

COMPARISON OF BLOOD LOSS AND TRANSFUSION REQUIREMENTS AFTER PRIMARY TOTAL KNEE REPLACEMENT WITH AND WITHOUT TOURNIQUET USE

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Abstract

Background: The tourniquet is a common medical instrument used in total knee arthroplasty (TKA). However, there has always been a debate about the use of a tourniquet. The purpose of our study was to compare blood loss and the need for transfusion in primary total knee replacement performed with or without a tourniquet. **Materials and Methods:** Using the aforementioned criteria, 150 cases were identified and their clinical notes were reviewed. These patients were then divided into two cohorts depending on whether a tourniquet was used or not. All TKRs also utilised a standardised interventions protocol including withholding of anticoagulants and antiplatelet medications, topical adrenaline injection, and both IV and topical tranexamic acid. Outcomes measured were estimated intra-operative blood loss, overall blood loss through comparison of pre and post-operative haemoglobin laboratory values, and the need for post-operative blood transfusion. **Result:** The majority of the patients underwent operations without the use of a tourniquet and in both groups' females' outnumbered males. Spinal anaesthesia was more common in both study groups and no significant difference was observed in the American Society of Anaesthesiologists physical status classification (ASA). Participants in the tourniquet group had less intra-operative blood loss, since almost half of them experienced minimal blood loss. Transfusion requirements were also similar among the groups (4.8% vs. 5.8%) and no tendency was suggested towards an increased rate of transfusion in the non-tourniquet group. **Conclusion:** Although estimated intra-operative blood loss is increased without a tourniquet, total blood loss as measured by haemoglobin levels is no different for primary TKRs that use a tourniquet and those that do not. Furthermore the post-operative blood transfusion rates are not significantly different between the two groups.

INTRODUCTION

Total knee arthroplasty (TKA) is an effective solution for patients with end-stage knee osteoarthritis.^[1] Total knee arthroplasty may lead to serious blood loss that may necessitate a blood transfusion. During a TKA operation, up to 2,200 mL blood loss has been reported in previous studies.^[2-5] Various pre-, intra-, and postoperative strategies are used to reduce blood loss during TKA. Preoperative methods include iron therapy, administration of erythropoietin, and autologous blood donation.^[3] Intraoperative methods can be listed as hypotensive anesthesia, local or systemic tranexamic acid (TXA) administration, cell salvage,

and tourniquet application.^[6,7] Blood loss and consequent anemia may have several undesirable effects both on mortality and morbidity, such as prolonged length of hospital stay, difficulty in achieving rehabilitation goals, and even death.

A recent study of the American Association of Hip and Knee Surgeons found that approximately 95% of surgeons used tourniquets during TKA.^[8] However, there has always been a debate about the pros and cons of tourniquet use.^[9] For supporters, the tourniquet has several advantages in TKA: (1) a tourniquet can provide a bloodless field of view for surgery, (2) a tourniquet may help reduce intraoperative blood loss and improve cement penetration, and (3) a tourniquet could also shorten

the operation time.^[10] The disadvantages of tourniquet use mainly include damaging blood vessels and local soft tissue and increasing fibrinolytic activity.^[11]

Although tranexamic acid can decrease fibrinolytic activity, when combined with the use of a tourniquet, fibrinolytic activity will increase.^[12] A tourniquet can also lead to local tissue swelling or hypoxia, which then affects wound healing,^[13-15] and produces more pain in the immediate post-operative surgery. Applying a tourniquet to the quadriceps femoris can affect the intraoperative patellar tracking and disturb the surgeon's judgment of this movement. Tourniquets are also thought to be associated with an increased risk of deep vein thrombosis (DVT), wound infection or poor healing, postoperative dysfunction, and increased blood loss.^[16] Moreover, some studies found that the use of a tourniquet may increase postoperative hidden blood loss.^[17]

Improved pain scores when a tourniquet has not been used have been documented. This is presumed to be due to the lack of ischaemic injury to the limb as well as the crush injury to the musculature.^[18-20] There is also recent evidence that when a tourniquet is not used the quadriceps musculature maintains a greater degree of strength, and the knee has a better range of movement.^[19-21] These factors can all improve patient recovery.^[21,22] The above findings and modern surgical and anaesthetic techniques have resulted in a trend to reduce the tourniquet time or even perform the surgery without a tourniquet. The purpose of our study was to compare blood loss and the need for transfusion in primary total knee replacement performed with or without a tourniquet. Our hypothesis was that there would be no difference in overall blood loss when implementing our standard practices for TKR without a tourniquet.

MATERIALS AND METHODS

Present study of all primary cemented TKRs carried out at tertiary care teaching institute of India for the duration of 1 year.

