After Total Knee Arthroplasty Different Knee Position Bring Distinct Effects—a Prospective Study of One Hundred Patients

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Research Article

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Abstract

Background Following total knee arthroplasty (TKA) blood loss is a major factor influencing functional recovery and quality of life in patients. The aim of this study was to determine the effect of postoperative leg position on blood loss and functional recovery after TKA.

Methods One hundred consecutive patients were enrolled in this prospective randomized study, which with degenerative osteoarthritis of the knee. An equal number of patients were randomly allocated to either flexion or extension groups. In the flexion group, the affected leg was elevated 45° at the hip and with 45° of flexion at the knee, while patients in the extension group had the knee extended fully. Primary outcomes were calculated total blood loss (CBL), hidden blood loss (HBL), intraoperative blood loss (IBL), haemoglobin (HB) level and haematocrit (HCT).

Results CBL, HBL, postoperative levels of HB and HCT, drop level of HB and HCT between the two groups after 72 hours were significantly different, with patients in the flexion group experiencing lower blood loss than those in the extension group (P < 0.05). However, there no difference between groups in the postoperative levels of HB and HCT, drop level of HB and HCT at 24 hours. Even though after 1 week range of motion (ROM) was statistical difference in groups, but after 6-week rehabilitation, patients from both groups attained a similar ROM in the knee.

Conclusions The results of this study definite that after TKA execute the protocol—maintaining a position with the hip 45° flexion and the knee flexed at 45° prolong 48 hours, is an effective method for reducing blood loss and increasing functional ROM.

Introduction

With the growth of the elderly, more people suffering the pain of knee osteoarthritis, and total knee arthroplasty as an effective choice to solve the problem. During procedure include capsule resection, soft tissue release and bone incisions, all the operation lead to significant blood loss.

Blood loss after total knee arthroplasty may reach up to 1500ml in average result to an important health issue and also economical concern[6]. With the blood loss, many factors about the success of TKA will be change, such as range of motion, infection, DVT and knee swelling. Therefore, search for better blood management minimizing blood loss has long been a major question. Intraoperative several aspects can reduce blood loss; the use of tourniquet[13], minimally invasive surgery[11], injection tranexamic acid (TXA)[23,2], computer assisted TKA [18] and drain placement protocols[20]. Methods of postoperative include utilize elastic bandage[4], cryotherapy[10], continuous passive motion (CPM) and postoperative knee position regimens[17].

Many research reported positing the knee in flexion postoperative is a simple and cost-effective way to reduce blood loss and improve patient outcomes while decreasing the hospitalization day and medical cost. However, nearly studies reported the effects of different position have contradictory results. A
recently systematic review study concluded that the flexion protocol has significantly decreased in hemoglobin level after surgery during 48h to 6days, while no significant difference at 24 h after surgery\(^2\)\(^2\).

With the state of no specific consensus, even though systematic review study has a conclusion, but there have not illustrated exact limb position or duration of flexion which can bring the most benefits\(^4\). So we choose the protocol of 48h after total knee arthroplasty in different knee position to examine the effect of blood loss and related parameters.

**Materials And Methods**

**Study design**

From July 2019 to June2020, one hundred consecutive patients who diagnosed degenerative osteoarthritis was randomized divide into two groups have been taken primary TKA. The study was approved by our hospital, and after declaring the risks and benefits of study, we obtained all patients informed consent. Patients were exclusion included the following: rheumatoid arthritis, revision TKA, diabetes, haemostasis defects(eg. Hemophilia arthritis), neuromuscular diseases, preoperative haemoglobin level less than 10g/dl, history of knee trauma or surgery, disorders of the hips, metabolic bone disease and other serious medical conditions.

One hundred patients are allocated to equal number of two groups, either flexion or extension, using a random number list produced after the TKA surgery. Patients in the flexion group which leg position with the hip 45° flexion and the knee flexed at 45° using a continuous passive motion machine. Other group had the knee extended fully, also with 45° hip flexion. All the patients maintain the position until 48 hours after surgery. Two group patients were matched for age, gender, body mass index (BMI), preoperative haemoglobin and haematocrit, preoperative ROM (Table 1).

**Table 1** Demographics and baseline measurements

|                         | Extension group | Flexion group | P value |
|-------------------------|-----------------|---------------|---------|
| Age(years)              | 66.11±8.26      | 65.91±7.10    | 0.91    |
| Gender F/M              | 35(24/11)       | 35=28/7       | 0.41    |
| BMI(kg/m2)              | 26.55±3.98      | 27.48±4.66    | 0.37    |
| Preoperative HB(g/dl)   | 12.4±1.29       | 12.6±1.38     | 0.43    |
| Preoperative HCT (%)    | 38.48±3.52      | 38.21±3.26    | 0.73    |
| Preoperative ROM        | 94.2±17.6       | 92.9±23.1     | 0.59    |

F: female, M: male, BMI: Body mass index, HB: hemoglobin, ROM : range of motion, HCT : hematocrit
**Surgical procedure**

