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Perioperative bleeding in total knee arthroplasty and need for blood transfusion with and without use of tourniquet

Abstract

Background: The use of tourniquet in Total knee arthroplasty is recommended by many surgeons. However, evidence of its usefulness in this operation is ambiguous. We assessed the effect of using tourniquet in reducing perioperative bleeding and the amount of transfusion requirement in TKA surgery.

Methods: The patients that referred to two hospitals in Tabriz for TKA surgery during a one-year period were entered in a case-control study. 8 male and 23 female patients were randomized into two groups in terms of tourniquet use during TKA surgery: The tourniquet was inflated from the beginning of surgery till end of cement hardening in one group, and only before cementation till hardening of cement in the second group. The procedures were all performed by a single surgeon, with uniform technique, and under regional anesthesia with uniform thromboembolic and infection prophylaxis. The drop in hemoglobin level was measured on the first day after surgery and was compared with pre-operative level in the two study groups. The need for blood transfusion was also assessed and compared between the two groups.

Results: 23 (74.2%) patients did not need blood transfusion, and 8 (25.8%) needed transfusion- 4 in tourniquet and4 in non-tourniquet group. The average duration of surgery was 75.81 ± 26.3 minutes. The mean preoperative HB level was 12.66 ± 1.67, which was 11.09 ± 1.62 after surgery. The difference in post- operative HB level was 1.36 without tourniquet and 1.96 with tourniquet.

Conclusion: Although tourniquet use reduces the duration of this surgery but does not significantly affect hemoglobin level maintenance and need for blood transfusion after surgery.

Keywords: Arthroplasty, Replacement, Knee, Tourniquets, Blood Transfusion

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Introduction

Total knee arthroplasty (TKA) is one of the common orthopedic surgeries, done for relief of pain, improvement in function and mobility in patients who have poor response to non-surgical treatment [1, 2]. Complications of knee arthroplasty are uncommon, but vary from minor to life-threatening problems. The incidence of complications is potentially reduced when surgery is carried out by high-volume surgeon in a specialized hospital [3]. The use of tourniquet is recommended by some surgeons, though its usefulness in knee replacement is still uncertain [4, 5]. Theoretically, the use of tourniquet can reduce blood loss, although it is related to other factors such as delay in wound healing and lower mobility [3]. Pneumatic tourniquet is usually used during TKA to reduce the loss of blood during surgery and improve surgical field viewing, reduce operating time, and improve cement bounding [2, 5]. The use of a tourniquet does not improve fixation, but it may cause more pain after surgery or decrease the range of movement [6]

. It facilitates exposure, reduces bleeding especially bone bleeding which could have deleterious effect on cement strength. The reactive blood flow reaches its peak within 5 minutes after releasing the tourniquet. On the other hand, the tourniquet can also be associated with damage to tissue and oxidative stress. The use of tourniquet, however, cannot control postoperative bleeding, and the role of a tourniquet is still a common concern in the overall loss of blood in TKA patients [2]. In 2009, the Association of American Hip and Knee announced that 95% of surgeons used tourniquet in TKA [7]. However, due to the harmful side effects of the tourniquet, some surgeons prefer to perform TKA without a tourniquet [4, 5, 8].

After surgery, pain, swelling of the limbs, stiffness, delayed recovery of muscle strength and discomfort, subcutaneous fatty tissue necrosis, scaling of the skin, hematoma, ulcer drainage, and higher risk of subcutaneous infections have been reported [5, 8, 9]. Limb pain in patients who have been operated with the use of tourniquet are probably due to the direct pressure of the tourniquet on the local nerves and soft tissue. Increased internal pressure of soft tissue due to reperfusion after the opening of the tourniquet may lead to pain in the area of operation [9]. Less frequent complications associated with prolonged use of the tourniquet during TKA include: Nerve palsy or neuropraxia, compartment syndrome, rhabdomyolysis, renal failure, vascular damage, deep vein thrombosis, lung embolism, acute pulmonary edema, and also cardiac arrest immediately after releasing the tourniquet [2]. Tourniquet would also affect post-operative return of knee function, mobility after surgery and clinical success [4, 8]. In spite of the mentioned issues, regarding the independent role of TKA as a risk factor for deep vein thrombosis (DVT), some researchers believe bone manipulation, medullary canal reaming, and duration of surgery are risk factors for DVT. Although, from all of these factors, the duration of surgery as a serious risk factor has attracted less attention [6].

