Pulmonary embolism following adolescent idiopathic scoliosis correction surgery: A case report

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ABSTRACT

Pulmonary embolism following adolescent idiopathic scoliosis correction surgery: a case report.

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Scoliosis is a musculoskeletal disorder, in which there is a sideways curvature of the spine. Surgical correction of scoliosis is a long-lasting high-risk procedure, which can lead to serious complications such as pulmonary embolism and substantial haemorrhage. In our case a 20 year-old male with idiopathic scoliosis curve of 82^{o} underwent a reconstructive spinal surgery. Tranexamic acid (TXA) i.v infusion was used intraoperatively to reduce the blood loss. The operation took 8h to complete and proceeded well without complications. Afterwards the patient was then transferred to ICU. The third postoperative day he was admitted back to the orthopedic ward. 7h after admission he presented clinical symptoms of pulmonary embolism (PE). The suspicion of a pulmonary embolism was confirmed by an emergency CT pulmonary angiogram. Consequently, the patient was again admitted to the ICU and was treated with LMWH in a therapeutic dose. Three days later he returned back to the orthopedic ward clinically stabilized and with normal ABGs. In this case report the cause and origin of pulmonary embolism was not clear. The patient was treated with chemical thromboprophylaxis (LMWH) from the first postoperative day and yet PE was not prevented. This event contradicts the supposed rarity of PE after correction of AIS surgery. It also results in a controversy over the efficacy of LMWH on reducing the incidence of VTE and over the safety and proper dosing of TXA.

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INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is the most common type of scoliosis and typically occurs after the age of 10. In some rare cases, scoliosis can be associated with particular syndromes or congenital diseases. Severity of respiratory and cardiovascular effects of the thorax deformity are directly associated with the extent of the curvature. It is usually asymptomatic, but if the final spinal curvature surpasses a certain critical threshold, the risk of health problems and curve progression is increased and there is an indication for surgical correction of scoliosis. Surgical correction of scoliosis entails either anterior or posterior instrumentation of the spine. It is a long-lasting, high-risk procedure which can lead to serious and sometimes fatal complications. Two severe complications that were associated with this case report include pulmonary embolism and substantial haemorrhage.

Venous thromboembolism consists one of the leading causes of morbidity and mortality following orthopaedic operations. Short-term complications include prolonged hospitalization, respiratory disorders, anticoagulation treatment complications of haemorrhage, local expanding of thrombus or further embolic events, whereas long-term complications include recurrent thrombosis, post-thrombotic syndrome, pulmonary hypertension.

Markovic-Denic L et al. showed that the incidence of PE in total hip arthroplasty is 1.6% and in total knee arthroplasty is 1.5%[1]. Senders Z.J et al demonstrated that PE seems to be more rare in spinal surgery with an incidence at 0.2% generally, and in scoliosis correction surgery, more accurately, but with quite fluctuating percentages reported up till now[2-8]. A study including 110 patients who underwent posterior spinal surgery found no cases of postoperative DVT or PE[9]. A further report of 313 patients with spine disease revealed a single case of clinically symptomatic postoperative DVT and none of PE[10].

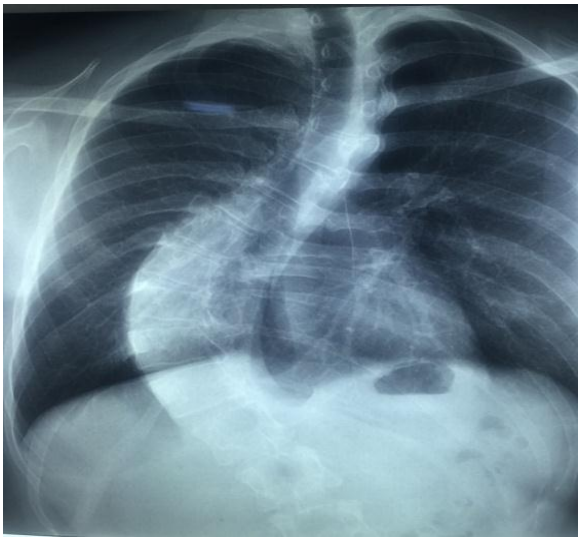
Reconstructive spinal surgeries have been associated with excessive blood loss. Intravenous Tranexamic acid (TXA) is established as an efficacious hemostatic agent in spinal surgery[11] and is the drug that we used to prevent haemorrhage[12-18]. This report presents a case of severe acute PE after posterior spinal correction surgery in a patient with idiopathic scoliosis

CASE PRESENTATION

A 20-year-old male with 1.78m height and 60kg weight, ASA II, presented with idiopathic thoracic scoliosis of 82^{o}curve. He was planned for elective surgery for the correction of scoliosis with posteriorspinal instrumentation fromT1 to L2.

