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Comparison of Bleeding Following Two Different Systems of Total Knee Arthroplasty: Medial Pivot Versus Posterior Stabilizer

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Abstract

Background: Bleeding is the most common post-operative complication of knee arthroplasty. Arthroplasty systems with posterior cruciate ligaments potentially affected the amount of postoperative bleeding due to a lower need for bone cutting.
Objectives: In this study, two types of prosthesis, including preserving and not preserving posterior cruciate ligament (PCL), were compared in terms of post-operative bleeding.
Methods: In the current cohort study, 100 patients participated in this study and were divided to two groups: 50 patients were treated by using posterior stabilized (PS) system and 50 patients were treated through the Wright cruciate retaining (CR) system with a medial pivot mechanism. Blood loss during surgery and hemoglobin and hematocrit levels were measured for three days after surgery.
Results: In the first group, the amount of collected blood through the drainage tube in first group was 261.87 cc and in the second group this was 225.86 cc, (P = 0.42). After three days the mean drop in hemoglobin in PS group was 2.69 g/dL and in the CR group, this was 2.77 g/dL (P = 0.741). Hemoglobin declined on the second day after surgery, to approximately 3.5 g/dL and 2.74 g/dL for the PS and CR group, respectively, and was significantly higher in the PS group (P = 0.003), and the blood loss in the two groups of nPS and CR were 92 cc and 71 cc, respectively (P = 0.003). The mean blood transfusion per patient in the PS group was 1.2 unit, which was significantly higher than the CR group with mean of 0.78 unit per patient (P = 0.012).
Conclusions: The PS system (Zimmer company product) leads to greater bleeding during the three days, which increased the need for blood transfusion. Consequently, the type of implanted prosthesis could influence the amount of bleeding. In certain circumstances, prevention of postoperative bleeding is crucial, and prostheses can be most beneficial to reduce the amount of acute bleeding in the patient.

Keywords: Arthroplasty, Knee, Arthroplasty Prosthesis, Bleeding

1. Background

Currently, total knee replacement of the joint is known as a safe therapeutic approach for osteoarthritis. For knee arthroplasty, various companies have developed and introduced various prostheses that are used in knee arthroplasty surgeries. Various studies have been done on the clinical implications of various prostheses, yet there was no particular superiority between them. Therefore, each of these prostheses with fewer side effects would be preferable to surgeons and patients (1-4). The most common problem is surgical site bleeding after knee arthroplasty. The instability of the hemodynamic system can lead to ischemic heart disease, a serious complication particularly in the elderly, who sustain an underlying cardiovascular disease. In addition, severe bleeding in patients with chronic renal failure can lead to acute renal failure (5, 6). Furthermore, bleeding is one important precipitating factor leading to factors in catastrophic infection in patients undergoing joint replacement surgery (7).

Different kinds of femoral components are consisted with two types from biomechanic point of view: Posterior stabilized (PS) and cruciate retaining. In the cruciate retaining method, there is no need for intercondylar notch box, leading to posterior articulation, thus, it is known as a low bone resection. In addition, due to lower bone resection technique, less bleeding may occur (8, 9).

2. Objectives

In this study, it was aimed to compare the amount of blood loss in knee replacement surgery, using different systems to recognize the effect of each technique on the hemoglobin as well as clinical outcome. Two conventional methods of joint replacement in Iran (Zimmer and Wright Companies) were compared in this study. The wright system, which is based on the medial pivot, does not include a bone cut associated with the removal of posterior cruciate ligament (PCL), therefore, in theory, there is less bleeding in comparison to Zimmer system. There are a few studies regarding the amount of bleeding following different kinds of knee arthroplasty techniques.

