

THE INFLUENCE OF TOURNIQUET USE AND TIMING OF ITS RELEASE ON BLOOD LOSS AFTER TOTAL KNEE ARTHROPLASTY

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ABSTRACT

- Objective** *To determine the influence of tourniquet use and the timing of its release on amount of bleeding during total knee arthroplasty.*
- Study design** *Clinical trial.*
- Place & Duration of study** *Department of Orthopedics, School of Medicine Hamadan University of Medical Sciences and Health Services, Hamadam , Iran From 2005 to 2008.*
- Patients and Methods** *Eighty four patients (96 knees) who underwent total knee arthroplasty were randomly assigned into three groups: group I: tourniquet not applied, group II: the tourniquet deflated intraoperatively, group III: the tourniquet released after the wound closure. Mean blood drainage and transfusions required, hemoglobin and hematocrit values and operation time were compared among the groups.*
- Results** *Hemoglobin and hematocrit, tourniquet time (for groups II and III) and number of blood transfusions given, were similar in all the groups. The operation time was significantly long for group I (p 0.012).*
- Conclusion** *Using tourniquet does not reduce blood loss in total knee arthroplasty however it reduces operation time significantly.*
- Key words** *Total knee arthroplasty, Tourniquet, Blood loss.*

INTRODUCTION:

Intraoperative and postoperative bleeding, in series of total knee arthroplasty (TKA), ranges from 0.34 to 1.5 liters, and various techniques of hemostasis are used to minimize this bleeding.¹⁻⁸ In order to reduce the blood loss and allow better visualization and easier cementing techniques, it is essentially accepted that TKA should be performed with a pneumatic tourniquet. However,

the timing of tourniquet deflation and ensuring hemostasis are subjects to debate.

Barwell and Anderson advocated early tourniquet release so as to avoid the potential complications of tourniquet use.¹ The coagulation of the genicular arteries in order to reduce blood loss was recommended by Shepard and Page though some reports recorded that hemostasis has no effect on blood loss in TKA.^{2,8,10-12} The aim of our study was to investigate the effect of tourniquet use and intraoperative release of it, on blood loss in TKA.

METHODOLOGY:

Eighty four patients (96 knees) who underwent bicompartamental posterior cruciate retaining knee replacement procedures for osteoarthritis, were studied prospectively (table 1). The inclusion criteria were a

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diagnosis of severe primary osteoarthritis, the insertion of bicompartamental TKA and patients without known coagulation disorder. Sealed opaque envelopes were used for randomization at the start of operation. In group I (31 knees) no tourniquet was used and hemostasis was ensured from beginning. In group II (36 knees), the tourniquet was deflated for hemostasis once all the components had been inserted. In group III (29 knees) the tourniquet was deflated after the wound had been closed and compression dressing applied.

Spinal-epidural anesthesia was used for all the operations and were performed by the same operating team in standardized manner. In groups II and III, a pneumatic tourniquet was inflated to 380 mmHg, and a straight midline skin incision and standard medial parapatellar arthrotomy, were used. In all the patients, the posterior cruciate ligament was preserved. In nine cases of group I, six patients of group II and six patients of group III, lateral retinacular release was required. Furthermore, the hole in the distal femur made for femoral guide was plugged with autogenous bone block. Intramedullary guide for femoral and extramedullary guides for tibial resection were used in all patients. Electrocautery was used for hemostasis.

In group II the tourniquet was deflated after insertion of prosthetic components and after packing for 2 minutes. Bleeding points were coagulated by electrocautery. In group III the tourniquet was not deflated before wound closure and dressing and no intraoperative hemostasis was practiced. A Jones compression bandage was applied in all patients of all groups. Suction drainage was routinely used and removed 24-48 hours after wound closure.

For thromboemboli prophylaxis, low molecular weight heparin (Enoxaprine) was used in all patients and no monitoring for INR was performed. Antibiotic prophylaxis was started just before tourniquet inflation in groups II and III, and just before incision in group I with one gram cephazolin and then continued three times daily for 48 hours. The same rehabilitation program was followed in all patients, including isometric quadriceps exercise during first postoperative day. Active movement being encouraged as soon as pain allowed and immediate full weight bearing the day after operation. Two different trade mark posterior cruciate-retaining total knee prostheses were used namely Scorpio (Stryker, USA) and Nexgen (Zimmer, USA).

Recording of hemoglobin and hematocrit levels was done preoperatively, immediately after surgery, and on the first postoperative days. Blood loss in the suction drain was recorded. The intraoperative blood loss in

group I, in sponges was recorded. The intra operative blood loss in group II and the blood loss in sponges in group II and III, were not recorded. Guided by laboratory values and clinical assessment, the need for transfusion was decided by the surgeon and anesthesiologist. The total of blood transfusion was recoded in blood units but converted into milliliters for ease of statistical evaluation. Tourniquet and whole operation times were recorded in all patients. Using SPSS for windows V 13.0 (SPSS Inc., IL, USA), statistical evaluation was made by computer. The independent t-test and U test were used for statistical evaluation of variables. P values of less than 0.05 were regarded as significant.

