USE OF TRANEXAMIC ACID IN SCOLIOSIS SURGERY

M.N. Lebedeva, A.A. Ivanova, A.V. Palmash, I.A. Statsenko, A.S. Vasyura
Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, Novosibirsk, Russia

Objective. To assess the effectiveness of tranexamic acid in the surgical correction of idiopathic scoliosis.
Material and Methods. The study included a retrospective analysis of intraoperative and postoperative blood loss during surgical correction of idiopathic scoliosis in 198 patients. In 70 patients, the operation was performed without administration of tranexamic acid. In 58 patients, tranexamic acid was administered 15 minutes before the skin incision at a dose of 10 mg/kg, and continued uninterruptedly at a dose of 1 mg/kg/h. In 70 patients, tranexamic acid was administered continuously during the operation at a dose of 10 mg/kg. Patients underwent surgery in a prone position with full decompression of the anterior abdominal wall.
Results. The registered intraoperative blood loss in most cases corresponded to Class I (no more than 750 ml or 15 % of blood volume) and Class II (no more than 750–1500 ml or 15–30 % of blood volume) according to the WHO classification of severity. The volume of intraoperative blood loss was not statistically different between groups. Significant differences were detected only in assessing parameters of postoperative blood loss.
Conclusion. The use of tranexamic acid in surgical correction of scoliosis does not affect the bleeding index of tissues at the surgical site and the total intraoperative blood loss. Using tranexamic acid in spine surgery is a technological procedure allowing for significant reduction in postoperative blood loss.
Key Words: idiopathic scoliosis, blood loss, tranexamic acid.

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Surgical correction of scoliotic spinal deformities is accompanied by significant intraoperative blood loss, which in some cases requires the use of donated blood components [5, 29]. The main causes of intraoperative hemorrhage include major trauma of the bone structures of the spine, technological features of applied instrumentation (transpedicular fixation technique), and duration of surgery under conditions of increased intra-abdominal pressure [11, 32]. Completion of the operation does not imply termination of blood loss, since there is drainage of the surgical area. According to the literature [1, 9, 15], postoperative blood loss may be higher than the considered intraoperative blood loss.

These circumstances require accurate organization of the transfusion management of the operations. However, there are still real risks associated with allogeneic transfusion: transfusion-related lung injury, hemolytic transfusion reaction. Moreover, despite the improvement of the methods of analysis of donated blood components, their use for blood loss compensation is still associated with the risk of infectious complications [6, 7, 12]. Furthermore, immunosuppressive effect of allogeneic blood components must be taken into account, which may increase the risk of infection under conditions of foreign material (endocorrector) implantation into the body [13, 24]. In addition, there is currently donated blood deficit due to significant decrease in the number of donors [4].

Therefore, on the one hand, transfusion therapy is an essential component of the management of perioperative period in the surgery of scoliosis to prevent tissue hypoperfusion associated with blood loss; on the other hand, it is associated with actual risks of complications associated with blood transfusion, which determines the need for the development of alternative methods to reduce blood loss [8, 14, 25, 26, 28]. Administration of tranexamic acid (TA), which is currently the most popular fibrinolysis inhibitor in cardiac surgery, obstetrics, abdominal surgery, and prosthetics of large joints, is one of these methods [2]. However, there are conflicting data on the efficacy and safety of the use of TA is spinal surgery, in particular in surgical correction of scoliosis [3, 35–37].

The objective of the study is to analyze the effectiveness of TA in the surgical correction of idiopathic scoliosis.

Material and Methods

We retrospectively analyzed the course of intraoperative and postoperative period in 198 patients, who were operated on at the hospital of pediatric vertebrology of Novosibirsk RITO in 2012–2015. The

study included patients with idiopathic scoliosis without significant preoperative signs of hemostatic disorders. We collected information, including age, body weight, severity of spine deformity, results of clinical and biochemical studies, type of used instrumentation, duration of the operation, number of transpedicular fixation levels, and amount of intraoperative and postoperative blood loss.

