

## Does Control Of Arterial Blood Pressure Post-Total Knee Arthroplasty Reduce Blood Loss?

### *Total Diz Protezi Uygulaması Sonrası Arter Kan Basıncı Kontrolü Kan Kaybını Azaltır mı?*

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#### ABSTRACT

**Objective:** Blood loss from bone and soft tissues after total knee arthroplasty (TKA) can be significant. Many patients undergoing TKA need blood transfusions postoperatively to increase their hemoglobin levels. Due to the small but real risks associated with blood transfusions, every effort should be made to prevent excessive blood loss in such patients. We hypothesized that blood loss post-TKA may be correlated with post-operative arterial blood pressure (ABP).

**Materials and methods:** In order to investigate the relationship between postoperative ABP and blood loss, we retrospectively evaluated the post-operative status of 27 knees from the charts of 24 patients [20 female, 4 male; mean age 69.8 (57–83) years] who underwent TKA. The relationship between post-operative ABP (uncontrolled:  $\geq 140/90$  mmHg or controlled:  $< 140/90$  mmHg) and postoperative blood loss via suction drains was analyzed using the Mann-Whitney U test.

**Results:** The average blood loss (610 mL, range 325-1440 mL) in patients with an ABP  $\geq 140/90$  mmHg was not significantly different than that (491 mL, range 250-775 mL; M-W U=66.0, p=0.44) in patients with an ABP  $< 140/90$  mmHg.

**Discussion:** The lack of association between post-operative ABP and blood loss should be further validated in a prospective study to determine if efforts should be made to carefully control ABP post-TKA for the purpose of decreasing post-operative hemorrhage.

**Key Words:** Total knee arthroplasty; Blood loss; Blood arterial pressure; Suction drain

#### ÖZET

**Amaç:** Total diz protezi (TDP) uygulaması sonrasında kemik ve yumuşak doku kaynaklı belirgin kanama oluşabilir. TDP uygulanan çoğu hastanın ameliyat sonrası dönemde düşük hemoglobin seviyesi nedeniyle kan transfüzyon ihtiyacı vardır. Kan transfüzyonu belirli riskler taşıdığı için bu hastaların ameliyat sonrası dönemde kan kayıplarının mümkün olduğunca azaltılması gerekir. TDP uygulamasını takiben ameliyat sonrası dönemde arter kan basıncının (AKB) kontrolü kan kaybını azaltabilir.

**Gereç ve Yöntem:** Ameliyat sonrası AKB ve kan kaybı arasındaki ilişkiyi araştırmak için TDP uygulanmış olan 24 hastanın [20 kadın, 4 erkek; ortalama yaş 69,8 (57–83 yaş)] 27 dizinin ameliyat sonrası durumu değerlendirildi. Ameliyat sonrası AKB (kontrolsüz:  $\geq 140/90$  mmHg veya kontrollü:  $< 140/90$  mmHg) ve cerrahi yara dreninden kan kaybı arasındaki ilişki Mann-Whitney U testi kullanılarak analiz edildi.

**Bulgular:** AKB  $\geq 140/90$  mmHg olan hastaların ortalama kan kaybı (610 mL; 325-1440 mL arasında) AKB  $< 140/90$  mmHg olan hastalarından (491 mL; 250-775 mL arasında; M-W U=66,0, p=0,44) farklı değildi.

**Tartışma:** TDP ameliyatı sonrası AKB ve kan kaybı arasında anlamlı ilişki tespit edilmedi. TDP ameliyatı sonrası AKB kontrolünün ameliyat sonrası kan kaybının önlenmesinde önemli olduğu varsayımı ret edilmeden önce daha fazla prospektif çalışma yapılmalıdır.

**Anahtar Kelimeler:** Total diz protezi; Kan kaybı; Arteriyel kan basıncı; Hemovak diren.

## INTRODUCTION

Blood loss from bone and soft tissues during and after total knee arthroplasty (TKA) may be significant and can be classified as intra-operative, occult, and postoperative blood loss (1,2). While intra- and post-operative blood loss can be measured visually, occult blood loss may need to be assessed more indirectly (2). Many patients who undergo TKA need blood transfusions afterwards to increase their hemoglobin levels. Due to the numerous risks associated with blood transfusions, every effort should be made to prevent blood loss in patients who undergo these procedures (3).

Minimization of blood loss during or after TKA may be achieved by using the tourniquets (4) and releasing them at the proper time (1,5,6), plugging the femoral medullary hole (7), using intra-operative autologous platelet-rich plasma (8), tranexamic acid (9) or aprotinin (10), applying low-dose norepinephrine locally to surgical wound (11), using closed suction drainage (12,13), and clamping the wound drain temporarily (14,15).