3. Methods

In a cohort study, patients, who were candidates for knee replacement were treated by one of the conventional methods. Approval of the Ethics Committee was attained and written consent was provided. Then, 100 patients participated in the study: 50 patients were placed in each group. One group were operated by PS system provided by Zimmer Company, and the other group was treated by the cruciate retaining system (CR). All patients were operated by the similar surgical approach medial para patellar. Patients were allocated to groups based on admission codes and subsequently the groups were matched in terms of age and gender. The inclusion criteria for this study was knee osteoarthritis disease and requiring knee arthroplasty. Exclusion criteria consisted of: Severe varus deformity (above 20 degrees), intake of nonsteroidal anti-inflammatory drugs (NSAIDs) within the last week, several medical problems requiring anticoagulant therapy, history of thromboembolism, consumption opioids before surgery, high and unstable blood pressure, history of knee fracture, circumstances requiring extra cutting during surgery or needed additional extra tools. All surgical procedures were performed by a senior knee surgeon. The CR prosthetic systems provided by Zimmer Company and PS system, provided by Wright Company, were used for patients. Tourniquet was used for all patients and standard approach of total knee arthroplasty. All patients were operated using spinal anesthesia. No intra-articular analgesic was used in any of the patients. Drain was removed 48 hours after surgery. Postoperative pain was controlled by injection of opioids or Apotel (intravenous acetaminophen) 1 g every 12 hours or implantation of spinal catheter. To prevent intravenous thrombosis, anti-thrombosis socks and subcutaneous injection of enoxaparin 60 mg (daily) were used, which began immediately after surgery. Antibiotics (cefazolin 2 g every eight hours) were started from 20 minutes before surgery and continued up to 72 hours after surgery. In case of low hemoglobin level (below 8.5 g/dL) or clinical symptoms, transfusion was performed and recorded. Pain was measured using the VAS method on the second day after surgery. Visual analog scale (VAS) was used, in which patients scored their pain from 1 to 10.

The level of Hb and Hct and volume of blood loss were measured daily up to three days after the operation and were recorded separately. Drain tubes were removed after 48 hours of surgery. The volume of red blood cell loss was measured using Gross method by formula [preoperative blood circulating volume $\times$ (preoperative Hct - post operative Hct)/preoperative Hct] (10).

Preoperative volume of circulating blood was measured by the Nadler formula K1 $\times$ hight (meter) + K2 $\times$ weight (kg) + K3 (k1 = 0.3561, k2 = 0.03308, K3 = 0.1833 for females; K1 = 0.3669, k2 = 0.03219, k3 = 0.6041 for males) (10).

The amount of blood loss during surgery was not calculated in the study due to the difficulty of measurement and the use of tourniquet. The wound infection was investigated two weeks after the surgery. If the bleeding was severe enough to be observed beyond the dressing, amount of bleeding was estimated by counting the number of soaked gauzes, and each one was considered by collecting about 30 cc of the blood. In addition, if there was a flow of blood after drain removal, it was collected in a sterile syringe and then recorded.

This reseasrch evaluated the range of motion of operated knee during the two weeks after surgery. In addition, on the third day, the circumference of the knee region was measured 5 cm above the patella by a sterile ruler and it was compared to the other side. In three days after the operation, the number and location of the ecchymosis were recorded only if their size was greater 10 cm^2. Measurement of ecchymosis was done by measuring the area of the geometric method (10). The data regarding next hospitalization or presence of any complication were collected. Patients were allowed to walk using the walker. The rehabilitation recovery protocol was the same in both groups. The person, who performed the clinical measurements was different from the one, who made the final laboratory calculations for the Hb drop.

3.1. Statistical Methods

Number, percentage, and mean $\pm$ standard deviation was used as descriptive statistics. In order to compare the quantitative data, the distribution normality was tested (one sample Kolmogorov-Smirnov test). To compare the qualitative data among the two groups of patients, chi-square or Fisher's exact tests were employed in the two

groups; independent *t*-test were used for comparison. Besides, repeated measures test was used for cases of quantitative data repeated measurements. Statistical analysis was done using the statistical package SPSS 16 (IBM, New York, USA) and P value of < 0.05 was considered as significant.

