

The effects of navigation and tranexamic acid in reducing the need for blood transfusion after TKA

Suk Kyoong Song

Catholic University of Daegu School of Medicine

Hee Chan Kim

Catholic University of Daegu School of Medicine

Seung Bum Chae

Catholic University of Daegu School of Medicine

wonkee choi (✉ cwk1009@hanmail.net)

Catholic University of Daegu School of Medicine <https://orcid.org/0000-0002-4671-5656>

Research article

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Abstract

Background:

We investigate the synergistic effect of the use of tranexamic acid and navigation in reducing the need for blood transfusion after total knee arthroplasty (TKA). Secondly, we compare the effects of navigation and tranexamic acid on blood transfusion reduction after TKA.

Methods:

Patients were divided into 3 groups and compared. Those who had manual TKA with the use of tranexamic acid were group 1 (N = 30), those who had navigated TKA without tranexamic acid were group 2 (N = 30), and those who had navigated TKA with tranexamic acid were group 3 (N = 30). Group 1 was studied prospectively, while group 2 and 3 were studied retrospectively. All operation was held by one operator. We measured the frequency of transfusion after the operation within the admission period. To compare the postoperative bleeding, drainage volume during two days after surgery was compared and analyzed.

Results:

Group 1 (Manual TKA with tranexamic acid) had 2 cases of transfusion (6.7%), while there were 9 cases in group 2 (Navigated TKA with no tranexamic acid) (30%), and 3 cases in group 3 (Navigated TKA with tranexamic acid) (10%). In Chi-square test, this difference was statistically significant. Average of 525.50 ± 194.91 ml of drainage was drained in two days after surgery in group 1 (Manual TKA with tranexamic acid), 611.60 ± 263.20 ml in group 2 (Navigated TKA with no tranexamic acid) and 411.42 ± 188.21 ml in group 3 (Navigated TKA with tranexamic acid). This difference was analyzed in one-way ANOVA which showed significantly different. The need for transfusion in group 2 (Navigated TKA with no tranexamic acid) was 5.86 times higher than that in group 1 (Manual TKA with tranexamic acid). The necessity of transfusion in the group 3 (Navigated TKA with tranexamic acid) was 0.199 times higher than that of the group 2 (Navigated TKA with no tranexamic acid).

Conclusion:

The combined use of navigation and tranexamic acid has no synergistic effect in reducing post TKA bleeding and the need for blood transfusion compared to tranexamic acid alone. And, use of tranexamic acid is more effective than navigation in reducing blood transfusions and blood loss after TKA.

Background

Transfusion of blood after total knee arthroplasty (TKA) has widely been known as one of the main causes of postoperative infection[1]. To prevent transfusion, operators use tourniquets or inject tranexamic acid or etc[1–4]. Use of tranexamic acid has been proved to decrease the necessity of transfusion after TKA. Using navigation is an alternative way to reduce transfusion[5–7]. In using navigation, operators can conduct femur side bone cutting without damaging the femoral medulla, which leads to less bleeding because it prevents intra-medulla hemorrhage[8]. We intend to investigate the synergistic effect of the use of tranexamic acid and navigation in reducing the need for blood transfusion after TKA. In addition, we will compare the results of manual TKA with tranexamic acid and navigated TKA without tranexamic acid to compare the effects of navigation and tranexamic acid on blood transfusion reduction after TKA. To the best of the authors' knowledge, this would be the first study for synergic effect of navigation and tranexamic acid in reduction transfusion and blood loss after total knee arthroplasty. This study has been conducted after the approval of IRB.

Method

Patient Group

Patients were divided into 3 groups and compared. Those who had manual TKA with the use of tranexamic acid were group 1, those who had navigated TKA without tranexamic acid were group 2, and those who had navigated TKA with tranexamic acid were group 3. Group 1 was studied prospectively, while group 2 and 3 were studied retrospectively by analyzing data from 2016 to 2018. All operation was held by one operator. Those who had ant-thrombotic medication were excluded due to risk of additional bleeding. Patients who had both TKA during one admission, 2nd operation was excluded because it has more risk of transfusion.

Group 1

Prospective study was conducted on 45 consecutive cases of TKA which held since January 2019 by one operator. In 45 cases, 10 cases which used antithrombotic agents and 5 cases of 2nd operations of TKA during one admission were excluded. All cases were manual (non-navigated), and 5ml of tranexamic acid was injected into knee joint. Closed drainage was clamped for 3 hours and released after the injection.

Group 2

Retrospective study was conducted on 30 consecutive cases of TKA which held between January 2016 and June 2016 by one operator. All cases were navigated but tranexamic acid was not used. Closed drainage was clamped for 3 hours and released after surgery.

Group 3

Retrospective study was conducted on 30 consecutive cases of TKA which held between January 2017 and June 2017 by one operator. All cases were navigated and 5ml of tranexamic acid was injected into knee joint. Closed drainage was clamped for 3 hours after injection and released.