The patient underwent a full preoperative check. His medical history included asthmatic disease. No abnormality was detected in the ECG and echocardiogram. Chest X-ray, which revealed a Lenke type II main thoracic curve of 82^{o} (Image 1).

Image 1. Chest X-ray before surgery.



Spirometry test revealed preoperatively moderate restrictive lung disease and small airways obstruction. Full blood count, urea, creatinine, Glucose, electrolytes, liver function tests, PT, aPTT, INR were within normal values. No abnormality was detected on clinical examination.

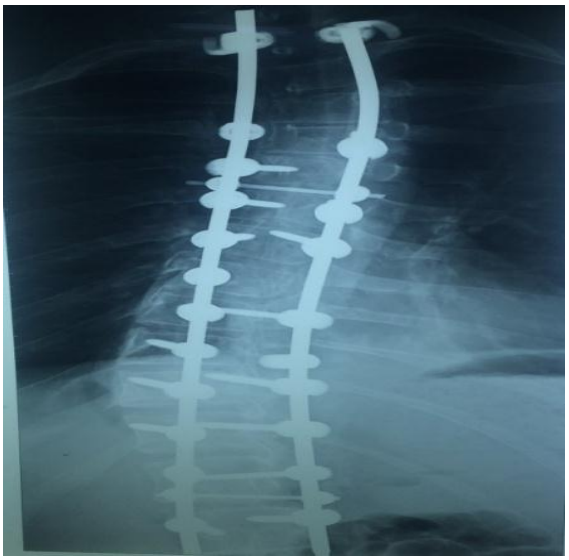
After patient's arrival in the operating room, standard monitoring was applied. After preoxygenation, anesthesia was induced with the use of i.v 0.2mg fentanyl, 60mg Lidocaine 2%, 150mg Propofol and 60mg Rocuroniu. After anesthesia induction and onset of mechanical ventilation, an arterial line, a central venous catheter in the right jugular vein and a Folley catheter were placed. Moreover, $LiDCO_{rapid}$-Pulse Contour Analysis System was also established and calibrated to measure SV, CO and increase in SV (ΔSV). Additional monitoring included the use of BIS in order to measure anesthesia depth. Then patient was moved in prone position for the surgical procedure. A loading dose of 30mg/kg Tranexamic acid (TXA) was administered before surgical incision and followed by a continuous infusion of 10mg/kg/h until the end of surgery. A cell salvage device was also available during the operation. Target controlled infusion of propofol and remifentanyl was used for maintenance of anaesthesia, intraoperatively. Continuous infusion of 0.15gm/kg/h Ketamine was also administered before skin incision until skin closure.

The duration of the surgery was 8h. Throughout the operation the patient remained haemodynamically stable and arterial blood gases (ABGs) were normal. Blood loss was limited regarding the extent of spinal instrumentation and the duration of surgery. Preoperative haemoglobin and haematocrit were 130g/l and 40% respectively, compared with postoperative values of 77g/l and 24.4%. Neither packed red blood cells nor salvaged red blood cells were transfused. The total volume of Ringer's Lactate infused was 9 liters (Goal Directed Fluid Therapy) throughout the operation and urine output was 125ml hourly.

At the end of surgery a wake-up-test was performed which showed normal motility of the

patient's four limbs. The patient was then transferred to the ICU, where he remained in mechanical ventilation under sedation for the first postoperative day. He was treated with antibiotics, gastric protection and anticoagulation (LMWH) and he was on inotropes. ABGs were normal (Image 2).

Image 2. Chest X-ray after surgery.



During the second postoperative day, patient was extubated and remained haemodynamically stable with normal ABGs and good motility at all limbs.

The third postoperative day he was transferred to the orthopedic ward. 7h later he complained for chest pain, shortness of breath. He presented sinus tachycardia, systolic pressure 105mmHg, diastolic pressure 65mmHg and a great decrease of O_2 saturation (SpO_2 82% with FiO_2 21%). The ABGs revealed a great deterioration of the blood oxygenation (pO_2 47.4, pCO_2 35.9, pH 7.44) and d-dimers were 0,6mcg/ml. The suspicion of a pulmonary embolism was confirmed by an emergency CT Pulmonary angiogram which showed bilateral filling defects in the pulmonary vessels together with a pleural effusion.