RESULTS:

There was no significant difference in age and gender between three groups. The mean blood loss was 810.12 ml (300-1300) in group I, 720.30 ml (240-1200) in group II and 705.35 ml (250-1150) in group III ($p = 0.062$). All hemoglobin and hematocrit levels, the mean volume of blood transfused and tourniquet times were similar in three groups (table II). There was no significant difference in results about the number of patients who did not require transfusion as well as wound complications between the three groups. The operation time was 115 minutes (96-260) in group I, 82 minutes (70-105) in group II and 77 minutes (70-115) in group III ($p = 0.012$), and significantly longer for group III compared to first two groups.

Table I: Clinical features of our patients

Variable	Group I	Group II	Group III
Patients	29	33	22
Knees	31	36	29
Age (Years)	66 (51-74)	64 (54-73)	68 (54-72)
Gender M/F	7/22	9/24	6/16
Side R/L	15/14	15/18	12/10

DISCUSSION:

In surgical practice hemostasis is used to minimize postoperative bleeding, better visualization and cementing techniques in TKA operations. Most of TKAs are performed using a tourniquet except in some special situations. There is no consensus on the timing of tourniquet deflation and ensuring hemostasis when this is used. Pattison and Protheroe reported a study of the causes of hemoglobin and hematocrit differences after TKA.¹² They suggested "hemolysis" as a possible explanation for hemoglobin reduction. On the other hand Erksin using chromium-labeled red blood cells

Table II: Results in three groups

Variable	Mean	Group I		Group II		Group III		P Value
		No tourniquet		Hemostasis		No hemostasis		
		SD (+)	Range	SD (+)	Range	SD (+)	Range	
Preoperative Hb (g/dl)	13.43	1.21	9.9-16.3	1.30	9.8-15.5	1.22	9.8-14.9	0.25
Day 1 hemoglobin	11.02	1.31	8.6-12.9	0.93	8.5-12.8	1.04	8.6-11.9	0.132
Blood loss (ml)	775.30	244	300-1300	266	240-1200	295	250-1150	0.062
Blood transfusion (ml)	240	201	0-1350	173	0-1350	144	0-900	0.052
Operation time (min)	96	18	96-260	12	70-105	12	70-115	0.012
Tourniquet time (min)	82	-	-	13	55-80	13	65-100	0.028

demonstrated that all of the total blood loss was associated with perioperative bleeding from the wound.⁴

It is obvious that the use of tourniquet, the timing of tourniquet release and hemostasis may play a role in the volume of blood loss associated with TKA.^{2,5,7,14,17} One research demonstrated that TKAs with or without using tourniquet did not result in any meaningful difference in blood loss,⁴ but patients operated on without a tourniquet had less postoperative pain and obtained earlier straight-leg raising and greater range of motion. Tourniquet was used in three different ways by Harvey and Leclerc: no tourniquet use at all, limited use only during cementing, use throughout the whole operation.⁵ They showed significantly higher blood loss without tourniquet use and also reported that deep vein thrombosis was not influenced by the use of a tourniquet. In this study tourniquet was used in two of three groups and we did not find any relation with deep vein thrombosis.

Widman and Isacson studied the effect of tourniquet release timing on blood loss in 85 knees.¹⁷ In group one, they released the tourniquet for hemostasis before wound closure, and in group two, the tourniquet remained inflated throughout the operation. They found no difference in blood loss and no effect of hemostasis on blood conservation in TKA. Cementless TKAs are generally related to a higher blood loss.^{2,7,16} Various properties of cement including mechanical, chemical and thermal effects were considered to be responsible for this reduced blood loss. All of our replacement procedures were made with cemented total knee prostheses.

Use of an early postoperative rehabilitation program was another factor that was considered to influence blood loss in TKA. Lotke and Faralli investigated the

relationship of blood loss in TKA with the timing of tourniquet deflation and the use of continued passive motion (CPM). They found a significantly higher blood loss in the group where the tourniquet was deflated intraoperatively and CPM then started in the recovery room. In the second group the tourniquet was deflated intraoperatively but CPM was started on day three. Patients in the latter group lost less blood. CPM was considered to be an important factor in the increase of blood loss associated with TKA.⁸ Our rehabilitation program was the same for all patients but we did not use CPM at all. The same results were reported by Vandebussche and Duranthon.¹⁶ Thus most of the blood loss in TKA occurred during the operation if the tourniquet was deflated intraoperatively.