Our inclusion criteria were that of any standard primary cemented TKRs. Patients with incomplete or inadequate medical records were excluded from the study. Patients with a history of hematological or coagulation disorders and thromboembolic events were also excluded.

Using the aforementioned criteria, 150 cases were identified and their clinical notes were reviewed. These patients were then divided into two cohorts depending on whether a tourniquet was used or not. For the purpose of our study any use of a tourniquet during the procedure put the patient in the tourniquet group. On reviewing the preoperative assessment notes, all patients who were on anticoagulant medication (including corticosteroids), as well as any patients who had an underlying bleeding disorder were identified, and

were a considered part of the analysis. All primary TKRs in our institution undergo several standard interventions that have a bearing on blood loss during the operation.

Anti-coagulants are maintained or stopped prior to surgery as per a standard protocol. Low dose (75 mg) aspirin and corticosteroids can be continued up to and beyond the time of the operation. Dipyridamole is discontinued 48 hrs before the operation, while Factor Xa inhibitors like rivaroxaban and apixaban are discontinued 3 days before surgery. Warfarin is stopped 5 days before surgery, with conversion to dalteparin if bridging anticoagulation is required. Clopidogrel is stopped 7 days before surgery.

A long acting local anaesthesia with adrenaline mix is injected intra-operatively. This consists of 150 ml of 2 mg/ml Naropin, with 1 ml of 1 in 1000 adrenaline, and 1 ml of 30 mg/ml ketorolac if renal function allows. This mixture is given at the start of the operation with 50 ml subcutaneously. A further 50 ml is infiltrated into the posterior joint capsule after the bony cuts have been made, and a final 50mls is infiltrated into the musculature and subcutaneous tissue during wound closure.

One gram of tranexamic acid is given intravenously 10 minutes before surgery is commenced. A further gram of topical tranexamic acid in 100 ml of normal saline is applied topically while the cement was curing. Our orthopaedic department's standard thromboprophylaxis involved a first dose of 5000 units of dalteparin given subcutaneously at 6 hours after surgery.

Data was collected on estimated intra-operative blood loss, measured changes in haemoglobin (Hb) levels, and whether a post-operative transfusion was required. Estimated blood loss is classified within our institution as minimal, under 100 ml, under 250 ml, between 250 to 500 ml, between 500 to 750 ml, and over 750 ml. It is calculated from the quantity of blood accumulated in the suction catheters (minus wash used), the weight of blood soaked surgical swabs, and views of how blood stained the surgical drapes are. Pre and post-operative haemoglobin (Hb) levels were retrieved from the pathology results electronic database within our institution. These blood samples were taken at the pre-operative assessment and 24-48 hours post surgery respectively. The difference between the two values of Hb indicates the actual blood loss for the perioperative period.

Statistical Analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2007) and then exported to data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). For all tests, confidence level and level of significance were set at 95% and 5% respectively.

RESULTS

Our final analysis included 150 patients who had undergone total knee replacement. Baseline characteristics of the participants are presented in [Table 1].

Upon comparison of the two cohorts with regard to baseline characteristics, no significant differences were noted. The majority of the patients underwent operations without the use of a tourniquet and in both groups' females' outnumbered males. Spinal anaesthesia was more common in both study groups and no significant difference was observed in the American Society of Anaesthesiologists physical status classification (ASA). Most of the participants were classified as ASA 2, whereas one participant in each group was characterized as ASA 4. More importantly, no statistical difference was detected in the percentage of patients receiving anticoagulants or antiplatelets; therefore minimising potential confounding factors. Most of the participants were receiving aspirin, while almost a quarter were using clopidogrel. Estimated blood loss and data related to other surgical parameters are presented in Table 2. Upon comparison of the estimated blood loss

between the two cohorts, statistical significance was noted ($p < 0.001$), hence a post hoc analysis was performed utilizing the Bonferroni correction. Participants in the tourniquet group had less intra-operative blood loss, since almost half of them experienced minimal blood loss ($p < 0.001$), hence a post hoc analysis was performed utilizing the Bonferroni correction. Participants in the tourniquet group had less intra-operative blood loss, since almost half of them experienced minimal blood loss. On the contrary, most of the patients in the non-tourniquet group (49%) were classified as having blood loss between 250-500 ml ($p \leq 0.05$).

The pre- and post-operative Hb levels were comparable among the groups. A slightly higher Hb level was evident pre-operatively in the non-tourniquet group, however this was not deemed statistically significant ($p = 0.058$). Transfusion requirements were also similar among the groups and no tendency was suggested towards an increased rate of transfusion in the nontourniquet group. Finally the analysis of the Hb drop (g/dl) after surgery, revealed that the use of a tourniquet had no significant effect ($p > 0.05$) [Table 2].

