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Effect of Early Release of Tourniquet in Total Knee Arthroplasty

Kashif Abbas, Hasnain Raza, Masood Umer and Kamran Hafeez

ABSTRACT

Objective: To evaluate whether tourniquet release intraoperatively is better than postoperative release in reducing overall blood loss, duration of surgery, duration of tourniquet, length of hospital stay, wound related complications and transfusion requirement.

Study Design: Comparative study.

Place and Duration of Study: Department of Surgery, The Aga Khan University Hospital, Karachi, from January 2004 to June 2007.

Methodology: One hundred and thirty patient files were reviewed retrospectively. Patients were divided into two groups. Group-A consisted of 65 patients with early deflation of tourniquet and group-B comprised of 65 patients with the release of tourniquet after applying compressive dressing. Total blood loss (determined by Gross method) and other study variables were noted as per objective and computed.

Results: There were 22 males and 108 females with comparable BMI. All had undergone posterior stabilized cemented total knee replacement. Calculated blood loss was 1.208 L and 1.108 L in group-A and B respectively ($p = 0.27$). Significant increase in duration of surgery was noted in group-A patients. Four patients in group-B showed complication related to wound with 3 being minor and 1 requiring additional operation room visit. Mean length of hospital stay was 9 days. Transfusion frequency was higher in group-B despite comparable postoperative haemoglobin values.

Conclusion: Intraoperative tourniquet release does not reduce overall blood loss with no effect in conserving blood after total knee replacement, however, this group had relatively shorter hospital stay.

Key Words: Tourniquet release. Haemostasis. Knee replacement. Blood loss.

INTRODUCTION

Total knee replacement (TKR) is a common procedure in developing countries. As techniques and instrumentation evolve with time, there is constant quest for improving the methods employed, making it more acceptable not only to the surgeons but the patients as well. Blood loss and the subsequent transfusion is a major cause of concern for these patients especially those undergoing bilateral replacements.

Many attempts have been made to reduce the amount of blood loss. One option to curtail excessive blood loss is the use of tourniquet.^{1,2} Use of tourniquet is a universally accepted phenomenon. Controversy, however, still exists about the most appropriate timing of the tourniquet release and its impact on total blood loss.³ Early release of tourniquet i.e. before final closure, allows homeostasis whereas release after skin closure and application of compressive dressing, saves time.

The aim of this study was to evaluate if tourniquet release intraoperatively (group-A) is better than postoperative release (group-B) in reducing overall

blood loss, duration of surgery, duration of tourniquet, length of hospital stay, wound related complications and transfusion requirement.

METHODOLOGY

This is a retrospective review of 130 patients undergoing total knee replacement (TKR) using posterior stabilized cemented implants between January 2004 and June 2007. Patients with intra-operative blood transfusion, bleeding diathesis, deranged coagulation, revision TKR, and diagnosis other than primary osteoarthritis were excluded from the study. Patients were identified through hospital records during the aforementioned time frame and were divided into two groups based on two different individual surgeons practice. Group-A consisted of patients who underwent TKR with release of tourniquet intra-operatively before closure of quadriceps layer, to secure homeostasis. Group-B constituted the patients in which tourniquet was released after wound closure followed by compressive bandage application. Pre-operative single dose low molecular weight heparin was given to all patients. Anti-platelet medications were discontinued a week prior to the surgery. The patients were admitted a day prior to the surgery. As this was a practice of two different surgeons, randomization was not possible, however, all other steps of the surgery in the two groups were identical from approach to closure including the use of compressive dressings, use of similar form of anaesthesia i.e. combined spinal epidural.

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Straight tourniquet was used irrespective of thigh shape and a single layer of cotton padding was applied between the skin and cuff. Tourniquet was inflated to a standard pressure of 100 mm of Hg above systolic pressure,⁴ which was the first blood pressure reading after induction of the spinal anaesthesia. Operative technique involved in both groups was same, utilizing the midline parapatellar approach. Intramedullary femoral and extra-medullary tibial resection guides were used to make cuts in all cases. Autogenous bone graft was used to fill in the holes for intra-medullary guides. Cancellous bone surface was covered with cement before final implant insertion. The capsule, subcutaneous tissue and the skin were sutured separately. All the patients were given pre-operative antibiotic prophylaxis with Cephazolin.⁵ Measurement of haemoglobin and haematocrit was done on the day of admission and 24 hours postoperatively. Decision to transfuse packed cell were made by operating surgeons based on postoperative haemoglobin level. Hospital based policy recommends keeping the haemoglobin levels > 10 gm/dl pre-operatively and transfusing the patient if the level drops down to 8 gm/dl, however, there is no fixed transfusion trigger currently being followed. Rehabilitation protocol for both the groups was same. Wound status and healing was noted at regular intervals, the first change of dressing was after 48 hours of the surgery, another after two days, one before discharge and then the wound was monitored during subsequent follow-ups at the clinic.