All patients performed operations under general anesthesia by the same group of surgeons skilled in TKA. Throughout the operation blood pressure was evaluated, tourniquet start use after osteotomy accomplish. Everyone received two endovenous doses of Tranexamic acid (500mg*2) and Cefuroxime sodium (1.5g) about 30 minutes before skin incision. All operation was performed via a midline skin incision and medial parapatellar approach. The implant type which used for surgery is posterior-stabilized, total knee prosthetic component(GEMINI PS ,LINK, Hamburg, GER). A bone graft obtained from previous bone cuts was inserted into the femoral canal to reduce blood loss. After reshaped of the patella to match better moving faces to the femoral component trochlea. At the end of operation, all patients positioned a drainage and keep in for the first 24h. A compressive bandage was applied to at the end of surgery. During the surgery none patient were transfused blood. All the affected knee injected an cocktail mixed drug (NS 60ml, ropivacaine100mg, adrenaline 0.3mg, tranexamic acid 1g) into cavum articulate for analgesia and sustain close the channel in the first 4 hours.

**Postoperative management**

At the first 24hours, ice bag was placed around the operation knee, and then removed the drainage after measured blood loss. Every patient received strict procedure for thromboprophylaxis in the form of low molecular weight heparin natrium (3200iu) daily before leave hospital. For control postoperative pain, NSAID drug was used. Even some patients were given a self-controlled analgesia system machine until 48h after surgery. The bandage changed during remove drainage, and removed on 3 days after surgery. It will be started at 48h postoperative, active isometric quadriceps. Initiative straight leg raises and extension-flexion motion. When the level of hemoglobin below 8g/d, and also accompany dizziness and tachycardia, transfusion blood be performed.

**Outcome assessment**

We obtained calculated total blood loss, hidden blood loss, intraoperative blood loss, haemoglobin level and haematocrit measured after 24 and 72 hours, ROM at 7days and 1 month postoperatively, pain score of preoperative and postoperative. CBL, as the sum of HBL and IBL, which calculated from the change of haematocrit using the formula reported by Gross and Nadler. Before the surgery, all the patients have been record ROM of operative knee. Using American knee society knee score (ASS) as the standard for evaluation two times, first is before operation, next is 1 month postoperative. All assessment had been accomplished by two surgeons independent and if have different score, they discussion result in one score. With surgery have some complications such as incision infection and deep vein thrombosis(DVT) had been diagnosed each DVT by doppler ultrasound. All the result of parameters except pain scores for analysing assessed by a surgeon who blinded to the groups.

**Statistical analysis**
Choose SPSS for Windows 17.0 software as for Statistical analysis, Continuous data with normal distribution were expressed as means (±SD). Use the two-tailed Student t-test for comparison, at the same time the chi-square test was used for nominal data. Define the different level of P<0.05 was statistically significant.

Results

The outcomes of this study are summarized in the Table (2). CBL in the extension group was 1150±391ml and flexion group was 880±310ml, between two groups is have different significant (P=0.03), IBL was 258±61ml and 263±310ml respectively, no different significant (P=0.75), HBL in the extension was 596±83ml and in the flexion was 462±78ml, (p=0.00). Drop of HB and HCT levels also been calculate, after 24h after operation, 1.57±1.10 in the flexion and 1.49±0.98 in the extension with HB, (P=0.74); HCT was 4.45±2.65 and 4.20±2.09 in flexion and extension respectively, they have no different (p=0.67). But postoperative 72h, the drop levels of HB in group flexion are 3.0±1.24, and have different significant (p=0.00) with group flexion, 2.48±0.97. Drop levels of HCT in two groups are 8.6±3.2 and 6.4±2.4, (p=0.00).

The functional results of the surgery knee, after the operation 7 days, ROM was 98±8.3° in the flexion group and 103±10.5° in another group, there was statistical difference, p=0.03; however, undergone 4 weeks rehabilitation, ROM of two group is 118±11.5° and 116±9.7°, they had no statistical difference, p=0.96;

There some common postoperative complications occurred in the patients. In the flexion group 3 incision infections and 1 in the extension group; all the cases have been observed DVT in the hospital.

Table 2 Clinical outcome and complications
|                           | Extension group | Flexion group | P value |
|---------------------------|-----------------|---------------|---------|
| CBL(ml) 72h              | 1150±391ml      | 880±310       | 0.03    |
| IBL(ml)                  | 258±61ml        | 263±57ml      | 0.75    |
| HBL(ml) 72h              | 596±83m         | 462±78ml      | 0.00    |
| Postoperative HB(g/dl)-24h | 11.3±1.74    | 11.0±1.34     | 0.94    |
| Postoperative HCT(%)-24h | 33.9±3.49       | 34.1±4.52     | 0.83    |
| Drop of HB level-24h     | 1.57±1.10       | 1.49±0.98     | 0.74    |
| Drop of HCT level-24h    | 4.45±2.65       | 4.20±2.09     | 0.67    |
| Postoperative HB(g/dl)-72h | 9.68±1.43    | 10.09±1.11    | 0.00    |
| Postoperative HCT(%)-72h | 29.8±4.13       | 32.4±3.92     | 0.01    |
| Drop of HB level-72h     | 3.0±1.24        | 2.48±0.97     | 0.00    |
| Drop of HCT level-72h    | 8.6±3.2         | 6.4±2.4       | 0.00    |
| ROM-1 week(°)           | 98±8.3          | 103±10.5      | 0.03    |
| ROM-4 weeks             | 118±11.5        | 116±9.7       | 0.96    |
| Infection                | 3               | 1             |         |
| DVT                      | 0               | 0             |         |