Table 1: Characteristics of patients undergoing total knee replacement

Variables	Tourniquet N=50 (%)	No tourniquet N=100 (%)	P value
Gender			
Male	16 (32)	34 (34)	0.10
female	34 (68)	66 (66)	
Anesthesia			
Spinal	41 (82)	90 (90)	0.65
General	9 (18)	10 (10)	
ASA			
1	1 (2)	4 (4)	0.20
2	36 (72)	78 (78)	
3	12 (24)	17 (17)	
4	1 (2)	1 (1)	

Statistically significance at $p \leq 0.05$

Table 2: Estimated blood loss and other surgical parameters in patients undergoing total knee arthroplasty

Variables	Tourniquet N=50 (%)	No tourniquet N=100 (%)	P value
Estimated blood loss (milliliters)			
Minimal	24 (48)	15 (15)	0.001*
<250	15 (30)	33 (33)	
250-500	10 (20)	49 (49)	
500-750	1 (2)	3 (3)	
Haemoglobin drop (g/dl)	23.6±8.70	25.2±8.5	0.45
Haemoglobin, pre-operative levels (g/dl)	128.70±12.90	132.40±11.5	0.05*
Haemoglobin, post-operative levels (g/dl)	103.9±11.20	107.10±12.40	0.24

*indicates statistically significance at $p \leq 0.05$

DISCUSSION

Our results indicate that more intra-operative blood loss occurs when a tourniquet is not used for primary TKR, but that overall blood loss (calculated by haemoglobin fall) is the same whether a tourniquet is used or not. Furthermore there was no difference in the transfusion rates between the two cohorts.

These findings are in keeping with recent metaanalyses.^[23,24] Our equivalent blood loss finding is further supported by a number of studies,

including studies comparing short and long duration tourniquet use.^[25-28] For this to occur post-operative blood loss must be greater when a tourniquet is used. The underlying mechanism as to why this is the case is still not fully understood, though a number of explanations have been postulated. Larsson et al. noted back in the 1970's that when a tourniquet is released there is an increased reactive blood flow to the limb.^[29] This effect was found to peak 5 minutes after tourniquet release, though persisted for several hours. Wakankar et al reported that this reactive hyperaemia can contribute to limb

swelling and increased soft tissue tension after a tourniquet release, which in turn may explain the increased wound pain that this group of patients feel.^[30] When all the strategies of this blood management protocol are followed, additional use of tourniquet does not have any statistically significant effect on the amount of blood loss. Orthopedic surgeons must be careful during major surgical procedures such as primary TKA in JW patients, and all blood loss prevention measures should be taken whenever possible to avoid life-threatening anemia.

The evolution of reducing tourniquet use in TKR has coincided with other techniques to control blood loss being developed. Comparison with earlier studies may not be valid given that these techniques may have evolved over time. It may be that these have tipped the balance in terms of blood loss in the operative field that means not using a tourniquet is possible. It must also be noted that our measurement of intra-operative blood loss is based on a series of somewhat subjective estimations, and is therefore open to inaccuracies. Other articles also describe measuring intra-operative blood loss based on the increased weight of the gauzes used and measuring the volume of blood aspirated.^[2,4] These inevitable estimates are likely to be the best achievable.

Using a tourniquet for TKR does confer some benefits in the form of decreased operative time, although this was not specifically examined by our study.^[33,34] Another quoted benefit to using a tourniquet is that better cementing technique is enabled by improved cement penetration into bone.³³ However, recent studies have refuted these claims. A randomised controlled trial by Ledin et al, demonstrated no difference using radiostereometric X-ray analysis at two years for implant migration.^[19] Vertullo et al evaluated radiographic evidence for cement penetration in the immediate post-operative period.^[35] They also found no significant difference between the tourniquet and no tourniquet groups. Although it is beyond the scope of this study to expand upon the numerous complications associated with the use of a tourniquet, they are worth briefly mentioning. There are reports of increased risk of thromboembolism, and of cardiac, pulmonary and cerebral microemboli.^[36-41] Preoperative coexisting diseases, such as atherosclerosis, blood hypercoagulability, poor blood glucose, or uncontrolled blood pressure, were associated with the increasing incidence of postoperative complications. Tourniquets should be avoided in these patients.

CONCLUSION

Although estimated intra-operative blood loss is increased without a tourniquet, total blood loss as measured by haemoglobin levels is no different for primary TKRs that use a tourniquet and those that do not. Furthermore the post-operative blood

transfusion rates are not significantly different between the two groups. More research is needed to determine if there are fewer complications without the use of tourniquets in TKA surgery.

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