There were two study groups:

Group I included 70 patients, who underwent surgical correction of spinal deformities under general anesthesia based on sevoflurane with mechanical ventilation without administration of TA; group II, 128 patients, who were operated on using similar option of general anesthesia with administration of TA. Group II included two subgroups: subgroup A, 58 patients who were administered with TA at a dose of 10 mg/kg 15 minutes before skin incision, and then continuously at a dose of 1 mg/kg/h. Subgroup B included 70 patients, who were continuously administered with TA during the operation at a dose of 10 mg/kg using infusion pump. All patients were intraoperatively laid in a prone position using modular operating table for spinal surgery, which precludes any compressing effect on the anterior abdominal wall. All operations were performed by two highly qualified surgeons in approximately equal shares. In all patients, posterior spinal fusion was performed using hybrid instrumentation with transpedicular fixation technique (TPF). Intraoperative blood loss was determined using gravimetric method and calculation of the blood volume aspirated to graduated container. Circulating blood volume (CBV) was determined according to the formula: CBV = Body weight x coefficient (children aged 6–12 years – 80 ml/kg, children over 12 years and adults – 70 ml/kg); Russian State Standard (GOST) R 53470-2009. The severity of recorded blood loss was evaluated using WHO classification (2001) with allowance for the CBV deficit (in ml and % of the CBV). The volume and nature of infusion-transfusion management were selected using fundamentally the same tactics in all the groups. We used the same tactics of wound drainage: after the operation, wound drainage placed at the endocorrector bed was closed for 4 hours to enable spontaneous hemostasis in the wound. Drainage systems were removed on day 2 of the postoperative period, an average of 45 ± 3 hours.

The average age of patients was 18.3 ± 5.7 years (group I), 18.6 ± 7.0 years (group IIA), 19.1 ± 7.8 years (group IIB); $p > 0.05$. Average weight: 51.0 ± 10.5 kg (I), 53.1 ± 9.5 kg (IIA), 51.7 ± 10.6 kg (IIB); $p > 0.05$. The value of the main curvature of spinal deformity was the lowest in group IIA and significantly differed from this parameter in group I and IIB patients: 67.1° ± 22.4° (I), 63.6° ± 21.4° (IIB).

Statistical analysis of the results was performed using the standard Microsoft Office 2003 software package for PC. Standard processing of variational series included calculation of the arithmetic mean values (M), standard deviations (m), and mean error (σ). Variational series were compared using two-sample t-test (t).

Results and Discussion

Analyzing of the literature over the past 10 years shows that the use of drugs inhibiting fibrinolysis process in order to reduce perioperative blood loss in all field of surgery is of undying interest [21, 22, 39, 42]. In particular, Brown et al. [18] reported that the use of TA in cardiovascular surgery reduced blood loss by an average of 250 ml and reduced the number of transfusions of donated red blood cells by 25 %. The authors of publications have reported that both low and high doses of TA, as well as different ways of administration of the drug are effective [33, 41]. Some authors [16, 31] draw attention to the fact that fibrinolysis has additional activation mechanisms characteristic of orthopedic surgery.

Our previous research demonstrated that the use of intraoperative positioning of the patient in a prone position with full decompression of the anterior abdominal wall is the most important factor to minimize the severity of intraoperative venous bleeding and significantly (by 41.6 %) reduces the amount of intraoperative blood loss [10]. In this study, a specialized surgical table precluded any compressing effect on the anterior abdominal wall in all patients, who were operated on. This enabled more objective evaluation of the effectiveness of TA, when using two regiments of drug administration.

The values of the studied parameters are shown in Table. As the data show, the duration of surgical correction of spinal deformities using hybrid tools was significantly different if group IIB as compared to duration of surgery in groups I and IIA ($p = 0.0016$). The number of levels of the TPF included in the area of the posterior spinal fusion also significantly differed between the groups and was the highest in group IIB ($p = 0.008$). Recorded severity of intraoperative blood loss in most cases corresponded to class I (<750 mL / <15 % of the CBV). Class II intraoperative blood loss (>750–1500 ml / >15–30 % of the CBV) has been recorded in group I in 21.2 % of cases, group IIA – 18.4 %, group IIB – 16.9 %. The extent of intraoperative blood loss was not statistically different between the groups. In all groups, postoperative blood loss did not exceed the intraoperative blood loss and in most cases corresponded to class I. Class II postoperative blood loss (>750–500 ml / >15–30 % of the CBV) was observed in group I in 11.3 % of cases, in group IIA – in 8.5 % , in group IIB – in 7.0 %. Significant differences in the recorded extent of blood loss were observed only when assessing the values of drainage blood loss.