Surgical technique

Tourniquets were applied in all operations. The Imageless Navigation System version 2.6 (BrainLAB, Feldkirchen, Germany) was used in all navigation cases. Measured gap technique was used in bone resections. Posterior cruciate-substituting type of implant was used in all TKA. In manual TKA surgeries, measured gap technique was also used in bone resections. All patients had PS type implants. To decrease the amount of bleeding in the femoral medulla, resected auto bone was used to block the opening of medulla[9]. All patients had a closed drainage catheter which was removed in two or three days after surgery depending on the amount of excretion.

Transfusion analysis

We measured the frequency of transfusion after the operation within the admission period (2weeks). Transfusion was done if the patient had Hemoglobin level less than 8g/dL according to American Blood Bank guideline, and the clinical symptoms of patient was also considered[10].

Analysis on postoperative bleeding

To compare the postoperative bleeding, the amount of drainage during two days after TKA was compared and analyzed[11,12].

Statistics

Chi-square tests and one-way ANOVA were used to identify the differences in the patient distributions among the three groups. A chi-square test was used to identify the difference in allogeneic transfusions in the three groups, and one-way ANOVA was used to determine the difference in drainage volume for the two days after surgery. We used multiple variables logistic regression analysis to determine the difference in allogeneic transfusion and postoperative drainage between the three groups.

Results

Patient distribution of 3 groups

There were no differences in Gender, Body mass index, age, preoperative hemoglobin level, preoperative hematocrit level and preoperative mechanical femoral tibial angle among 3 groups (Table 1).

Transfusion in 3 groups

Group 1 had 2 cases of transfusion (6.7%), while there were 9 cases in group 2 (30%), and 3 cases in group 3 (10%). In Chi-square test, this difference was statistically significant (Table 2).

Analysis of bleeding by comparing 2days of drainage after operation among groups

Average of 525.50 ± 194.91 ml of drainage was drained in two days after surgery in group 1, 611.60 ± 263.20 ml in group 2 and 411.42 ± 188.21 ml in group 3. This difference was analyzed in one-way ANOVA which showed significantly different ($p < 0.01$). In post hoc analysis, group 3 had significantly less drainage than group 2 ($p < 0.01$).

Logistic regression analysis in difference in transfusion and drainage among 3 groups

As a result of multiple variables logistic regression analysis, which analyzed the difference in transfusion and postoperative drainage of the three groups, the necessity of transfusion in group 2 was 5.66 times higher than that of group 1 ($P = 0.04$). The drainage of group 3 was 0.997 times higher than that of group 1 ($P = 0.04$). After adjusting the patient's age, gender, and body mass index, the need for transfusion in group 2 was 5.86 times higher than that in group 1 ($P = 0.05$). The necessity of transfusion in the group 3 was 0.199 times higher than that of the group 2 ($P = 0.05$) (Table 3).

Discussion

Two important things have been known in this study. First of all, in group which navigation and tranexamic acid were both used and in group which tranexamic acid was only used had statistically lower rate of transfusion after surgery compare to the group which navigation was only used. In other words, use of tranexamic acid effectively lowers rate of transfusion after surgery. However, using both navigation and tranexamic acid did not lower the rate of transfusion compare to using only tranexamic acid statistically. Secondly, comparing drainage during 2 days after operation which indirectly represents postoperative bleeding[11,12], group 3 showed significantly less drainage than group 2. However, group 3 and group 1 showed no difference statistically. That is, using tranexamic acid decreased postoperative bleeding statistically. However, there was no difference in postoperative bleeding between the group which tranexamic acid and navigation were both used and the group with tranexamic acid was used only.

Tranexamic acid is widely used to decrease postoperative transfusion and bleeding. The efficacy is well proved by various studies already[1,2,4]. Use of navigation is also known to decrease the transfusion and bleeding, but the efficacy has been controversial among physicians[5,7]. According to Han's Meta analysis[8], use of navigation did not decrease postoperative transfusion, but did decrease the postoperative bleeding. In this study, the drainage (411.42 ± 188.21 ml) of the group using tranexamic acid and navigation was lower than the group using tranexamic acid alone (525.50 ± 194.91 ml). But, this statistical analysis did not have significant results

Already it is published that the use of anti-platelet agents increases bleeding after TKA[13]. Also, in one common admission period, having both knees operated sequentially over a period of two weeks increases the rate of transfusion because the hemoglobin level didn't recover properly within in 2 weeks. Therefore, in this study, those who had anti-thrombotic agents and both knees operated sequentially in one common admission period were excluded. Using navigation is known to reduce bleeding compare to conventional method by resecting the bone without harm to medulla which prevents intramedullary hemorrhage[8]. However, a pin has to be placed in the lower femur for navigation. This could cause extra

hemorrhage. Also, most patients had their medulla packed with auto bone to prevent intramedullary hemorrhage. Because of these reasons, researchers assumed that there was no synergic effect of using both navigation and tranexamic acid compare to using only tranexamic acid. There are some restrictions in the study.

