve palsy, vascular injury, muscle damage, post-operative swelling and stiffness.^{7,8} A tourniquet application during TKA may also associated with an increased incidence of symptomatic deep vein thrombosis (DVT) and pulmonary embolism (PE),^{9,10} by venous stasis and endothelial damage with increased platelet adhesion secondary to distal limb ischemia.

The use of a tourniquet for TKA is therefore controversial. Based on the current conflicting evidence, there is a fundamental need to further investigate the efficacy and safety of tourniquets during TKA. We thus conducted a randomized controlled trial (RCT) to examine the benefits and risks associated with the use of long duration over short duration tourniquets during TKA. We did this study to analyze the functional outcome and pain score both the groups after primary TKA and hoped that the findings of our study will contribute to improvements in procedural recommendations for TKA.

2. Material and methods

The study was a prospective RCT and included patients who were admitted for bilateral simultaneous TKA, same surgeon doing one knee after the other in single anaesthesia setting, for severe and symptomatic Osteoarthritis (OA) of the knees. A total of 80 knees (40 knees in each group) were included in the study. Inclusion and exclusion criteria's were pre-defined (Table 1). A prior Institutional Ethical Committee (IEC) approval was taken before conducting this study. Informed consent was obtained from all the included patients before they underwent pre-operative assessment. Pain score, using visual analog scale (VAS scale), Functional scores using Knee Society Score (KSS), the range of motion (ROM) were recorded. All the cases were operated by the same surgeon and by the same technique, using similar implants. Randomization and blinding was done. Bilateral simultaneous TKA was done in all these patients by an anterior midline approach Scorpio™ Knee System (Stryker, Mahwah, New Jersey, USA). The knees selected for surgery were randomly allocated to one of the two groups: Group A

– long duration tourniquet (LT-group) or Group B – short duration tourniquet (ST-group).

2.1. Randomization

A surgeon, who was not involved in the study, picked up the slip from non-transparent sealed envelope containing the slip of both the knees of the patient to decide which knee should receive long or short duration tourniquet.

2.2. Blinding

Subjects and personnel involved in the study were blinded to treatment group until before surgery. Both the patients and the staff in the operating theater were aware of the side for which knee, long, or short duration tourniquet was being used. The investigator collecting the data was blinded during procedure and follow-up.

In the long duration tourniquet group (Group A), the tourniquet was set to 150 mmHg above the patient's systolic blood pressure and was inflated just before the skin incision and deflated after setting of the bone cement. Whereas, in short duration tourniquet group (Group B), the tourniquet was inflated to the same level (150 mmHg above the patient's systolic blood pressure) just before cement application and deflated after setting of the bone cement. Electrocautery was used for hemostasis, and a suction drain was used in both the groups. A pneumatic tourniquet was applied on the thigh and inflated after two minutes of elevation of the limb. No exsanguination was done in either group (by Esmarch bandage). The operative time was taken from the time of the inflation of the tourniquet to the setting of bone cement in Group A, while in Group B, it was calculated from the time of incision taken to the setting of the bone cement. Intraoperative blood loss was measured [(volume in suction container-amount of saline wash used) + (total weight of wet mops used – total weight of dry mops used)] in all the cases. Postoperative blood loss was calculated from the volume of blood in drains. On the first post-operative day, hemoglobin and X-ray of both knees were done. The threshold of

Table 2

A comparison of operating time between short and long duration tourniquet groups.

	Short duration tourniquet	Long duration tourniquet	p value
Operating time (in minutes)	51.7 ± 2.56	43.53 ± 3.11	.03*

Table 3

Comparison of blood loss (intra, post operative and overall) between short and long duration tourniquet.

Blood loss (ml)	Short duration tourniquet	Long duration tourniquet	p value
Intra operative	288.41 ± 2.1	165.98 ± 2.33	.001*
Post operative	210.73 ± 1.46	266.94 ± 1.02	.04*
Overall	499.14 ± 3.56	432.92 ± 3.35	.003*

Fig. 1. Graph showing post-operative VAS score in short v/s long duration groups.

post-operative blood transfusion was hemoglobin less than 8gm/dl. The drain was removed on the second postoperative day and physiotherapy was started. Early mobilization and above knee stockings were used to prevent DVT. In addition, tablet Ecosprin (75 mg once daily) was given for six weeks. All the patients were monitored for complications like wound complications, and thrombo-embolism. Staples were removed on the 10th post-operative day. The patients were assessed again by KSS, ROM and VAS scale in follow-up at one, two and six weeks.

3. Results

In this study, a total of 40 patients were included who underwent bilateral simultaneous TKA and who fulfilled all the inclusion and exclusion criteria. In both groups, 40 knees were included. All the patients were followed up for six weeks, and no patients were lost to follow-up.

The average operating time in Group A, using long duration tourniquet (43.53 ± 3.11 min) was statistically less significant than that of Group B (51.7 ± 2.56 min) with a p -value of 0.030* (Table 2). In addition, intra-operative blood loss in Group B, was significantly more than that of long duration tourniquet (p -value: 0.001*). Post-operative blood loss in the drain was more in long duration tourniquet group (p -value 0.040*). However, total blood loss (intra-operative + post-operative) was more in short duration tourniquet group (Table 3). Pain score (using VAS scale) was significantly less with short duration tourniquet (Group B) at one week post-operatively (p value: 0.030*) (Fig. 1 Graph 1). But, it was comparable in both the groups at the end of the second and sixth week. The ROM was comparable pre-operatively, in both the groups. However, in the post-operative period, it was significantly better in short duration tourniquet group than long duration tourniquet group at first and second week. But, at sixth weeks there was no significant difference in the range of motion in both the groups (p value: 0.070) (Table 4). The KSS score was not

significantly different in both the groups in post operative period at first, second, and six weeks (Fig. 2 Graph 2).