4. Results

In this study, 100 patients were divided to two groups; 50 patients in the PS group and 50 patients in the CR group. There was no significant difference between the two groups in terms of demographic findings such as age, gender, and weight (Table 1).

The blood volume collected in the Hemovac PS group was 261.87 $\pm$ 32.54 cc and in the CR group it was 225.86 $\pm$ 23.43 cc. P value was not significant between the two groups using the independent *t*-test. The amount of blood loss collected in drain tube was the same in the two groups. The average of final hemoglobin loss on the third day after surgery in the PS group was 2.69 $\pm$ 0.6 g/dL and in the CR group it was 2.77 $\pm$ 0.3 g/dL. P value using independent *t*-test was 0.741. The result was similar in the two groups. The decrease in hemoglobin 48 hours after operation was 3.5 $\pm$ 0.6 g/dL in the PS group and 2.74 $\pm$ 0.7 g/dL in the CR group (P = 0.003). Thus, it was significantly higher in the PS group. The blood loss on the first and second day in both PS and CR groups was 92 $\pm$ 10.4 cc and 71 $\pm$ 12.2 cc, respectively, which was significant (P = 0.002).

The amount of blood loss on the third day after surgery in groups 1 and 2 was 71 $\pm$ 11.2 cc and 70 $\pm$ 10.4 cc, which was not significant (P = 0.7).

The average blood intake for each patient in the PS group was 1.2 unit, which was significantly higher than the CR group with mean of 0.78 unit per patient (P = 0.01).

The increase in hemoglobin in the PS group on the third day after surgery was due to a greater number of overall transfusion in this group. In total, 60.9 $\pm$ 12.8 units of pack cell were injected in the PS group, while this was 39 $\pm$ 10.8 units for the CR group. There was a significant difference in the amount of blood transfusion between the two groups (P = 0.02) (Figure 1). The severity of pain using VAS score was 38.86 $\pm$ 11.2 in the PS group and 45.12 $\pm$ 12.8 in the CR group. The extension of knee swelling was 50.4 $\pm$ 10.7 cm and 51.8 $\pm$ 11.4 cm in the PS and CR groups, respectively and there was no significant difference between them. Final knee range of motion was similar between the two groups (89.6 $\pm$ 6.2 in the PS and 90.5.5 $\pm$ 4.3 in the CR).

Two (4%) patients had complications, andboth cases were in the PS group. These cases had post-operative infection that was treated by irrigation and debridement, and the other one sustained pulmonary embolism.

5. Discussion

Although in this study there wasno significant difference was found between the two groups, yet the decrease in Hb level was significantly higher in the second day after surgery in the PS group compared to the CR group. Besides, the PS system leads to more bleeding within the first 24 hours, which resulted in a higher need for blood transfusion. In other words, the choice of prostheses type could influence the amount of bleeding.

A few studies are available on the comparison of bleeding in PS and CR groups. Mahringer-Kunz et al. compared the amount of blood loss and the need for blood transfusion in PS and CR groups (11). In this study 473 patients undergoing total knee arthroplasty were studied, although blood loss in the PS group was significantly higher, yet no difference was observed in the need for blood transfusion in the two groups (11). Cankaya et al. in Turkey compared PS and CR bleeding. In their randomized study, 100 patients with primary OA diagnosis were randomly assigned to CR and PS groups. Results indicated no significant differences between the two groups in terms of Hb and HCT on the first, third and fifth day after surgery. There were also no significant differences in the total volume of blood loss and postoperative drainage and the volume of blood transfusion (12). This study is in line with previous studies and it confirmed that the amount of bleeding in the Zimmer system with PS femoral concomitant system is negligible.

