



Potentials of tranexamic acid injection to reduce bleeding in patients of total knee replacement procedure

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Abstract

Background: The high number of patients with knee osteoarthritis causes an increasingly frequent arthroplasty. This surgical procedure of Total Knee Replacement poses a risk of massive bleeding, which can affect albumin levels and cause intra-compartmental pressure on the nerves. **Objective:** This study aims to determine the effect of tranexamic acid injection on total blood loss, the degree of pain, and the need for blood transfusions after surgery in patients undergoing the procedure for Total Knee Replacement. **Method:** The study was an experimental research using primary data from laboratory examination obtained before and after surgery in 64 patients of Total Knee Replacement surgery in the ER operating theater of Dr. Soetomo Regional Public Hospital, Surabaya. **Result:** In the group receiving tranexamic acid, the group with 32 people (100%) reported a low postoperative VAS score, and did not require blood and albumin transfusions. In the group not receiving tranexamic acid, 32 people (100%) had a moderate postoperative VAS score, where four people (12.5%) required blood transfusions, and three people (9.4%) required albumin transfusions. **Conclusion:** The administration of tranexamic acid reduce total blood loss, the degree of pain, and reduce the need for blood transfusions after total knee replacement surgery.

Keywords: total knee replacement, tranexamic acid, hemoglobin, albumin, bleeding, VAS Score, transfusion

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INTRODUCTION

The World Health Organization (WHO) estimates that 37.4% of the world's population over 70 years old suffering from knee osteoarthritis, and 12.1% of them have symptomatic knee osteoarthritis (Ganvir, 2013). WHO includes knee osteoarthritis in the list of Global Burden of Disease (sbagio, 2004). The arthroplasty procedure, as one of the most common joint replacement actions, includes the total hip replacement (THR) and total knee replacement (TKR) because the procedure is safe and cost-effective for complaints of knee pain due to osteoarthritis. In addition, the recovery of physical functions is simple and quick in patients who do not respond to conservative treatment (Utomo, et al. 2018, Nugraha, Haryadi, & Cahyono, 2019). The surgery is considered successful if the patient is capable of doing 10⁰-90⁰ flexion (Utomo, et al. 2018).

TKR surgery is a major surgery in the orthopedic field with the potential for significant blood loss due to the extensive soft-tissue release and bone cutting. The total blood loss in total knee replacement surgery is approximately 800–1,800 ml (Dang, & Schwarzkopf, 2013). It is estimated that approximately 15 million

transfusions are carried out annually, and approximately 20% of them poses side effects. Various methods are used to reduce bleeding, including tourniquet use, although previous studies have proven it to be ineffective (Prasad, Padmanabhan, & Mullaji, 2007; Tamiru, et al, 2015).

Hyperfibrinolysis is one of the main factors in postoperative bleeding after Total Knee Replacement procedure (Pabinger, et al. 2017). Therefore, one of the pharmacological options is using an anti-fibrinolytic agent, such as tranexamic acid. Tranexamic acid is a fibrinolytic inhibitor that prevents clot lysis by inhibiting the proteolytic activity of the plasminogen activator because tranexamic acid has a strong bond with the lysine binding sites on plasminogen and plasmin, competitively causing the inhibition of plasmin activation and inhibiting the clots from degradation, thus, stopping the bleeding (Winter, 2017, Henry, et al. 2011).

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Table 1. Examination Results of Average Hb and Albumin Levels Before Surgery

| Types of examination | With Tranexamic Acid | Without Tranexamic Acid |
|----------------------|----------------------|-------------------------|
| Hemoglobin (g/dl) | 13.06±1.46 | 12.44±0.87 |
| Albumin (g/dl) | 3.91±0.26 | 3.87±3.9 |

Table 2. Patient Examination Results After Total Knee Replacement Actions

| Types of examination | With Tranexamic Acid | Without Tranexamic Acid |
|-----------------------------------|----------------------|-------------------------|
| Hemoglobin (g/dl) | 13.06±1.46 | 12.44±0.87 |
| Albumin (g/dl) | 3.91±0.26 | 3.87±3.90 |
| Total blood loss | 219.38±25.89 | 377.50±46.14 |
| VAS scores | | |
| Low | 32 (100%) | 0 (0%) |
| Moderate | 0 (0%) | 32 (100%) |
| The need for blood transfusions | | |
| Yes | 0 (0%) | 4 (12.5%) |
| No | 32 (100%) | 28 (87.5%) |
| The need for albumin transfusions | | |
| Yes | 0 (0%) | 3 (9.4%) |
| No | 32 (32%) | 29 (90.6%) |

Tranexamic acid works in maintaining hemostatic clots to make hemostasis more efficient by reducing the risk of postoperative bleeding in total knee replacement. Therefore, it is expected to reduce blood loss, the degree of pain after surgery, and hypoalbuminemia and hemoglobin levels after surgery (Crash-2 Collaborators. (2011).. This study aims to determine the effect of tranexamic acid injection on total blood loss, the degree of pain, and the need for blood transfusions after surgery in patients undergoing the Total Knee Replacement procedure.

