Intravenous Tranexamic Acid Decreases Allogeneic Transfusion Requirements in Periacetabular Osteotomy

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Abstract

Bernese (Ganz) periacetabular osteotomy is associated with significant blood loss and the need for perioperative transfusion. Tranexamic acid decreases blood loss and minimizes transfusion rates in total joint arthroplasty. However, no reports have described its use in patients undergoing Bernese periacetabular osteotomy. This study reports the use of intravenous tranexamic acid in these patients. The study included 137 patients (150 hips) who underwent isolated periacetabular osteotomy at a single institution between 2003 and 2014. Of these, 68 patients (75 hips) received intravenous tranexamic acid 1 g at the time of incision and 1 g at the time of closure. A group of 69 patients (75 hips) served as control subjects who underwent periacetabular osteotomy without administration of intravenous tranexamic acid. Thromboembolic disease was defined as deep venous thrombosis or pulmonary embolism occurring within 6 weeks of surgery. Outcomes measured included transfusion requirements, pre- and postoperative hemoglobin values, operative times, and thromboembolic disease rates. Aspirin was used as the thromboembolic prophylactic regimen in 95% of patients. The rate of allogeneic transfusion was 0 in the tranexamic acid group compared with 21% in the control group \( (P=0.0001). \) No significant difference was found in the autologous cell salvage requirement \( (0.96 \text{ vs } 1.01; \ P=0.43) \) or the thromboembolic disease rate between the tranexamic acid group and the control group \( (2.67\% \text{ vs } 1.33\%; \ P=0.31). \) The use of intravenous tranexamic acid led to a decreased transfusion requirement with no increased risk of thromboembolic disease in this contemporary cohort of patients undergoing periacetabular osteotomy. \[ \text{Orthopedics.} \ 2016; \ 39(1):44-48. \]

Bernese periacetabular osteotomy is a reliable and durable procedure for the treatment of symptomatic hip dysplasia without osteoarthritis. A variety of exposures and surgical techniques can be used; however, all rely on subperiosteal dissection of vascular-rich territories involving the medial ilium and ischium. The deep dissection, in combination with the intravenous tranexamic acid, led to a decreased transfusion requirement with no increased risk of thromboembolic disease in this contemporary cohort of patients undergoing periacetabular osteotomy.
Antifibrinolytic medication, specifically, tranexamic acid, has been used successfully to reduce blood loss and the need for allogeneic transfusion in many fields, including cardiovascular and orthopedic surgery.\(^8\) Tranexamic acid is a synthetic lysine analog that competitively blocks lysine-binding sites on plasminogen, thus inhibiting the degradation of fibrin by plasmin.\(^14\) Multiple prospective studies showed that tranexamic acid is effective in reducing blood loss and transfusion requirements in orthopedic patients undergoing hip and knee arthroplasty without an increased risk of thromboembolic disease.\(^1,8-15\) Furthermore, the medication is inexpensive and easy to administer around the time of surgery.\(^18\) Although there has been no reported increased risk of cardiovascular complications after intravenous tranexamic acid administration, its use in high-risk patients undergoing total hip arthroplasty and total knee arthroplasty is controversial.\(^12,19,20\) In general terms, patients undergoing periacetabular osteotomy may be considered a lower-risk group, with significantly lower American Society of Anesthesiologists scores compared with patients undergoing arthroplasty. The reported incidence of deep venous thrombosis and symptomatic pulmonary embolism in patients undergoing periacetabular osteotomy is less than 1%.* Because of the rarity of symptomatic venous or arterial thromboembolic events and the increased risk of postoperative bleeding, there is no consensus on optimal postoperative thromboembolic prophylaxis after periacetabular osteotomy.

Because of the addition of intravenous tranexamic acid as a blood conservation tool in patients undergoing hip and knee arthroplasty, the authors examined its efficacy in those undergoing hip preservation surgery. Although tranexamic acid has not been associated with increased rates of thromboembolic disease in the hip and knee arthroplasty literature, its safety in patients undergoing periacetabular osteotomy has not been reported. Therefore, the authors asked the following questions: (1) Is intravenous tranexamic acid effective in decreasing transfusion requirements after periacetabular osteotomy? (2) Does intravenous tranexamic acid increase the rate of thromboembolic disease in these patients?

