Original Article

Effect of Closed Suction Drainage Tube Length after Total Knee Arthroplasty: A Double-Blind, Randomized Controlled Trial

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Objective: To evaluate the effect of the length of closed suction drainage tubes on the quantity of postoperative blood loss.

Materials and Methods: A double-blind, randomized controlled trial study was conducted on 140 primary total knee arthroplasty patients between August 2012 and January 2015. Half the patients received a 3-centimeter (14 side hole) drainage tube and half a 7-centimeter (32 side hole) tube. Blood loss was measured postoperatively at 8, 16, 24, 48, and 72 hours. Hematocrit levels, red blood cell transfusion, and any drainage-related complications were also recorded.

Results: Mean postoperative blood loss was significantly lower in the group with a 3-centimeter drain than in the group with a 7-centimeter drain at 8-hour (109±125.26 ml versus 173±149.80 ml, p=0.02) and at 16-hour (255.40±139.35 ml versus 328.80±164.20 ml, p=0.02). Red blood cell transfusion was also significantly lower at 48 hours in the 3-centimeter drain group than the 7-centimeter drain group (0.20±0.40 units versus 0.46±0.54 units, p=0.01).

Conclusion: A 3-centimeter (14 side hole) drainage tube following total knee arthroplasty results in less blood loss and reduced red blood cell transfusion compared to a 7-centimeter (32 side hole) drainage tube.

Keywords: Total knee arthroplasty, Postoperative blood loss, Close suction drainage, Drainage tube length

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The postoperative period after total knee arthroplasty (TKA) surgery is associated with significant blood loss requiring blood transfusion[1]. The greatest blood loss occurs during the first few hours after surgery, with 55% of total blood loss in first four hours. Several methods have been shown to be effective in reducing blood loss, e.g., tranexamic acid[2-5], dilute epinephrine[6] administered via intra-articular or periarticular injection[7] or via combined routes[8], temporary drain clamping[9,10], no drainage[11], fibrin sealant[12], and an intramedullary plug[13]. A closed suction drainage system is routinely used in postoperative orthopaedic surgery for removing collected blood, which can be a cause of infection and wound complications. However, those methods frequently increase blood loss because they reduce the intracapsular tamponade effect. Temporary drain clamping is another method that effectively reduces postoperative blood loss[14], especially in the first four hours[9].

In the present study, there have been no clinical studies of the correlation between the length of suction drainage and the amount of postoperative blood loss. The number of side holes in a drainage catheter is directly proportional to the length of the suction drainage tube. Thus, the authors hypothesized that a shorter drain length, i.e., fewer side holes, would result in reduced postoperative blood loss after TKA surgery. The purpose of the present study was to compare the quantity of blood loss with a 3-cm (14 side hole) and a 7-cm (32 side hole) suction drainage catheter.

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Materials and Methods

One hundred forty patients with osteoarthritis who underwent unilateral TKA at Department of Orthopaedics of Khon Kaen Hospital were prospectively studied between August 2012 and January 2015. The

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Table 1. Patient demographics

	3-cm drain length group	7-cm drain length group	p-value
Number of patients, n	70	70	
Age (years), Median (range)	63.54 (56 to 76)	61.46 (51 to 77)	0.07
Sex, n (%)			0.81
Male	12 (17.14)	14 (20.00)	
Female	58 (82.86)	54 (77.14)	
Body weight (kg), Mean±SD	65.36±11.63	66.16±8.31	0.69
Height (cm), Mean±SD	156.66±7.57	159.72±8	0.05
Body mass index (kg/m^2), Mean±SD	26.50±3.81	26.04±3.65	0.54

SD=standard deviation

present study was approved by the Hospital Ethics Committee. All patients provided written informed consent before participation. Patients were randomly assigned in equal numbers to one of two groups by computer generated numbers based on blocks of two and four. Each randomized result was sealed in an opaque envelop. Complete blood count, prothrombin time, partial thromboplastin time, and creatinine level were recorded for all patients. Exclusion criteria were simultaneous bilateral TKA, bleeding disorder, previous knee surgery, and anticoagulant use. Patient demographic characteristics are described in Table 1. The demographic characteristics of both groups were similar.