One of the factors that can affect the amount of bleeding and related complications is the duration of the operation. Although the duration of the operation in the PS method is more than CR, yet because of the tourniquet, this factor could not play a role in the patients. Vermesan et al. in Romania, in a paper entitled "reduction of surgical time without increased bleeding using CR in knee replacement" showed that surgical time was significantly lower in the CR system. The mean operating time in the Vanguard implant was 68.9 minutes and in the NexGen II Legacy, it was 80.2 minutes (13). In the current study, there was no need to open the tourniquet in any of the patients before the end of surgery because of the length of surgery.

The greater amount of bleeding in the PS group is probably due to the greater number of bone cuts. Intravenous, transexamic acid was not used in the patients, yet taking advantage of TXA-treated gauzes on the cutting walls could reduce the amount of bleeding in the PS group (14).

A drawback of this study is that all patients were treated by cemented prostheses. Fujimoto et al. clearly showed that bleeding is greater in knee arthroplasty patients without cement (9). The use of cement in the presence of tourniquet can be the reason for the reduction of bleeding from the walls of the notch box in the PS group.

Table 1. The Demographic Characteristics of Patients in Two Groups

Variable	Posterior Stabilized (PS), N = 50	Cruciate Retaining (CR), N = 50	P Value
Sex (male/female), %	4/96	2/98	0.2
Age, y	66.4 ± 10.7	67.2 ± 11.4	0.3
Height, cm	172.9 ± 12.4	170.8 ± 11.5	0.7
Weight, kg	77.4 ± 12.6	78.3 ± 11.9	0.4
Hb before, g/dL	12.8 ± 1.7	11.8 ± 0.8	0.07
Blood volume before, cc	3.37 ± 0.62	3.31 ± 0.42	0.06

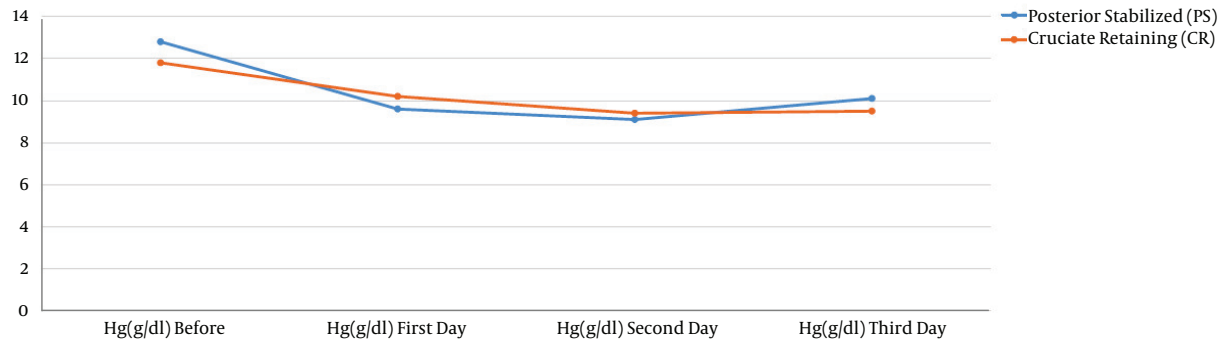

Figure 1. The Hb drop curve in patients during the hospitalization in two groups

Consequently, the results of this study can be generalized only for cement prosthesis. The most important clinical achievement of this study was that if acute post-operative bleeding is critical to the patient, the selection of CR prostheses can be helpful in reducing the amount of acute bleeding.

The other restrictions of this study consisted of the limited number of patients and short period of follow-up. In addition, only acute manifestation of infection was addressed while the latent and chronic presence of infection was not considered in this study.

5.1. Conclusions

The PS system provided by Zimmer Company causes higher amounts of bleeding in the first 24 hours in comparison to CR prosthesis, leading to greater need for blood. The amount of postoperative bleeding is critical for the patient; CR prosthesis can be helpful in reducing the amount of acute bleeding.

Footnotes

Conflict of Interests: There was no conflict of interest to be reported.

Ethical Considerations: The study was confirmed by Ethics Committee of Urmia University of Medical Sciences.

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