Consequently the patient was admitted again to the ICU. Standard monitoring and invasive blood pressure were applied. He remained on spontaneous breathing with an O_2 face mask. The patient was treated with fondaparinux in a therapeutic dose. While in ICU he remained haemodynamically stable without any other complications. Three days later he returned back to the orthopedic ward clinically stabilized and with normal ABGs.

Examination of the patient's blood revealed no hereditary abnormal clotting disorders.

DISCUSSION

Pulmonary Embolism in AIS surgery

Venous thromboembolism consists one of the leading causes of morbidity and mortality following orthopedic operations. However the incidence of venous thromboembolism seems to be very low in idiopathic scoliosis correction surgery, in spite of quite fluctuating percentages reported up till now. According to a study on thromboembolic complications in children after spinal fusion surgery, the incidence of VTE in children varied a lot with mean value of 21 events per 10,000 spinal fusions, whereas the incidence of PE varied as

well with a mean value of only 2 events per 10,000 spinal fusions. In contrast, a higher incidence of VTE in children was associated with older age and certain diagnosis (congenital scoliosis, kyphoscoliosis, syndromic scoliosis) [3,4].

The diagnosis of postoperative PE can be challenging as it depends on a pulmonary ventilation perfusion scan, pulmonary spiral CT, magnetic resonance imaging and pulmonary arteriography. Pulmonary arteriography is the gold standard[19]. Diagnosis can also be confirmed by the presence of a thrombus echo in the right chambers of the heart[19]. The diagnostic value of many tests is limited, including clinical symptoms, chest X-radiography electrocardiography, arterial blood gas analysis and D-dimer analysis[19]. This complicates PE diagnosis, in critically ill postoperative patients, in whom the lack of emergency management can have serious consequences. In the current case the suspicion of a pulmonary embolism was confirmed by an emergency CT Pulmonary angiogram.

It has been shown that PE occurs more commonly in anterior than in posterior spinal surgery[20-22]. Patender DB et al found that in adult patients with thoracolumbar spinal deformity, the rate of PE was 0.65% following posterior spinal surgery compared with 2.4% following anterior spinal surgery[22]. Another study found an overall PE rate of 2.2%, but patients who underwent anterior spinal surgery had a much higher incidence than those that underwent posterior spinal surgery alone[20,22].

The proven risk factors for thrombosis include smoking, hormone replacement therapy, previous thromboembolism, neoplasm, diabetes, steroid use and inherited coagulation disorders[23]. Noted risk factors for DVT development, in patients who undergo spinal surgery, are lengthy operative procedures, prolonged postoperative bed rest, manipulation of the great vessels during anterior approaches, and the use of frames that may compress the femoral venous system[9,23]. These patients may have additional risk factors for venous thromboembolism, including advanced age, cervical versus lumbar surgery, anterior surgical approach, surgery for malignancy, and reduced preoperative and postoperative ambulation[24]. The patient described in the current report apart from the use of TXA and the long duration of the surgery had no other risk factors.

There are multiple hereditary abnormal clotting disorders, such as resistance to activated protein C, or deficiency of protein C, protein S or antithrombin III, which could lead to abnormal perioperative clot formation[25,26]. However, postoperative examination of the current patient's blood revealed no such congenital risk factors.

PE in patients undergoing idiopathic scoliosis surgery may seem to be rare, but there is still a

need for larger scale studies to accurately determine the overall incidence of PE in spinal fusion patients. It is frequent enough to warrant attention from the medical team. In most patients VTE is subclinical and obviously PE can become fatal[5-8].

The role of chemical thromboprophylaxis

A question arises on the need for chemical thromboprophylaxis. On the one hand spinal surgeons may be unwilling to use LMWH on the fear of epidural haematoma formation postoperatively and also the efficacy of LMWH on reducing the incidence of PE is not yet confirmed. On the other hand the incidence of epidural haematoma while on LMWH is relatively low, whereas PE can be a life-threatening complication. As a result LMWH may be a worthwhile option to consider for prophylaxis[4-8].

However the incidence of PE in spinal fusion patients is less well studied and definitive prophylaxis guidelines are lacking. Further research and analysis is necessary to determine if the current prophylaxis guidelines and treatments are adequate. Longitudinal studies are lacking and will be required to determine if PE prophylaxis in spinal fusion patients has been effective in the long term[5].

The role of Tranexamic Acid

Reconstructive spinal surgeries have been associated with excessive blood loss. Substantial bleeding may occur intraoperatively and perioperatively. It is related to the surgical technique, duration of surgery, number of vertebra instrumented, mean arterial pressure, platelet disorders, coagulation disorders or degree of primary fibrinolysis[27,28].