There were no events of thrombo-embolism and deep vein thrombosis in either groups. In 11 patients (27.5%) of long duration tourniquet group, swelling, and redness of knee was seen post operatively as compared to three patients (7.5%) of short duration tourniquet group.

4. Discussion

The use of tourniquet is still a common practice during TKA. However, doubts have been raised about routine use of these in TKA, because of several reported complications related to their use.^{11,12} The most common complications related to the use of tourniquet are seen in early postoperative period and therefore these may have short term effects on the patient,^{13,14} however these complications often do not persist for longer duration of time. It is well known that the use of tourniquet is surgeon friendly, since it provides a bloodless field during the surgery. There is still no consensus regarding the duration of its use during TKA. Our RCT was aimed to evaluate the outcomes of short versus long duration use of tourniquet during TKA.

We noticed from this study that the use of long duration tourniquet during the whole surgery provides better visibility intra-operatively, reduces the operating time and also reduces intra-operatively blood loss significantly as compared to short duration use of a tourniquet. However, in our RCT the post-operative blood loss was more with the long duration tourniquet than that of short duration tourniquet use. This finding is in line with the findings of many other previous authors^{15,16} however there are few studies which do not show any difference in the blood loss.^{17,18} The difference in these studies could be due to the fact that the tourniquet duration was variable in different studies and thus could have a bearing on the amount of blood loss. In the study of Abdel-Salam and Eyres,¹⁹ the tourniquet was deflated after the dressings, whereas in the study of Tetro and Rudan,²⁰ the tourniquet was deflated after cementation, like in our study. Due to compression of vessels of lower limb by tourniquet, the blood flow distal to tourniquet is reduced, and therefore the blood loss is lesser. We believe that with the use of tourniquet a bloodless operating field is created which helps in better visualization and requires less operative time. However, once the tourniquet is deflated at the end of the procedure, there is a reactionary increase in the blood flow to that limb, due to which there is comparatively more blood loss in the drain in long duration tourniquet group, as compared to short duration tourniquet group.

Our finding of lesser operative time with long duration tourniquet is also supported by other studies.²¹ However, there are few studies which do not show any significant difference between the operative time of each group.²² We presume that these discrepancies between the operative times could be due to local surgical practices or the varied population. Moreover, the beneficial effects of shorter operative times on the final patient outcome require further validation.

In our RCT, the pain control was better in knees operated using short duration tourniquet to that of knees operated with long

Table 4

Comparison of range of motion pre operative, at first, second and sixth week between short and long duration tourniquet.

	Short duration tourniquet (in degrees)	Long duration tourniquet (in degrees)	p value
Pre operative	116 $\pm$ 5.6°		–
ROM at 1st week	80.78 $\pm$ 7.24	72.25 $\pm$ 8.78	.03*
ROM at 2nd week	91.23 $\pm$ 4.23	83.43 $\pm$ 5.66	.02*
ROM at 6th week	98.67 $\pm$ 2.31	94.25 $\pm$ 3.89	.07*

Fig. 2. Graph showing Knee Society Score in short v/s long tourniquet groups.

duration tourniquet at one and two weeks but there was no significant difference at six weeks. These findings are similar to Worland et al.,²³ but they also reported unpleasant thigh pain following tourniquet application due to release of Catecholamine. Kohro et al.²⁴ reported accelerated blood hyper coagulability (but not fibrinolysis) after the use of tourniquet in TKA. We feel that the a comparatively higher pain score in the knees operated using long duration tourniquet could be due to the use of a high-pressure tourniquet leading to compression of superficial nerves and vessels leading to ischemia and pain. Injury to superficial vessels, reactionary increased blood flow and muscle injury due to ischemia may be the cause of post-operative wound complications, swelling, and redness of the skin in long duration tourniquet group, in our series.

The reported influence of the use of tourniquet on the functional outcomes after TKA is variable. Stroh et al.²⁵ found excellent clinical outcomes in TKA performed without a tourniquet and commented that the use of tourniquet negatively impacts patient outcome. Zhang et al.²⁶ showed small benefits in the early postoperative period in their study in surgery done without tourniquet. Zhang et al.²⁷ further reported that the tourniquet use negatively affect the early postoperative rehabilitation in. We noticed better ROM in short duration group at the end of one week, however at the end of two and six weeks it was comparable in both the groups. KSS score was comparable in both the groups and did not significantly change with the passage of time. Li et al.²⁸ found that the patients undergoing TKA without tourniquet achieved earlier straight-leg raising (SLR) and knee flexion. Increased pain and swelling were found to be the contributory factor in comparative limitation of RPM in long duration tourniquet groups during the first post-operative week, however, once pain and swelling were settled, there was the insignificant difference between the two groups. During the early postoperative period as the functional and mobilization status of the patient was limited there was not much difference between the two groups in KSS scoring.

5. Conclusion

The use of long duration tourniquet is not a benign procedure as it may be associated with several complications and hence a judicious use of tourniquet during TKA is advisable. Although, the side effects and complications associated with the use of tourniquet last for short term but still may cause significant distress, pain and slow functional recovery after TKA. Hence, we suggest that a rational thinking is required and reconsidering the

practice of routine use of long duration tourniquet in each and every case of TKA. The use of a short duration tourniquet during TKA gives better symptomatic pain relief in the early postoperative period as compared to long duration use of tourniquet. However, this is associated with increased blood loss, more operating time and not having a clear operative field. Larger and multi centric studies are required to validate our recommendations and to further find strategies to optimize better functional outcomes after TKA.

Conflicting interests

The author(s) declared no potential conflicts of interest on the research, authorship, and publication of this article.

Ethical approval

This study was approved by our institutional review board.

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