In the present study, we assessed the effect of tourniquet use in reducing bleeding during and post TKA surgery and also the amount of transfusion requirement.

Method

We included patients who referred to department of orthopedic of Imam Reza and Valiasr hospitals for TKA, from October 2017 to September 2018 in form of a case-control study. The group in one hospital had TKA performed without tourniquet – except at the time of cementing -and in the second hospital the tourniquet was used for the entire period of surgery.

The study was approved by the Regional Ethics Committee in Tabriz medical university (number Ir.Tbzmed.rec.1398.414). To determine the sample size, the G-power 3.1.9.2 software was used. Considering α = 0.05 and the power of 80%, the sample size was estimated to be 15 in each group. Inclusion criteria for study was: Patients between 50 and 85 who would undergo TKR (total knee replacement) with either primary or secondary osteoarthritis of the knee. We excluded patient with coagulation disorders and consumers of anticoagulant drugs and the patients undergoing simultaneous bilateral total knee replacement and those undergoing revision surgery.

In this study, 8 (25.8%) males and 23 (74.2%) females were present with an average age of 63.6 ± 7.86 (minimum 52, maximum 81 years). The Patients were randomly assigned to two groups. In the first group, after patient's preparation and induction of anesthesia, the tourniquet was inflated and surgery was performed and the tourniquet was released immediately after the cement was hard. In the

second group, tourniquet was not used, except for the cementing stage. All surgical procedures were performed by the same experienced surgical team in both centers under spinal/ epidural anesthesia. The incision was anterior midline skin and medial parapatellar capsular. The same type and brand of knee prosthesis was used in both groups. The post-operative dressing was Jones' compression dressing. Thromboembolic disease (TED) prophylaxis was low molecular-weight heparin (LMWH)- as Enoxaparin sodium 4000 U.I (40 mg) - administered within the first 12 to 24 hours after surgery, and continued daily for four weeks. Antibiotic prophylaxis, and rehabilitation protocols were similar in both groups. Prothrombin time and platelet counts were also evaluated in all patients before surgery. Hemoglobin level was evaluated in patients before and within the first 24 hours after surgery.

The need for transfusion was determined in both groups by the orthopaedic surgeon on call, and was administered if patient Hb was <8.0 g/dl or if symptoms of acute anemia (dizziness, nausea, asthenia, mucocutaneous pallor) were present with Hb between 8.0 and 10.0 g/dl. In patients with cardiovascular or pulmonary comorbidities, the transfusion threshold was set at 9.0 g/dl [10, 11]. Blood transfusion was calculated on the basis of injectable blood units and was converted to milliliter before statistical analysis. The surgical time was recorded in each patient in both groups.

The results of the study were analyzed using descriptive statistics (mean ± standard deviation and frequency (percent). In order to compare the blood hemoglobin and blood transfusion and surgical time in groups with and without tourniquet, Independent sample T-test was used. Also, hemoglobin values were tested in the two groups before and in the morning after surgery using ANOVA. Comparison of the indices in both sexes was done by independent t-test. Statistical analysis was performed using SPSS 24 software and a significant level of P <0.05 was considered.

Results

31 patients were included in this study. They were divided into two groups with tourniquet and without tourniquet. In this study, 8 (25.8%) males and 23 (74.2%) were females, with a mean age of 63.6 ± 7.86 (minimum 52, maximum 81 years). 23 (74.2%) patients did not need blood transfusion, and 8 (25.8%) patients needed transfusion. The mean duration of surgery was 75.81 ± 26.3 minutes a (minimum 30, maximum 125 minutes). The mean preoperative hemoglobin level was 12.66 ± 1.67, which was 11.09 ± 1.62 one day after surgery). Normality of data was evaluated using Kolmogorov-Smirnov test and the results showed that both duration of operation and HB had normal distribution (P> 0.05). The mean of this index in both groups showed that before and after the operation, the HB level was higher in the tourniquet group, and this difference was significant (P = 0.025) at the time of the preoperative assessment, but after the surgery it was not significant (P = 0.22). Regarding the normal distribution of data, this comparison was performed by independent t-test. The descriptive statistics of these variables are presented in Table 1. Also, tables 1 to 3 show the average of these variables in both groups with and without tourniquet.