**MATERIALS AND METHODS**

After institutional review board approval was obtained, the authors retrospectively reviewed 137 patients who underwent periacetabular osteotomy performed by 2 orthopedic surgeons (R.T.T., R.J.S.) at a single institution between 2003 and 2014. The authors excluded all patients who underwent periacetabular osteotomy associated with concomitant procedures except femoral chordoplasty. The thromboembolic prophylactic regimen in 95% of hips consisted of aspirin 325 mg twice daily for 6 weeks and mechanical prophylaxis while in the hospital. Anesthesiologists administered tranexamic acid 1 g intravenously at the beginning and end of each procedure. Full chart review was performed for patients identified within the registry who underwent an isolated periacetabular osteotomy. The authors collected patient demographic data, American Society of Anesthesiologists scores, preoperative and postoperative hemoglobin levels, operative times, and intraoperative and postoperative transfusion requirements (allogeneic and autologous cell salvage).

All patients routinely have an epidural catheter with local anesthesia for pain control for 48 hours after surgery. The surgery was performed with either combined epidural-spinal or general anesthesia. Intraoperative cell salvage was used in all cases. Surgical exposure was done with a modified Smith-Petersen approach, with a 10- to 12-cm anterior incision and dissection through the plane of the tensor fascia lata and sartorius, sparing the abductors laterally. The medial aspect of the ilium was exposed, extending to the sciatic notch, and the psoas was retracted medially for exposure of the pubis. The 3 osteotomies, starting at the anteromedial ischium and progressing to the pubis and ilium, were performed indirectly under fluoroscopy to mobilize and reorient the acetabulum. The surgeon used 2 to 3 fully threaded cortical screws measuring 4.5 mm for fixation of the osteotomized fragment. The posterior column was left intact, allowing for immediate rehabilitation without casting or a brace. All patients underwent mechanical (sequential compressive device) deep venous thrombosis prophylaxis and early mobilization with physical therapy.

Of the operated hips, 75 were treated with intravenous tranexamic acid and 75 received no antifibrinolytic medication. One surgeon selected patients for the intravenous tranexamic acid group at random, and 1 began routine use of intravenous tranexamic acid in 2005. Primary outcome measures were thromboembolic disease, defined as deep venous thrombosis or pulmonary embolism occurring within 6 weeks of the procedure. The authors also measured allogeneic and autologous transfusion requirements and compared the values in the 2 groups. Age (mean, 26.3 years), body mass index (mean, 26.1 kg/m\(^2\)), and preoperative hemoglobin level (mean, 13.5 mg/dL) were similar in the 2 groups (Table 1). No patients were lost to follow-up; however, 1 death occurred perioperatively secondary to arrhythmia in a patient who was not treated with tranexamic acid. The authors used 1-way analysis of variance and a Pearson chi-square test to assess differences in thromboembolic complications and transfusion requirements between the tranexamic acid group and the control group. There were no missing data.

**RESULTS**

The mean number of total units transfused in the tranexamic acid group was lower than that in the control group (1.05 vs 1.60, \(P<.05\)). No patient received predonated autologous blood. The tranexamic acid group received no allo-
geneic transfusion vs 21% in the control group \( (P=0.001) \) (Table 1). No difference in autologous cell salvage requirements was found between the tranexamic acid group and the control group (0.96 vs 1.01, \( P=.43 \)). Preoperative hemoglobin levels were similar in the 2 groups. Postoperative hemoglobin levels were higher in the tranexamic acid group; however, this difference was not statistically significant \( (P=.09) \). Mean operative times were longer in the tranexamic acid group \( (P=.07) \), although there was no correlation between operative time and transfusion \( (R=.07) \). In the cohort of patients undergoing isolated periacetabular osteotomy, there was no difference in the risk of venous or arterial thromboembolic disease events between the tranexamic acid treatment group and the control group \( (2 \text{ of } 75 \text{ vs } 1 \text{ of } 75, P=.31) \) (Table 2 and Figure).

**DISCUSSION**

Blood loss and the need for perioperative transfusion are unavoidable in some patients undergoing periacetabular osteotomy.\(^21-23\) Pulido et al\(^5\) reported a 20% (21 of 108) overall allogeneic transfusion rate, with an average transfusion amount (autologous cell salvage and allogeneic) of 2.14 units per patient undergoing periacetabular osteotomy. In a meta-analysis of well-done prospective studies, Henry et al\(^24\) found that antifibrinolytic drugs provide worthwhile reductions in blood loss and the need for allogeneic red cell transfusion without serious adverse effects in patients undergoing total joint arthroplasty. The search for safe blood conservation methods in patients undergoing periacetabular osteotomy led the authors to ask the following questions: (1) Is intravenous tranexamic acid effective in decreasing transfusion requirements after periacetabular osteotomy? (2) Does intravenous tranexamic acid increase the rate of thromboembolic disease in these patients? In this report, 75 hips undergoing periacetabular osteotomy were treated intraoperatively with intravenous tranexamic acid. These hips had a significantly lower transfusion requirement compared with 75 hips that were not treated with intravenous tranexamic acid. Furthermore, there was no significant difference in rates of thromboembolic disease between the tranexamic acid group and the control group.