Prior to starting this study we had hypothesized that keeping arterial blood pressure within normal limits may decrease postoperative blood loss. We therefore examined the relationship between post-TKA arterial blood pressure ( $\geq 140/90$

mmHg or  $<140/90$  mmHg) and the amount of post-operative visible blood loss.

## MATERIALS And METHODS

Patients with primary gonarthrosis (Kellgren-Lawrence (16) stage IV by X-ray) and who were scheduled for a primary TKA using the cruciate-retaining method were approached for inclusion into the study. Pain, deformity, and functional limitation were the main indications for TKA. Patients with revision TKA, secondary knee osteoarthritis, bilateral TKAs, patients with bleeding disorders, and those undergoing prosthetic replacements with a posterior stabilized-design prosthesis were excluded from the study.

All operations were performed under spinal/epidural combination anesthesia by the same surgeon using a standard technique. The pneumatic tourniquet was inflated to 100 mmHg above the systolic blood pressure. An anterior midline incision and medial parapatellar arthrotomy were performed. A lateral patellar release was performed when there was an indication for centralizing the patella. Both femoral and tibial components were cemented. The femoral hole was plugged with a piece of intramedullary bone to prevent medullary bleeding.

The tourniquet was deflated and bleeding was controlled before closure. A suction drain was placed into the joint and the layers of the surgical wound were closed anatomically. A bulky cotton compressive dressing was wrapped from foot to groin. Continuous passive motion was started immediately despite the drain. The drain was removed after 24 hours. There were no patellar replacements among the operated knees.

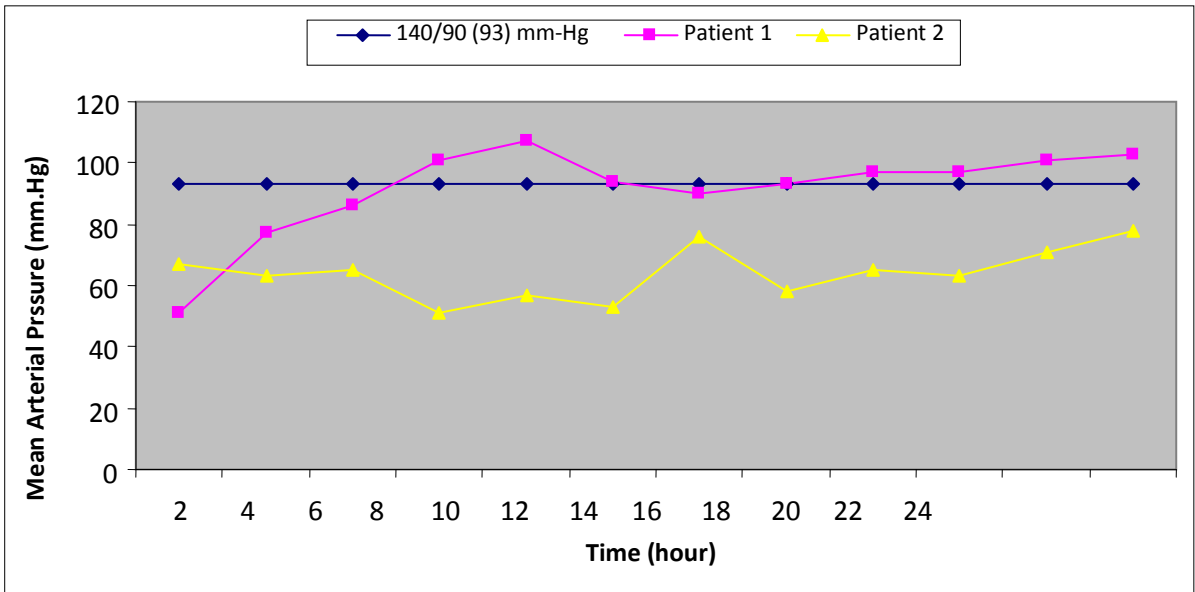
Postoperative blood loss was measured by examining the amount of blood in the wound drainage bottle. Postoperative arterial blood pressure (ABP) was measured every two hours, and the mean arterial pressure (MAP) was calculated (17) (Figure 1). If the blood pressure went above 140/90 mmHg (MAP=93 mmHg) at any time during the first 24 hours, the

patient was placed in the high ABP group for statistical analysis of blood loss. Those with an ABP <140/90 mmHg were placed in the normal ABP group for statistical analysis. We used time/MAP graphic to determine whether ABP was controlled (Figure 2).

$$MAP \cong P_{dias} + \frac{1}{3}(P_{sys} - P_{dias})$$

**Figure 1:** Formula of main arterial pressure (MAP)

Mann-Whitney U test was used to analyze the relationship between postoperative ABP and blood loss. All analyses were performed with SPSS version 11.0 for Windows® (SPSS Inc., Chicago, USA). Analyses with a p-value of less than 0.05 were considered statistically significant.