All 140 primary TKA were performed using an identical type of prosthesis, a cemented PFC® Sigma® with posterior stabilized design for primary total knee prosthesis (DePuy Synthes, Warsaw, Indiana). All TKA operations were performed by the same surgeon (Piyakunmala K) using the same surgical technique. In each case, a pneumatic tourniquet was placed at the upper thigh and inflated to a pressure of 350 mmHg. The knee was exposed through a midline skin incision and medial parapatellar approach. During wound closure, the randomized numbered envelope was opened, and the assisting surgeon inserted either a 3-cm (14 side hole) or a 7-cm (32 side hole) suction drainage catheter according to the randomized result. A suction drainage catheter was placed in the lateral gutter of the knee. The tourniquet was deflated after completion of wound closure. The surgeon was blinded to the patient's catheter assignment. A closed suction drain (Redon-Drain® pfm medical CH 8, Germany) with a 2 mm inner diameter central hole and a 1 mm diameter side holes was placed in each patient. The vacuum bottle was pre-evacuated to 98,000 Pa/980 mbar pressure and had an indicator of negative pressure. The drain was clamped for the first four postoperative hours in both groups after which it was unclamped until 72 hours postoperatively. The amount of drainage in the closed suction bottle was recorded every eight hours for the first 24 hours and then once daily until 72 hours. The hematocrit (Hct) level was checked once daily until 72 hours. Red blood cells were transfused if the Hct level was below 30%. The number of transfused red blood cell units was recorded once daily for 72 hours. Wound infection, abnormal wound discharge, and fever after the first 24 hours were monitored until discharge from the hospital. The assessor did not know the group of patients. All patients had a same postoperative physical therapy protocol, and none received deep venous thrombosis prophylaxis.

Statistical analysis was performed using the Stata statistical software, version 13 (StataCorp, College Station, TX, USA) for Windows®. Power calculation was based on the primary outcome measurement of blood loss per group. The sample size of 140 patients (70 per group) was determined using a two-tailed continuity corrected unpaired Student's t-test with 80% power and a 5% level of significance. Data are reported as mean ± standard deviation. Statistical analysis was performed with Student's t-test for interval data and Fisher's exact test for categorical data. A p-value of less than 0.05 was considered statistically significant.

Results

There was significant difference in the amount of blood loss between two groups (Table 2). Blood loss was significantly lower in the 3-cm drain group than in the 7-cm drain group at 8-hour (109±125.26 ml versus 173±149.80 ml, p=0.02) and at 16-hour (255.40±139.35 ml versus 328.80±164.20 ml, p=0.02). Blood loss at 24-hour, 48-hour, and 72-hour was not significantly different between the two groups. The number of red blood cell transfusion units at 48 hours was 0.20±0.40 units in the 3-cm drain

Table 2. Comparison of operative time, blood loss, Hct, red blood cell transfusion, and wound condition

	3-cm drain length group Mean±SD	7-cm drain length group Mean±SD	p-value
Operative time (minutes)	99.50±24.56	95.70±19.46	0.39
Intraoperative blood loss (ml)	20.50±10.46	21.80±4.38	0.42
Postoperative blood loss (ml)			
8 hours	109.00±125.26	173.00±149.80	0.02*
16 hours	255.40±139.35	328.80±164.20	0.02*
24 hours	362.80±188.17	419.40±196.90	0.14
48 hours	575.00±272.14	598.00±258.00	0.66
72 hours	612.20±284.27	629.44±279.39	0.76
Preoperative Hct (%)	37.39±3.69	38.08±4.42	0.39
Postoperative Hct (%)			
24 hours	34.33±3.66	34.97±3.97	0.41
48 hours	32.26±2.94	32.06±3.52	0.75
72 hours	33.26±2.15	33.14±2.48	0.80
Red blood cell transfusion (units)			
24 hours	0.16±0.37	0.20±0.40	0.60
48 hours	0.20±0.40	0.46±0.54	0.01*
72 hours	0.08±0.27	0.12±0.33	0.05
Wound infection, n (%)	0 (0.00)	0 (0.00)	0.00
Abnormal wound discharge, n (%)	0 (0.00)	0 (0.00)	0.00
Fever after 24 hours, n (%)	2 (2.85)	4 (5.71)	0.68