In this connection, the literature data on the effectiveness of administration of TA in the surgical correction of scoliotic spinal deformities are of interest. It was found that the use of TA in idiopathic scoliosis surgery reduces the extent of intraoperative blood loss to 30 % compared to the operations,

where TA was not used [19, 40]. It has been reported that the use of TA during spinal surgery in children reduces the need for transfusion of donated red blood cells [30]. At the same time, other studies produced no reliable evidence of decrease in the extent of blood loss when using TA in spinal surgery [23]. There are publications demonstrating more significant efficacy of blood preserving effect of aminocapronic acids as compared to TA [39].

Our findings agree with the views of Endres et al. [22], who conducted a similar study and concluded that there is no clinical difference between the study and control groups in spinal surgeries with low probability of bleeding.

The results of evaluation of postoperative blood loss are fully consistent with the findings of the researchers, who reported that the extent of postoperative blood loss is more significantly affected by antifibrinolytics [17, 20, 34, 38]. Meanwhile, TA dosage regimen has no significant effect on the extent of perioperative blood loss. There were no complications associated with administration of TA.

Conclusion

Our study demonstrated that the use of TA during surgical correction of scoliotic spinal deformities does not affect the amount of tissue hemorrhage at the surgical area and the final extent of intraoperative blood loss. At the same time, there is reliable evidence that it reduces blood loss through drainage systems in the postoperative period. These circumstances lead to the conclusion that timely (preoperative, intraoperative) administration of TA is a technique that significantly affects the extent of postoperative blood loss.

At the same time, the issue of safety of TA administration in spinal surgery should be clarified. The majority of publications dealing with the use of TA in various fields of surgery demonstrate safety of the drug. However, some recent reports mention the need to consider practical risk of thrombotic complications [27], which requires further research using modern methods to diagnose possible hemostatic disorders.

Table

Comparing the studied parameters in groups of patients, M ± m

Parameter	Group I (n = 70)	Group II (n = 128)	
		A (n = 58)	B (n = 70)
Duration of the operation, min	168.0 ± 30.0	169.0 ± 30.0	149.0 ± 40.0
Transpedicular fixation levels, n	4.0 ± 1.2	3.8 ± 1.0	4.7 ± 2.5
Intraoperative blood loss, ml (% of the CBV)	628.0 ± 236.0 (18.2 ± 7.5)	595.0 ± 200.0 (16.7 ± 6.2)	572.0 ± 192.0 (16.1 ± 6.0)
Postoperative blood loss, ml (% of the CBV)	655.5 ± 130.7 (18.5 ± 6.7)	508.5 ± 160.0 (13.9 ± 6.4)	518.0 ± 152.0 (14.6 ± 5.4)

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Address correspondence to:
Lebedeva Maya Nikolayevna
NNIITO, Frunze str., 17,
Novosibirsk, 630091, Russia,
MLebedeva@niito.ru

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Maya Nikolayevna Lebedeva, DMSc, chief researcher, Department of anesthesiology and intensive care, Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, Novosibirsk, Russia, MLebedeva@niito.ru;
Anastasia Aleksandrovna Ivanova, post-graduate student in the Department of anesthesiology and intensive care, anesthesiologist-intensivist, Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, Novosibirsk, Russia, niito@niito.ru;
Aleksey Viktorovich Palmash, anesthesiologist-intensivist, Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, Novosibirsk, Russia, niito@niito.ru;
Ivan Anatlyevich Statsenko, anesthesiologist-intensivist, Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, Novosibirsk, Russia, niito@niito.ru;
Aleksandr Sergeyevich Vasyura, MD, PhD, traumatologist-orthopedist, Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, Novosibirsk, Russia, niito@niito.ru.