**Figure 2:** Time/Main arterial pressure (MAP) graphic. Patient 1 has uncontrolled and patient 2 has controlled postoperative arterial blood pressure during postoperative 24 hours.

## RESULTS

Of the 45 patients who were scheduled to have a unilateral total knee arthroplasty over the course of two years and screened for inclusion, 24 consecutive patients (27 knees in 20 females and 4 males; mean age 70 years, range 57–83 years) met the inclusion criteria and were enrolled in the study. Three of the patients were operated upon bilaterally with a minimum interval of ten months between the two TKA operations.

Eighteen patients were normotensive (ABP <140/90 mmHg) after TKA, while nine had episodes of ABP  $\geq$ 140/90 mmHg within the first 24 hours. The mean blood loss in these two groups was  $491 \pm 155$  mL (range 250-775 mL) and  $610 \pm 333$  mL (range 325-1440 mL), respectively (M-W U=66.0, p=0.44). One patient in the high ABP group had 1440 mL of postoperative blood loss. When the data were analyzed with the exclusion of the one outlier stated above, the difference in blood loss between the groups was not statistically significant (M-W U=66.0, p=0.74).

## DISCUSSION

Significant blood loss occurs both during and after TKA, and surgeons are continually searching for ways to minimize bleeding and thus decrease the need for post-operative blood transfusions (1). The type of knee arthritis (primary osteoarthritis or inflammatory arthritis) does not seem to be important to the degree of blood loss after TKA operations (1). In our study, all patients had the same etiology for gonarthrosis as that for primary osteoarthritis. Also, the transfusion rate is higher in patients with inflammatory arthritis, possibly due to lower pre-operative hemoglobin levels (1,18).

We preferred to exclude the bilateral TKAs (single-stage) because of to produce homogenous study groups and we also known that single-staged bilateral total knee arthroplasty has significant risk factors for development of preoperative complications in elderly patients (19).

Peri-operative blood loss has previously been shown to be greater in male patients (1,18). It was impossible to determine the importance of gender for blood loss in our study because of the small numbers of patients in each group.

It has also been shown previously that blood loss in patients with cemented TKA is lower than in patients with cementless TKA (6,20). However, in patients with placement of a cemented prosthesis, blood loss may not be significantly less than in patients with inflammatory arthritis (21). We used a cemented cruciate-retaining design in all patients. As an additional step, we placed a bone plug to close the femoral medullary hole in all of our patients in an attempt to decrease postoperative blood loss (7,22).

Vandenbussche et al (4) reported no difference in postoperative blood loss between patients with and without a tourniquet. The timing of tourniquet release is still hotly debated. For instance, Hersekli et al (5) and Christodoulou et al (6) reported more blood loss with intra-operative release of the tourniquet than with continual inflation of the tourniquet until the application of a compressive bandage at the end of surgery. Others (1,23) are opposed to this practice and argued that increased tourniquet time may increase peri-operative blood loss due to increased fibrinolysis associated with tourniquet use. In our patients, we released the tourniquet and controlled bleeding with

cauterization, which resulted in a tourniquet time of less than one hour in all patients.

Administration of autologous platelet-rich plasma can reduce intra- and post-operative blood loss by sealing the tissues and delivering platelets directly to the wound (8). Another method that can reduce blood loss is intra-operative local administration of low-dose norepinephrine to the surgical field (11) Aprotinin (10) or  $\epsilon$ -aminocaproic acid (9) may also be used to minimize blood loss during and after total knee arthroplasty.

Closed suction drainage has also been applied to decrease bleeding after uncomplicated TKA, but these efforts conferred no apparent advantage (12,13). Clamping the drain postoperatively could reduce excessive bleeding by temporary hemostasis and the creation of a tamponade effect within the joint (14). However, Kiely et al (15) have found this to be of no benefit.

Our study was limited by its small number of patients and by its design (retrospective). This lack of relationship should be verified prospectively in larger patient populations before the idea of controlling blood pressure after surgery to decrease post-operative bleeding is entirely abandoned.

Thus, we reported here that post-operative arterial blood pressure (above or below 140/90 mmHg) during the first 24 hours after TKA was not related to the amount of post-operative blood loss.