ROM: range of motion, DVT: deep vein thrombosis

**Discussion**

After TKA the blood loss and functional recovery can be influenced by many factors. How to reduce blood loss be interested in orthopaedic doctors, many techniques be used in such as Intravenous tranexamic acid during pre-operative; use tourniquet; administration of erythropoietin and so on.

Intra-operative pharmacological treatment, TXA have been used frequently. AS an inhibitor of fibrinolysis, tranexamic acid acts by blocking the lysine-binding site of plasminogen to fibrin. It has been reported to reduce intraoperative and post-operative blood loss after TKA[5,3]. Not only can reduce blood loss, but also which can inhibit plasmin and lower inflammation. Therefore, in this study every patient administered intravenously TXA[16,8].

To minimize blood loss surgeons are often using a tourniquet in operation, which could reduce the intraoperative blood loss and decrease surgery time. But there some argument about the effect of use tourniquet, Tetro et al reported that during TKA using tourniquet can reduce the total blood loss[21], however in the other research showing the contrary viewpoint. Whatever the effect of tourniquet, we agree
that using it in the operation can take the view of incision clear and the surgery time more shortly. Tourniquet use also significantly decreases the risk of complications [19,1]. Tourniquets were used during the procedure and not one patient occur adverse reaction.

There numerous studies reported postoperative flexion TKA reducing blood loss and transfusion rate and improving ROM. On the contrary also a lot of research showed between leg extension and flexion they have no significant difference on blood loss and others. On the study from Ong et al, which compare three different postoperative positioning on blood loss, groups of knee flexion at 70°and 35°less than about 25% of CBL in the full extension group[7]; Li et al. performed a study with flexion patients knee to 30°and extension prolong 72h postoperative, the result of compare two groups that knee flexion significantly less blood loss, which include CBL and HBL[12].

On the other side, Ma et al. reported the blood loss between knee flexion of 70°and extension for the first 24h is no significant difference[14]. Madarevic et al reported similar results comparing four methods which contain knee position to reduce blood loss. No difference in the two groups [15].

There some factors influence the results. Firstly, different surgical technique by the surgeon may bring different outcome, such as surgery time, intraoperative blood loss and so on. Secondly, the angle of flexion and prolong time affect postoperative blood loss. Prolong high angle of knee will compress the popliteal vessels lead to local perfusion reduction and increase incision oxygen tension result in wound complications, such as infection of the incision. Not just the angle, but the maintenance time also important for the affection. Many researches have shown results which maintain time from 6hours to 72 hours, but there no clear standard for the time. Faldini et al make a meta-analysis include 7studies found the project lasting 48-72h postoperatively can be effective and way to improve ROM and reduce blood loss[5][9]. On the other hand, Charalambides C et al report that patients treated for 48 hours compression with high–elasticity bandages have shown faster postoperative recovery, shortly hospital days[4]. Based on these, in our study all patients execute the program which maintains 48 hours and 45°of flexion for the study group. With the drop of blood loss the function ROM also restore more quickly. On the on hand, which took less time to regain an adequate level of health; on the other hand, lower degree of swelling and effusion reduce the burden on the quadriceps, bring leg straight for exercises easier.

From the result of this study, mild flexion position with 48 hours could be an effective protocol to reduce blood loss after TKA. Not only the prolong time is easier to be accepted, but also the angle of leg is not deep bring some positive impact, which include lower blood loss, high ROM in the initial postoperative section and shorter time to recovery. So this program is worthy to be done popularized.

There are must be some limitations kept in our results. First, the number of included patients was relatively small; this limitation the degree of reliability. Second, all the medical history of people was not deeply investigated. Therefore, there some morbidities could influence the results. Whereas, the protocol to be done easily repeatable and the results are inspiring.
Conclusion

The results of this study definite that after TKA execute the protocol, maintaining a position with the hip 45° flexion and the knee flexed at 45° prolong 48 hours, is an effective method for reducing blood loss and increasing functional ROM, which can reduce length of hospitalization and social cost for TKA procedures.

Abbreviations

TKA: total knee arthroplasty; CB: calculated total blood loss; HBL: hidden blood loss; IBL: intraoperative blood loss; HB: haemoglobin; HCT: haematocrit; ROM: range of motion; TXA: tranexamic acid; DVT: deep vein thrombosis

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

We obtained permission from the participants to publish their data

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Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Contributions

Ke Zheng : idea, surgery (assistant), writing, and correction; Wen-xiang Liu: surgery (assistant), clinical follow-up and data collection; Jie-bin Zhang: surgery (performer), expert opinion and correction. The authors read and approved the final manuscript
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