SD=standard deviation; Hct=hematocrit

* Statistically significant p<0.05

group and 0.46±0.54 units in the 7-cm drain group, a statistically significant difference (p=0.01). There was no significant difference in either postoperative Hct level or drainage-related complications.

Discussion

The postoperative blood loss into the closed suction drain in the 3-cm drain group was reduced significantly as compared with the 7-cm drain group at both 8- and 16-hour, but the difference was not significant at 24-, 48-, or 72-hour.

The tamponade effect in the joint space is a major factor related to postoperative blood loss. When intracapsular pressure is released slowly, effective hemostatic pressure can be maintained, reducing blood loss. Thus, the shorter drainage length method results in slower release of intracapsular pressure and thus less blood loss.

An ideal method of reducing postoperative blood loss should be easy to use with every patient, should require no special equipment or techniques, and should present no potential complications. Several studies have reported on the effective methods to reduce postoperative blood loss in TKA, e.g., injection of diluted epinephrine solution or tranexamic acid, temporary clamping of drainage, and using no drainage system. However, adverse effects resulting from those medical procedures can potentially adversely affect the health of the patient. For example, epinephrine can cause serious side effects such as breathing difficulty, dangerously high blood pressure, severe headache, chest pain, and palpitation as well as less severe side effects including nausea, vomiting, sweating, dizziness, and anxiety. Tranexamic acid is an antifibrinolytic drug that reduces excessive bleeding. In clinical practice, however, there is a caution of tranexamic acid use with some patients, especially those with a history of coronary artery disease, stroke, or thromboembolic event due to the potential risk of adverse events from promoting clotting. Previous meta-analysis studies have reported that patients with no drainage had more complications than patients who received drainage, e.g., soft tissue ecchymosis and a requirement for wound dressing reinforcement[11]. The present study showed that a shorter drainage length was easy to use, safe, and resulted in no additional cost.

Although the difference in red blood cell

transfusion at 48 hours (0.2 unit versus 0.46 unit) was statistically significant, the standard deviation was quite large. In practice, a physician replaces blood transfusion in a minimum of one unit. From these results, it probably had minimally clinical benefit. That postoperative Hct level was not reduced significantly may have been due to the influence of factors such as dehydration and postoperative red blood cell transfusion.

The present study had some limitations. First, the amount of blood in the suction drainage bottle was not the exact amount of postoperative blood loss because some lost blood remained in the knee joint. However, the amount of blood in the suction bottle was the most practical method. Second, suction drainage function can be disturbed by a kinked or pinched catheter during the postoperative rehabilitation program.

Conclusion

The present study found that the length of the suction drainage tube was associated with the amount of postoperative blood loss after TKA surgery. A 3-cm (14 side hole) drain significantly reduced blood loss in the first 16 hours and reduced red blood cell transfusion 48 hours postoperatively compared to a 7-cm (32 side hole) drain. The shorter drain length method was shown to be both easy and safe.

What is already known on this topic?

Several methods have been shown to be effective in reducing blood loss after total knee arthroplasty surgery. Temporary drain clamping is one of those methods. There have been no clinical studies of the correlation between the length of suction drainage and the amount of postoperative blood loss.

What this study adds?

The present study found that the length of the suction drainage tube was associated with the amount of postoperative blood loss after total knee arthroplasty surgery.

Conflicts of interest

The authors declare no conflict of interest.

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