The major source of blood loss has been continuous bleeding from cut cancellous bone, as mentioned by Mylod and France, and unfortunately, there is no possibility of stopping this source of bleeding with electrocautery.⁹ Hernandez and Ponce included 46 TKAs in a prospective study, dividing them into two groups. Group A in which the tourniquet was released prior to wound closure and group B, release of tourniquet was done after suturing and bandaging. They concluded that releasing ischemia prior to wound closure did not demonstrate a statistical difference.⁶ Christodoulou and Plaumis have also confirmed this.³ Schuh and Hausel found no significant blood conservation by using tourniquet in TKA.¹⁵ We recorded the same results as well.

Although major vascular damage in TKA is very rare, intraoperative tourniquet release would be a practical way to determine the major vascular damage. Lotke and Faralli found no vascular damage in more than 1,500 TKAs.⁸ We have encountered no patients, who

had a popliteal artery injury related to operation. However, as most of the reported vascular complications during TKA are due to atherosclerotic vascular disease,¹³ intraoperative tourniquet release may not be indicated.

CONCLUSIONS:

Intraoperative tourniquet deflation and hemostasis as well as use of a pneumatic tourniquet, have no effect on blood conservation in TKA. No significant difference found in blood transfusion given in three groups. Eliminating tourniquet use in TKA thus has no effect on blood loss during operation. However, this would increase the operation time significantly. Keeping the tourniquet inflated throughout the entire operation is an effective and safe method for decreasing blood loss in TKA.

REFERENCES:

- Barwell NJ, Anderson G, Hassan A, Rawlings I. The effects of early tourniquet release during total knee arthroplasty. A prospective randomized double-blind study. *J Bone Joint Surg [Br]* 1997; 79: 265-8.
- Burkart BC, Bourne RB, Rorabeck CH, Krik PG, Nott L. The efficacy of tourniquet release in blood conservation after total knee arthroplasty. *Clin Orthop* 1994; 299:147-52.
- Christodoulou AG, Plaumis AL, terzidis IP, Chantzidis P. The role of timing of tourniquet release and cementing on perioperative blood loss in total knee replacement. *Knee* 2004;11:313-7.
- Erksine JG, Fraser C, Simpson R, Protheroe K, Walker ID. Blood loss with knee joint replacement. *J Roy Coll Surg Edinburgh* 1981;26:295-7.
- Harvey EJ, Leclerc J, Brooks CE, Burke DL. Effect of tourniquet use on blood loss and incidence of deep vein thrombosis in total knee arthroplasty. *J Arthroplasty* 1997;12: 291-6.
- Hernandez DM, Ponce V, Gil F. Release of ischemia prior to wound closure in total knee arthroplasty: a better method. *Inter Orthopedics* 2008;32:635-8.
- Jorn LP, Linstrand A, Toksving-Larsen S. Tourniquet release for hemostasis increases bleeding. A randomized study of 77 knee replacement. *Acta Orthop Scand* 1999; 70:265-7.
- Lotke PA, Faralli VJ, Orenstein EM, Ecker ML. Blood loss after total knee replacement: effects of tourniquet release and continuous passive motion. *J Bone Joint Surg [Am]* 1991;73:1037-40.
- Mylod AG, France MP, Muser DE, Parsons JR. Perioperative blood loss associated with total knee arthroplasty. A comparison of procedures performed with and without cementing. *J Bone Joint Surg[Am]* 1990;72:1010-12.
- Newman JH, Jackson JP, Waugh W. Timing of tourniquet removal after knee replacement. *J R Soc Med* 1979;72:492-4.
- Page MH, Shepard BD, Harrison JM. Reduction of blood loss in knee arthroplasty. *Aust NZ J Surg* 1984;52:141-4.
- Pattison E, Protheroe K, Pringle RM, Kennedy AC, Dick WC. Reduction in haemoglobin after knee joint surgery. *Ann Rheum Dis* 1973;32:582-4.
- Rand JA. Vascular complications of total knee arthroplasty. Report of three cases. *J Arthroplasty* 1987; 2:89-93.
- Salam AA, Eyres KS. Effects of tourniquet during total knee arthroplasty. *J Bone Joint Surg [Br]* 1995;77:250-3.
- Schuh A, Hausel M, Salminen S. Effect of tourniquet use on blood loss in total knee arthroplasty. *Zentralbl Chir* 2003;128:866-70.
- Vandenbussche E, Duranthon LD, Couturier M, Pidhorz L, Augereau. The effect of tourniquet use in total knee arthroplasty. *Int Orthop* 2002;26:306-9.
- Widman J, Isacson J. Surgical hemostasis after tourniquet release done not reduce blood loss in knee replacement. A prospective randomized study of 81 patients. *Acta Orthop Scand* 1999;70:268-70.