Complications after periacetabular osteotomy have been well documented by...
multiple surgeons. Davey and Santore reported a consistent decrease in complications from 17% to 2.9% over a 70-case experience. The most common complication was lateral femoral cutaneous nerve palsy. Transfusion and overall blood loss were not included. Major bleeding occurred in 3% of patients, and causes included external iliac injury and postoperative hematoma.

Lysine analog antifibrinolytics such as tranexamic acid have an excellent safety record in orthopedic surgery. A concern among surgeons using antifibrinolytic medication is a theoretical prothrombotic effect and increased risk of thromboembolic disease. The Bernese periacetabular osteotomy patient population is a relatively healthy, homogeneous group, with few baseline risk factors for postoperative thromboembolic disease. Zaltz et al reported on the crude incidence of deep venous thrombosis and pulmonary embolism in adult and adolescent patients undergoing Bernese periacetabular osteotomy and found a low rate of 9.4 of 1000 with variable anticoagulation protocols. Polkowski et al studied the frequency of thromboembolic disease in adult patients undergoing periacetabular osteotomy and receiving aspirin twice daily as well as mechanical prophylaxis by assessing an ultrasound at 1 week postoperatively. They found a 1.3% rate of deep venous thrombosis on routine screening of 136 hips, with a mean patient age of 30 years. In adolescents undergoing periacetabular osteotomy, Thawrani et al found no cases of symptomatic deep venous thrombosis in a cohort of 83 patients. The current study reports a thromboembolic disease rate of 2 of 75 (2.67%) in patients receiving aspirin twice daily as well as mechanical prophylaxis after undergoing Bernese periacetabular osteotomy with intravenous tranexamic acid. In the tranexamic acid group, 1 patient had a pulmonary embolism 6 weeks postoperatively after undergoing 2 subsequent surgical procedures for wound dehiscence and infection. This thromboembolic disease rate with concomitant administration of intravenous tranexamic acid is consistent with baseline risks from the procedure alone.

Limitations
This study has a number of limitations. Bernese periacetabular osteotomy is a technically demanding procedure with a learning curve that can affect blood loss and intraoperative complications. The study took place over the course of a decade (2003-2014), and many patients who did not receive tranexamic acid were operated on earlier in the senior surgeon’s (R.T.T.) experience. However, no significant correlation was found between operative time and blood transfusion, which is consistent with previous reports from the authors’ institution. During this period, at the authors’ institution, the decision to perform transfusion was based on symptomatic anemia and/or a hemoglobin value greater than 8 mg/dL, and this was consistent throughout the study period. Variability in the decision to transfuse was potentially influenced by awareness of tranexamic acid administration because this study was not blinded. Randomized, blinded prospective studies could reduce the risk of this bias. However, the inclusion of only 2 contributing surgeons minimized the risk of wide variation in the transfusion trigger. Although this study examined the rate of thromboembolic disease, it was underpowered to define a significant difference in rates of venous thromboembolism (1.33% vs 2.67%). Another limitation was the lack of precedent in dosing tranexamic acid in patients undergoing Bernese periacetabular osteotomy. Therefore, the authors chose to administer tranexamic acid 1 g intravenously at incision and 1 g at closure without reference to body weight or body mass index, consistent with protocols for routine use of intravenous tranexamic acid in patients undergoing arthroplasty.

CONCLUSION
The risks of allogeneic transfusion are well documented and include transmission of infectious disease, immune sensitization, transfusion-related acute lung injury, fever, hemodynamic overload, and postoperative bacterial infection. Currently, the number of allogeneic transfusions needed by patients undergoing periacetabular osteotomy can be decreased with various blood conservation strategies. One of the mostlogistically compelling strategies is the use of tranexamic acid, which is relatively inexpensive and easy to implement. Although the current study has limitations, the findings should provide impetus for further prospective study of intravenous tranexamic acid in patients undergoing periacetabular osteotomy. The current study found that intravenous tranexamic acid use in these patients resulted in a lower overall transfusion requirement and a decrease in the allogeneic transfusion rate compared with the control group. Furthermore, this result was achievable with a rate of thromboembolic disease that was clinically acceptable, considering the nature of the procedure. These results support the current routine use of intravenous tranexamic acid in most patients undergoing periacetabular osteotomy at the authors’ institution.

REFERENCES