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## REFERENCES

1. Prasad N, Padmanabhan V, Mullaji A. Blood loss in total knee arthroplasty: an analysis of risk factors. *Int Orthop* 2007;31:39-44.
2. Sehat KR, Evans R, Newman JH. How much blood is really lost in total knee arthroplasty? Correct blood loss management should take hidden loss into account. *Knee* 2000;7:151-155.
3. Walker RH. Transfusion risks. *Am J Clin Pathol* 1987;88:374-378.
4. Vandebussche E, Duranthon LD, Couturier M, Pidhorz L, Augereau B. The effect of tourniquet use in total knee arthroplasty. *Int Orthop* 2002;26:306-309.
5. Hersekli MA, Akpınar S, Ozkoc G, Ozalay M, Uysal M, Cesur N, et al. The timing of tourniquet release and its influence on blood loss after total knee arthroplasty. *Int Orthop* 2004;28:138-141.
6. Christodoulou AG, Ploumis AL, Terzidis IP, Chantzidis P, Metsovitis SR, Nikiforos DG. The role of timing of tourniquet release and cementing on perioperative blood loss in total knee replacement. *Knee* 2004;11:313-317.

7. Raut VV, Stone MH, Wroblewski BM. Reduction of postoperative blood loss after press-fit condylar knee arthroplasty with use of a femoral intramedullary plug. *J Bone Joint Surg Am* 1993;75:1356-1357.
8. Gardner MJ, Demetrakopoulos D, Klepchick PR, Mooar PA. The efficiency of autologous platelet gel in pain control and blood loss in total knee arthroplasty: an analysis of the hemoglobin, narcotic requirement and range of motion. *Int Orthop* 2007;31:309-313.
9. Orpen NM, Little C, Walker G, Crawford EJ. Tranexamic acid reduces early post-operative blood loss after total knee arthroplasty: a prospective randomised controlled trial of 29 patients. *Knee* 2006;13:106-110.
10. Kinzel V, Shakespeare D, Derbyshire D. The effect of aprotinin on blood loss in bilateral total knee arthroplasty. *Knee* 2004;12:107-111.
11. Gasparini G, Papaleo P, Pola P, Cerciello S, Pola E, Fabbriciani C. Local infusion of norepinephrine reduces blood losses and need of transfusion in total knee arthroplasty. *Int Orthop* 2006;30:253-256.
12. Crevoisier XM, Reber P, Noesberger B. Is suction drainage necessary after total joint arthroplasty? A prospective study. *Arch Orthop Trauma Surg* 1998;117:121-124.
13. Adalberth G, Byström S, Kolstad K, Mallmin H, Milbrink J. Postoperative drainage of knee arthroplasty is not necessary: a randomized study of 90 patients. *Acta Orthop Scand* 1998;69:475-478.
14. Shen PC, Jou IM, Lin YT, Lai KA, Yang CY, Chern TC. Comparison between 4-hour clamping drainage and nonclamping drainage after total knee arthroplasty. *J Arthroplasty* 2005;20:909-913.
15. Kiely N, Hockings M, Gambhir A. Does temporary clamping of drains following knee arthroplasty reduce blood loss? A randomised controlled trial. *Knee* 2001;8:325-327.
16. Kellgren JH, Lawrence JS. Radiological assessment of osteo-arthrosis. *Ann Rheum Dis* 1957;6:494-501.
17. Klabunde RE. Mean Arterial Pressure. *Cardiovascular Physiology Concepts*. <http://www.cvphysiology.com/Blood%20Pressure/BP006.htm>
18. Cushner FD, Friedman RJ. Blood loss in total knee arthroplasty. *Clin Orthop Relat Res* 1991;269:98-101.
19. Hersekli MA, Akpınar S, Özkoç G, Özalay M, Cesur N, Uysal M, et al. Tek seansta iki taraflı total diz artroplastisi: İleri yaşın (70+) perioperatif komplikasyonlardaki rolü. *Joint Dis Rel Surg* 2005;16:1-4.

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- 20.** Mylod AG Jr, 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;72:1010-1012.
- 21.** Fujimoto H, Ozaki T, Asami K, Kato H, Nishida K, Takahara Y, et al. Blood loss in patients for total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2003;11:149-154.
- 22.** Ko PS, Tio MK, Tang YK, Tsang WL, Lam JJ. Sealing the intramedullary femoral canal with autologous bone plug in total knee arthroplasty. *J Arthroplasty* 2003;18:6-9.
- 23.** Aglietti P, Baldini A, Vena LM, Abbate R, Fedi S, Falciani M. Effect of tourniquet use on activation of coagulation in total knee replacement. *Clin Orthop Relat Res* 2000;371:169-177.