Table 1. Descriptive statistics of quantitative indexes in our two groups with and without tourniquet (independent t-test)

	Preoperative HB (g/dL)	Post-Operation HB (g/dL)	Surgery Duration (min)
Without Torniquet	12.08 ± 1.64	10.72 ± 1.45	95.13 ± 11.17
With Torniquet	13.41 ± 1.46	11.43 ± 1.75	77.5 ± 30.30
P-Value	0.025	0.226	0.043

The relationship between tourniquet use and the need for blood transfusion was statistically insignificant P = 0.618 (Table 2).

Table 2. Frequency distribution of the need for transfusion in both groups.

Group		Frequency (%)
Without tourniquet	No transfusion	11 (73.3%)
	With transfusion	4 (26.7%)
With tourniquet	No transfusion	12 (75%)
	With transfusion	4(25%)

The hemoglobulin- level difference before and after surgery in two groups were evaluated by covariance analysis with paired t-test (Table 3). The difference between hemoglobin level before and after surgery, and with and without transfusion was significant (P<0.001)

Table 3. Average of HB Level difference before and after surgery of the groups (paired t-test)

	Mean difference before and after	P-Value
With tourniquet	1.96	<0.001
Without tourniquet	1.36	<0.001
With transfusion	2.11	<0.001
Without transfusion	1.52	0.003
Total	1.67	<0.001

Discussion

The use of tourniquet is based on the idea that the preoperative blood loss will be reduced and also produce less bloody surgical field, giving a more clear view. Subsequently patients might require less blood transfusion [12, 13]. Theoretically releasing the tourniquet immediately after cementing due to the blood oozing in operation field, would extend the operation time. In contrast, some studies show no significant relation between tourniquet time and duration of surgery [14]. Although some studies show less and some more need for blood transfusion with the use of tourniquet, our study showed no difference [15-19].

Some researchers believed that the use of tourniquet has no effect on the overall amount of blood loss, which are in line with the present paper, but contradict the study of Alcelik *et al*. that, mainly concentrated on intraoperative blood loss [20]. Our study considered both visible blood loss and hidden blood loss in soft tissue which is not visible during the surgery, by measuring HB Levels before and the morning after surgery.

Studies by Haung *et al.* and Zan *et al.* show an increase in blood loss during the surgery in case of early release of the tourniquet [21, 22]. In contrary, Tie *et al* shows no significant difference in blood loss [23]. To sum up these three studies, releasing the tourniquet causes reperfusion which then causes an increase in blood loss by fibrinolytic activity [18, 24]. But on the other hand, we would control the bleeding in the field of operation by homeostasis better and more efficiently. We could also have better control over post-operative hidden blood loss -a point not considered in studies by Haung *et al*. and Zan *et al.*

In the meta-analysis conducted by Tai and colleagues in 2011, the use of tourniquet reduced the duration of surgery without affecting the amount of bleeding [9].

Studies by Tai *et al.* Concluded that Long-Duration use of tourniquet would reduce intraoperative blood loss and Short-Duration use of tourniquet would reduce Hidden blood loss and post-operative blood loss resulting in less requirement of blood transfusion [25]. Our study showed no significant difference in blood transfusion need in either of our two groups. This difference in result might be caused by different homeostasis methods or times of inflation and deflation of tourniquets.

In the present study, blood transfusion was not significantly reduced when tourniquet was used. The use of hemostatic powders at the surgical site, different surgical techniques, the different time to release the tourniquet and the evaluation of hidden bleeding can be all

reasons for the difference in reported results [26].

Our study has few limitations: The main one being small number of patients studied. The hospitals were, also, in different regions of the city, with different socio-economic characteristics and, therefore, their general health condition might have an effect on overall results. We looked only in the hemoglobulin in the first day post- surgery and not on the third or fourth day when hemodynamic of circulation may be more stabilized. We, also did not look at infection rate, prosthetic position accuracy, wound healing or delay in healing.

Conclusion

We studied the effect of tourniquet use in TKA surgery. Although the duration of Surgery was shorter with the use of tourniquet, the need for blood transfusion was not significantly different with or without tourniquet. It is suggested to evaluate the effect of tourniquet use on the rate of infection, postoperative recovery, wound healing and the correct position of the prosthesis in subsequent studies with higher sample sizes.

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