J Orthop Spine Trauma. 2025 September; 11(3): 124-8. DOI: 10.18502/jost.v11i3.19407

Case Report

Posterior Fusion in a Case of Lenke Type 2 Adolescent Idiopathic Scoliosis with Severe Factor VII Deficiency: A Case Report

Siamak Shabani[1], Maziar Malekzadeh[1], Babak Mirzashahi[2,*]

[1] Spine Fellowship, Department of Spine Surgery, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran
[2] Assistant Professor, Department of Spine Surgery, Imam Khomeini Hospital Complex, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran

[*] Corresponding author: Babak Mirzashahi; Department of Spine Surgery, Imam Khomeini Hospital Complex, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran. Tel: +98-9121760682; Email: babakmirzashahi54@gmail.com

Received: 18 April 2025; **Revised:** 21 June 2025; **Accepted:** 24 July 2025

Abstract

Background: Congenital factor VII (FVII) deficiency is a rare autosomal recessive coagulation disorder that poses significant challenges during major surgeries, particularly high-risk procedures like instrumented spinal fusion for adolescent idiopathic scoliosis (AIS).
Case Report: We present the case of a 15-year-old girl diagnosed with Lenke type 2 AIS and severe congenital FVII deficiency. She was referred to Imam Khomeini Hospital Complex, Tehran, Iran, for corrective spinal fusion. Preoperatively, a single dose of recombinant activated FVII (rFVIIa) at 20 mcg/kg was administered to maintain hemostasis. The instrumented spinal fusion was performed under general anesthesia using meticulous surgical techniques. Notably, no additional doses of rFVIIa were required during the procedure.
Conclusion: This case demonstrates that with appropriate preoperative factor replacement and careful intraoperative hemostatic management, patients with severe FVII deficiency can safely undergo corrective spinal fusion. It underscores the critical importance of sustaining hemostasis in managing high-risk surgical patients with coagulopathies.

Keywords: Scoliosis; Factor VII Deficiency; Adolescent; Spinal Fusion

Citation: Shabani S, Malekzadeh M, Mirzashahi B. **Posterior Fusion in a Case of Lenke Type 2 Adolescent Idiopathic Scoliosis with Severe Factor VII Deficiency: A Case Report.** *J Orthop Spine Trauma* 2025; 11(3): 124-8.

Background

Factor VII (FVII) is a vitamin K-dependent clotting factor produced by the liver, playing a crucial role in the extrinsic pathway of the coagulation cascade in conjunction with tissue factor. Congenital FVII deficiency is a rare autosomal recessive disorder caused by mutations in the F7 gene, with an estimated prevalence of one in 300000 to 500000 individuals, affecting both men and women equally (1-63). This deficiency has a higher prevalence in certain populations, notably among French-Canadian and Ashkenazi Jewish communities (7-9, 15, 34).

Acquired FVII deficiency can occur due to conditions such as vitamin K deficiency, liver disease, sepsis, or the use of anticoagulants like warfarin (6-8, 14, 15, 17, 18). Clinical manifestations vary widely, ranging from asymptomatic cases to severe bleeding episodes, including gastrointestinal hemorrhage, postoperative bleeding, and intracranial hemorrhage (6-8, 14, 15, 17, 18). Diagnosis typically involves coagulation screening tests; an isolated prolonged prothrombin time (PT) with normal activated partial thromboplastin time (aPTT) and platelet count suggests FVII deficiency. Mixing studies can help differentiate between a true deficiency and the presence of inhibitors. Definitive diagnosis may be confirmed through genetic analysis of the F7 gene (1, 6-8, 14, 15, 17, 18, 22, 27).

The severity of FVII deficiency is often classified based on coagulant activity levels: severe (< 10%), moderate (10-20 percent), and mild (> 20%). Notably, there is a weak correlation between FVII activity levels and bleeding tendency, distinguishing it from other bleeding disorders like hemophilia A and B (1, 2, 4, 6-8, 14-18, 22, 24, 29, 31, 50, 57-60). Management strategies depend on the severity and clinical presentation. Mild bleeding episodes may be managed with local measures or antifibrinolytic agents, while severe bleeding may require replacement therapy using fresh frozen plasma (FFP), prothrombin complex concentrate (PCC), plasma-derived FVII (pdFVII), or recombinant activated FVII (rFVIIa) (2, 6-8, 17, 18, 21, 22, 25, 26, 31, 44, 48, 50-54, 58-63).

In surgical contexts, particularly major procedures like spinal deformity correction, patients with FVII activity levels below 10-15 percent or a history of recurrent bleeding are recommended to receive prophylactic factor replacement to minimize bleeding risks (49). Reports of scoliosis cases accompanied by congenital FVII deficiency are scarce, making perioperative hemostatic management in such scenarios particularly challenging (26, 30, 47, 48, 57-61). This report details our experience managing a patient with adolescent idiopathic scoliosis (AIS) and severe FVII deficiency who underwent successful corrective spinal surgery with effective hemostatic control.