Since there are only 30 cases in each group, it is hard to generalize the results. Also, to prove the effect of navigation only, a group of non-navigated TKA with no tranexamic acid is needed to compare the results. However, the surgeon did not have cases. And, we checked two days of drainage after operation to evaluate post operation bleeding loss. But, this parameter underestimates total bleeding by not including hidden blood loss[14].

Conclusion

The combined use of navigation and tranexamic acid has no synergistic effect in reducing post TKA bleeding and the need for blood transfusion compared to tranexamic acid alone. And, use of tranexamic acid is more effective than navigation in reducing blood transfusions and blood loss after TKA.

Abbreviations

TKA: total knee arthroplasty

Declarations

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Authors' contributions

All authors made significant contributions to this study and manuscript in general. Specific contributions are listed below: Conception and design of the study: WKC. Drafting manuscript: WKC. Data collection and preparation of datasets: SKS and SBC. Statistical analysis: SKS and SP. Interpretation of results: WKC and HCK.

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Availability of data and materials

These data are not publicly available. However, the data would be available upon reasonable request and with permission.

Ethics approval and consent to participate

Consent for publication

It does not require consent for publication.

Competing interests

The authors declare no conflict of interest or have no financial disclosures concerning the materials and methods utilized in this research or the findings of this article.

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Tables

Table 1. Epidemiology of all participants.

| Variable | Group 1 (N= 30) | Group 2 (N=30) | Group 3 (N=30) | P value |
|---|--------------------|-------------------|-------------------|---------|
| Age(years) | 68.70 ± 8.65 | 71.07 ± 7.73 | 68.60 ± 5.74 | 0.35 |
| Body Mass Index (m/kg ²) | 25.09 ± 2.92 | 25.01 ± 3.39 | 24.70 ± 3.17 | 0.87 |
| Pre operation Hemoglobin | 12.81 ± 1.24 | 12.45 ± 1.51 | 12.51 ± 1.26 | 0.53 |
| Pre operation Hematocrit | 38.24 ± 3.82 | 37.62 ± 4.65 | 37.72 ± 3.93 | 0.82 |
| Pre operation MFTA(varus(-)) | -8.22 ± 4.71 | -7.85 ± 6.32 | -11.38 ± 7.51 | 0.06 |
| Gender(F/M) | (19/11) | (22/8) | (25/5) | 0.21 |

Abbreviation: N=number, MFTA= mechanical femoral tibial angle, F= female, M= male.

Group 1: manual method + tranexamic acid

Group 2: navigation method

Group 3: navigation method + tranexamic acid

Table 2. A chi-square test to identify the difference in transfusions in the three groups

| | Group 1 | Group 2 | Group 3 | Total | P value |
|--------------------|------------|------------|------------|-------------|---------|
| Transfusion Yes | 2 (2.2%) | 9 (10.0%) | 3 (3.3%) | 14 (15.6%) | 0.03 |
| Transfusion No | 28 (31.1%) | 21 (23.3%) | 27 (30.0%) | 76 (84.4%) | |
| Total | 30 (33.3%) | 30 (33.3%) | 30 (33.3%) | 90 (100.0%) | |

Group 1: manual method + tranexamic acid

Group 2: navigation method

Group 3: navigation method + tranexamic acid

Table 3. multiple variables logistic regression analysis, which analyzed the difference in transfusion and postoperative drainage of the three groups.

| Group | Variable | Crude | | | Adjusted† | | |
|----------|-----------------|-------|---------------|---------|-----------|---------------|---------|
| | | OR | 95% CI for OR | P value | OR | 95% CI for OR | P value |
| G3 vs G2 | Transfusion Yes | 0.257 | 0.054/1.220 | 0.09 | 0.199 | 0.038/1.039 | 0.05* |
| | Drain | 0.996 | 0.993/0.998 | 0.01* | 0.996 | 0.993/0.999 | 0.01* |
| G2 vs G1 | Transfusion Yes | 5.665 | 1.086/29.540 | 0.04* | 5.864 | 1.031/33.352 | 0.05* |
| | Drain | 1.001 | 0.999/1.004 | 0.24 | 1.001 | 0.999/1.004 | 0.27 |
| G3 vs G1 | Transfusion Yes | 1.456 | 0.215/0.983 | 0.70 | 1.165 | 0.163/8.333 | 0.88 |
| | Drain | 0.997 | 0.994/1.000 | 0.04* | 0.997 | 0.995/1.000 | 0.09 |

Abbreviation:

OR= odds ratio, CI= confidence interval, G1= group 1, G= group 2, G3= group 3

Group 1: manual method + tranexamic acid

Group 2: navigation method

Group 3: navigation method + tranexamic acid

†Adjusted by age, gender and body mass index.