The calculated total blood loss (CBL) was obtained by the method of Gross. With this method, the estimated blood volume (EBV) was calculated from the height and weight of the patient, using a correction factor for gender.⁶

$$EBV = \text{height}^{0.178} \times \text{weight}^{0.47} \times 74.49 \times \text{Factor}/10000$$

where factor for males = 2.74 and for females = 2.37. CBL was calculated from the maximum reduction in haemoglobin, standardized with respect to EBV (assuming isometric haemodilution): CBL = EBV x (Start Hb) - (Low Hb) / (Start Hb + Low Hb) / 2.

The above mentioned formula calculates blood loss based on pre-operative and postoperative haemoglobin values over a period of 48 hours only, patients only receive fluids intra-operatively and upto 6 hours, therefore, the effect of fluids during such a limited time is minimal.

Overall length of hospital stay was noted and compared between the two groups. Data was analyzed using Statistical Package for Social Sciences (SPSS) version 16. The independent student's t-test and chi-square test were used to compare the mean values of calculated total blood loss, length of hospital stay, transfusion

requirement, and proportion of wound complications; as application of p-values < 0.05 were taken as significant.

RESULTS

The demographics of the patients are presented in Table I. The patients in the two groups were comparable with respect to age, gender distribution, height, weight, pre-operative haemoglobin values, consumptions of NSAIDs and type of cementing techniques.

Out of the 130 patients, 65 were in group-A and 65 in group-B. Mean age of patients in group-A and B was 56.7 ± 6.11 and 58.3 ± 5.32 years respectively. Sixty eight point five percent (68.5%) of patients had evidence of some form of systemic disease changing the functional class as based on the American Society of Anesthesiology score. Mean BMI was 32.4 ± 6.04 kg/m². Mean pre-operative haematocrit was 36.4 ± 4.8 and postoperative haematocrit was 29 ± 5.07 . Measurement of calculated blood loss was done using the formula described above. Mean blood loss in group-A and B was 1.208 ± 0.489 L and 1.118 ± 0.436 L respectively, with p-value of 0.27, which was statistically insignificant. Patients in group-B received higher number of transfusion with p-value of 0.005. Four patients developed wound complications with 3 being minor complications (marginal necrosis) and 1 major complication requiring additional operative procedure, all patient were from group-B (p = 0.1192). Mean length of hospital stay was 7.38 ± 2.70 and 9.91 ± 3.15 days in group-A and B respectively with p-value of 0.0001 i.e. statistically significant.

Table I: Patient data who underwent total knee replacement.

	Group-A (early tourniquet release) n = 65	Group-B (delayed release) n = 65	p-value
Male	07 (5.4%)	15 (11.5%)	0.0613 ²
Female	58 (44.6%)	50 (38.5%)	
Total	65 (50%)	65 (50%)	
Age (years)	56.7 ± 6.11	58.3 ± 5.32	0.118 ¹
BMI ⁴	32.5 ± 5.27	32.2 ± 6.7	0.777 ¹
Comorbids	39 (30%)	50 (38.5%)	0.029 ²
NSAIDs use	05 (3.9%)	04 (3.1%)	1.0 ³
Mean duration of surgery (minutes)	186.7 ± 48.7	150 ± 44.1	< 0.001 ¹
Mean duration of tourniquet (minutes)	140.8 ± 34.1	110.1 ± 20.8	< 0.001 ¹
Preoperative haemoglobin (gm/dl)	12.2 ± 0.9	12.8 ± 1.2	0.0016 ¹
Postoperative haemoglobin (gm/dl)	9.4 ± 1.03	9.7 ± 1.28	0.1434 ¹
Calculated blood loss (litres)	1.208 ± 0.489	1.118 ± 0.436	0.27 ¹
Hospital stay (days)	7.38 ± 2.70	9.91 ± 3.15	0.0001 ¹
Complications	0	4 (3.1%)	0.1192 ³
Transfusion	7 (5.4%)	21 (16.2%)	0.005 ³

1 = Student's t-test; 2 = χ^2 test; 3 = Fisher's exact test; 4 = Body Mass Index; 5 = Non-Steroidal Anti-Inflammatory Drug.