METHOD

This study was an experimental study in patients undergoing Total Knee Replacement surgery by administering the tranexamic acid injection. The study was divided into two patient groups that received and did not receive the tranexamic acid injection. The tranexamic acid (15 mg/Kg BW) was administered 15 minutes before the tourniquet was installed (150 mmHg + patient's systolic pressure), three and six hours after surgery. Furthermore, measurements were carried out on hemoglobin and albumin levels, total blood loss, and the degree of pain.

The population in this study included all patients who underwent Total Knee Replacement surgery at Dr. Sootomo Regional Public Hospital, Surabaya that fulfilled the inclusion and exclusion criteria. The total samples in each group amounted to 32 patients, while the grouping was carried out using systematic random sampling.

The data from the study results were presented descriptively. Furthermore, the data were processed and analyzed using a dependent t-test to determine the differences in hemoglobin levels, total blood loss, albumin levels, and the need for blood transfusions. On the other hand, the Mann-Whitney test was utilized to determine the differences in the degree of pain between groups who received and did not receive the preoperative intravenous tranexamic acid injection.

RESULT

The results of preoperative hemoglobin examination in the patient groups who received tranexamic acid therapy indicated the average albumin level of 13.06±1.46g/dl. In the patient group who did not receive tranexamic acid therapy, the average hemoglobin level reached 12.44±0.87g/dl.

The results of preoperative albumin examination in the patient groups who received and did not receive tranexamic acid therapy indicated an average albumin level of 3.91±0.26 g/dl and 3.87±3.9 g/dl, respectively.

After a total knee replacement action was conducted, the patients were examined for hemoglobin and albumin levels, total blood loss, the need for blood, and albumin transfusions. The results of postoperative hemoglobin examination in the patient groups who received and did not receive tranexamic acid therapy reached an average hemoglobin level of 10.29±1.14 g/dl and 9.16±0.97 g/dl, respectively.

The results of postoperative albumin examination in the patient groups who received and did not receive tranexamic acid therapy indicated an average albumin level of 3.20±0.28 g/dl and 3.10±0.40 g/dl, respectively.

The calculation results of total blood loss after surgery in the patient groups who received and did not receive tranexamic acid therapy suggested average blood loss level of 219.38±25.89 ccs and 377.50±46.14 ccs, respectively.

Based on the measurement results of the degree of pain using VAS scores, the patients who received tranexamic acid therapy indicated a low VAS score in 32 people (100%) and a moderate VAS score in 0 people (0%). On the other hand, in the patient groups who did not receive tranexamic acid therapy, 0 people (0%) had a low VAS score category, and 32 people (100%) had a moderate VAS score category.

In the calculation results of the needs for blood transfusions, the number of patients with tranexamic acid therapy who required blood transfusions reached 0

people (0%) and those who did not require blood transfusions amounted to 32 people (100%). In the patient group without tranexamic acid therapy, the patients requiring blood transfusions were four people (12.5%) and those who did not reached 28 people (87.5%).

DISCUSSION

In this study, it had been found that there were statistically significant differences in the average hemoglobin levels after surgery between the groups with and without tranexamic acid therapy. The average hemoglobin levels in the patient group with tranexamic acid administration were higher than that without tranexamic acid administration. These results proved that tranexamic acid could lower the bleeding effectively because bleeding after arthroplasty surgery often occurs in the first 24 hours (Ganvir, 2013, Goyal and Sardana, 2019, Isbagio, 2004, Prasad, Padmanabhan, & Mullaji, 2007., Pabinger, et al. 2017).

Low albumin level could increase the complication risks in total knee replacement surgery (Triyudanto, & Lubis, 2016). In this study, the groups with and without tranexamic acid therapy indicated the statistically insignificant differences in the average levels of postoperative albumin level. The average levels of albumin in the patient group with tranexamic acid were higher than that without tranexamic acid ($p = 0.257$). Higher albumin levels in the patient group with tranexamic acid therapy could reduce the risk factors for bleeding.

This study found that the groups with and without tranexamic acid therapy had statistically significant differences in the average levels of total blood loss after surgery. The average levels of total blood loss after surgery in the patient group with tranexamic acid was lower than that in the group without tranexamic acid ($p =$

0.000). The study meta-analysis indicated that the use of tranexamic acid in total knee replacement significantly lowered the total blood loss. Tranexamic acid inhibits the activation of the plasminogen molecule, which prevents plasmin from binding to fibrinogen and fibrin structure after clots are formed (Breugem, & Haverkamp, 2014).

Postoperative bleeding can also increase intra-compartmental pressure, which also increase the pain and VAS scores in the patients. This study indicated that low VAS scores reached the most occurring in the patient group with tranexamic acid therapy ($p = 0.000$). The small amount of bleeding in the group administered with tranexamic acid injection could be a factor in patients' pain reduction.

The decrease in blood transfusions was found in this study, in which the patient group with tranexamic acid therapy did not require blood transfusions ($p = 0.113$). This result may come from the fact that postoperative bleeding was a hemostatic mechanism of fibrinolysis, where anti-fibrinolytic drugs, such as tranexamic acid, are very effective in treating bleeding (De-jie, et al. 2013, Yang, Chen, & Wu, 2012). The researchers realized that the number of samples in this study was limited. Therefore, further studies with the same topic were highly recommended.

CONCLUSION

The administration of tranexamic acid reduces total blood loss, the degree of pain, and the need for blood transfusions after total knee replacement surgery.

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