Many different methods have been tried to reduce haemorrhage and allogeneic blood transfusion. These methods include proper positioning of the patient in the prone position avoiding abdominal pressure increase, controlled hypotensive anaesthesia, acute normovolemic hemodilution, preoperative autologous blood donation, blood salvage, surgical haemostastis and also drugs that modify clotting pathways in the body.

Medication known as antifibrinolytic drugs can significantly reduce bleeding by preventing the breakdown of a blood clot. Tranexamic acid (TXA) and Epsilon Aminocaproic acid (EACA) are the representative antifibrinolytic agents, which have been introduced in clinical practice[29-31].

TXA is the drug that we used in this case report to prevent haemorrhage. The amount of TXA needed to prevent fibrinolysis in vivo remains unknown[32].The dose of TXA administered prophylactically varies considerably between institutions with dosing schedules for TXA varying a much as 10-fold in the published literature[33]. In this case report we choose neither a high nor a low TXA dosage

regimen, as per our local protocol, to be effective and safe. A loading dose of 30mg/kg Tranexamic acid (TXA) was administered before surgical incision, followed by a continuous infusion of 10mg/kg/h until the end of surgery. Haemorrhage was indeed limited, in spite of the duration of surgery and the extent of spinal instrumentation. The minimized blood loss was attributed to careful patient positioning, good surgical technique, controlled hypotensive anaesthesia, and the use of TXA[34].

In the ESA guidelines of 2013, for the management of severe perioperative bleeding, administration of antifibrinolytic drugs is recommended in total hip arthroplasty, total knee arthroplasty and major spine surgery[12]. In several RCTs performed in children and adults undergoing scoliosis/spine surgery, a loading dose of 10-30 mg/kg TXA followed by a continuous infusion of 1mg/kg/h has been shown to be effective and well tolerated[12]. A recent retrospective cohort study concerning the efficacy of TXA in reducing operative blood loss during posterior spinal fusion for the treatment of severe AIS, showed that patients undergoing surgery with the use of TXA presents reduced total blood loss and use of transfused blood. The total blood loss was decreased after controlling for maximum major curve, age, surgical parameters, clotting capability, and infusion of coagulation factors. In the above study all TXA group patients received an IV loading dose of 100mg/kg TXA followed by a maintenance dose of 10mg/kg/h, administered until the skin closure[14]. Another retrospective study published in 2016 elevates the efficacy and safety of the same large dose of TXA in reducing transfusion requirements of allogeneic blood products in AIS surgery[15].

Gillete et al retrospectively reviewed 2046 patients who underwent primary THA or TKA and received TXA from 2007 to 2009. They found that a low complication rate was seen when using TXA as a blood conservation modality during primary THA and TKA with less aggressive thromboprophylactic regimens such as aspirin alone and dose-adjusted warfarin[35]. A Systematic Review demonstrated that TXA is a weak provoking factor for thromboembolic events[36]. It is clear that further studies and analysis are required to determine the risk, indications and optimal dose of TXA for spine surgery on patients with idiopathic scoliosis and to provide additional information on the efficacy and safety of this antifibrinolytic drug[12,14-18].

In this case report we used TXA intravenous infusion intraoperatively. Blood loss was limited in spite of the duration of surgery and the extent of spinal instrumentation. Our patient was treated with chemical thromboprophylaxis (LMWH) from the first postoperative day and yet PE was not prevented. So there is a contro-

versy over the efficacy of LMWH on reducing the incidence of VTE and over the safety and proper dosing of TXA. It is impossible to decide the cause and origin of PE in this case report. Further research needed in order to prove the efficacy and safety of antifibrinolytc drugs in spinal surgery and determine the risks, indications and appropriate dosing. In addition further studies are required to clarify the incidence of VTE and PE in spinal operations and to determine definitive thromboprofylaxis guidelines.

CONCLUSION

In AIS correction surgery high level of vigilance is required because the risk of thromboembolic complications is high, especially in patients with associated risk factors. TXA has been shown to significantly reduce blood loss and transfusion requirements. Although the benefit and safety of tranexamic acid in patients undergoing major spinal surgery have yet to be thoroughly established, tranexamic acid appears to have a potential beneficial role. Hopefully, future studies will clarify the exact role of TXA has in spine surgery regarding thromboembolic complications. We cannot confirm also that LMWH is effective in reducing the incidence of PE. Prospective randomized trials are needed in order to assess the efficacy of LMWH in reducing DVT and above all PE in spinal surgery patients.

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Author Disclosures:

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