DISCUSSION

The use of tourniquet is a common practice in most orthopaedic procedures.⁷ 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, haematomas can be prevented, which may subsequently lead to complications related to wound, such as infection or dehiscence and in case of flaps. Nevertheless, their use is still associated with potentially serious morbidity and even mortality.^{8,9} 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.¹⁰ The reported incidence of soft tissue damage and tourniquet paralysis is 0.15%.¹¹ Systemic and local changes related to the use of tourniquet are well described in literature.¹²

Of importance in this study is the haematologic effect of tourniquet use. At the end of operations performed with tourniquet, there is a profound increase in fibrinolytic activity in the blood from the systemic circulation as well as from the operated limb, whereas only a small systemic increase exist after surgery on the leg without a tourniquet. The vasa vasorum are possibly the major source of plasminogen activator in the vasculature and may be stimulated to respond maximally by complete ischaemia; increase in fibrinolytic activity does not appear to be related to the duration of the application of tourniquet. However, evidence regarding effect of using pneumatic tourniquets on the incidence of post-operative deep vein thrombosis is contradictory.¹³⁻¹⁵ Increase in fibrinolytic activity is short lived. It is maximal at 10 minutes and returns to pre-operative levels within 30 minutes of release of tourniquet. It then falls below the pre-operative levels, where it remains for at least 48 hours. The tourniquet appears to alter the period of increased fibrinolytic activity without altering the overall pattern. It is unlikely that this would alter the incidence of deep vein thrombosis, but it may affect the degree of bleeding after release of tourniquet and systemic activations in thrombosis and fibrinolysis start when local mediators are released after tourniquet deflation.^{16,17}

The timing of tourniquet release and its influence on blood loss have been studied previously in TKR surgery. Controversy has been found in literature regarding the issue of early tourniquet release for homeostasis, release before closure or deflation after closure. Earlier studies have found decreased blood loss in the former group.^{18,19} Others have found no difference in the blood loss among the two groups.^{20,21}

Estimation of blood loss can prove to be a difficult task, especially during the postoperative period when no

drains are used. Use of anaesthesia charting of estimated blood loss is again subject to variability. Thus, in this study, total blood loss was not measured *per se*, but it was calculated on the basis of maximum decrease in haemoglobin value between the pre-operative and the postoperative level and normalized to patient's weight and height. Measured blood loss after total knee arthroplasty is generally an underestimation and can only be 50% of the "true" blood loss, as calculated with several methods.^{6,23}

In this study, increased but statistically insignificant calculated blood loss was observed, in the group where tourniquet was released for homeostasis. A closed wound and apposed tissue layers with firmly applied dressing can produce a local compressive effect and control this bleeding. Based on this data, early release of tourniquet was found not to have any effect in conserving blood in total knee replacement. Moreover, it increased the total duration of surgery in comparison to group-B.

Although postoperative haemoglobin values were almost the same, the transfusion requirement was significantly higher in group-B, reflecting too generous a hospital policy and individual surgeon threshold for transfusion at varying level of haemoglobin. Length of hospital stay was also significantly high ($p < 0.0001$) in group-B.

Wound related complications were noticed in group-B patients. Besides general risk factors, the haematoma associated with closure without haemostasis may be responsible for relatively higher incidence of wound complications. Out of the 4 patients with wound complications, only one required intervention in operating room. The possible explanation for above mentioned findings in group-B may be that group-B had higher number of patients with systemic comorbidities ($p = 0.03$).

This study is the only study from Pakistan addressing these issues. The main limitation of this study is its retrospective design, however, it can be a foundation stone to design a prospective study considering our results and the un-answered questions. Furthermore, this study reflect two different surgeons' practice, thus is not free of intervention bias.

CONCLUSION

Intra-operative tourniquet release and securing homeostasis does not reduce overall blood loss, thus keeping the tourniquet inflated throughout the procedure is equally effective and reduces operative duration. Difference in transfusion requirement in the groups reflects cognitive bias and low threshold for transfusion on the part of surgeon.

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