Case Report

A 15-year-old girl with a known history of severe congenital FVII deficiency was referred to our hospital for evaluation of her scoliosis. Imaging studies revealed a rigid Lenke type 2 AIS, characterized by a main thoracic curve of 66° and a flexible proximal thoracic curve of 37°, consistent with the Lenke classification system. Neurological examination findings were unremarkable.

The patient's medical history included multiple episodes of epistaxis beginning at six months of age, as well as recurrent joint pain and swelling since the age of three.

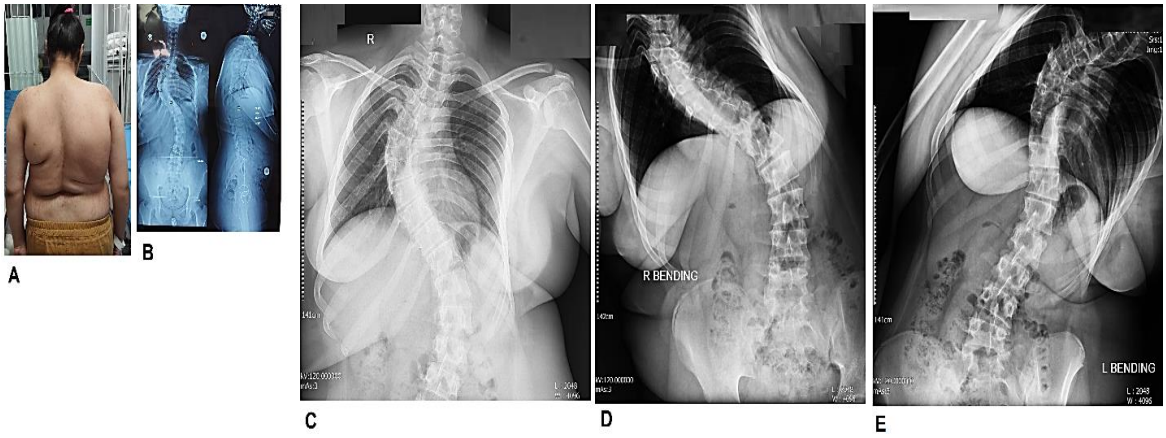

Figure 1. A to E) Preoperative photography and radiographies of the patient

She also had comorbid conditions of asthma and valvular heart disease. Her current medications included fluticasone and salbutamol nasal sprays, amlodipine, and prednisolone. There was no family history of bleeding disorders.

Preoperative laboratory evaluations showed a PT of 12.2 seconds (control: 12.2 seconds), aPTT of 26 seconds, international normalized ratio (INR) of 1.0 (control: below 1.1), bleeding time of six minutes, and a platelet count of 159000 per microliter. Specific FVII activity was measured at 6%. The preoperative hemoglobin (Hb) level was 9.3 g/dl.

Imaging studies of the spine showed a rigid scoliotic main thoracic curve of 66°, and a 37° flexible proximal thoracic curve which were consistent with Lenke type 2 AIS (Figure 1).

Following a comprehensive preoperative evaluation and consultation with a hematologist to manage the patient's coagulation status, informed consent was obtained. The surgical procedure was conducted at Imam Khomeini Hospital Complex in Tehran City, Iran. Intraoperative neuromonitoring, including somatosensory-evoked potentials (SEPs) and motor-evoked potentials (MEPs), was utilized to ensure neural integrity.

To minimize intraoperative blood loss, a single dose of rFVIIa at 20 mcg/kg was administered intravenously immediately before the surgery. The entire procedure was performed under controlled hypotensive anesthesia to further reduce bleeding risk.

Under general anesthesia, the patient was positioned prone on a radiolucent table. A standard posterior midline incision was made, and subperiosteal dissection of the paravertebral muscles exposed the posterior elements of the spinal column from T4 to L4. Pedicle screws were inserted bilaterally from T4 to L4 using the freehand technique, with fluoroscopic guidance confirming proper placement.

Multilevel V-shaped osteotomies were performed at levels T8 through L2 to correct the spinal deformity. Subsequently, bilateral rods were placed, and corrective maneuvers, including derotation and compression-distraction techniques, were applied to achieve optimal spinal alignment. Posterolateral fusion was accomplished using a combination of autograft and allograft bone materials. A surgical drain was placed, and the wound was closed in anatomical layers (Figure 2).

The total estimated blood loss during the procedure was 350 milliliters. Postoperative monitoring revealed no significant drop in Hb levels attributable to surgical bleeding. The patient experienced no early postoperative neurological complications, cerebrospinal fluid (CSF) leakage, or surgical site infections.

Prophylactic antibiotics and the surgical drain were discontinued on postoperative day two. The patient was discharged on postoperative day five in stable condition. Subsequent follow-up assessments indicated the development of a solid fusion mass without signs of pseudoarthrosis. Notably, no bleeding complications related to the corrective surgery were reported during the follow-up period.

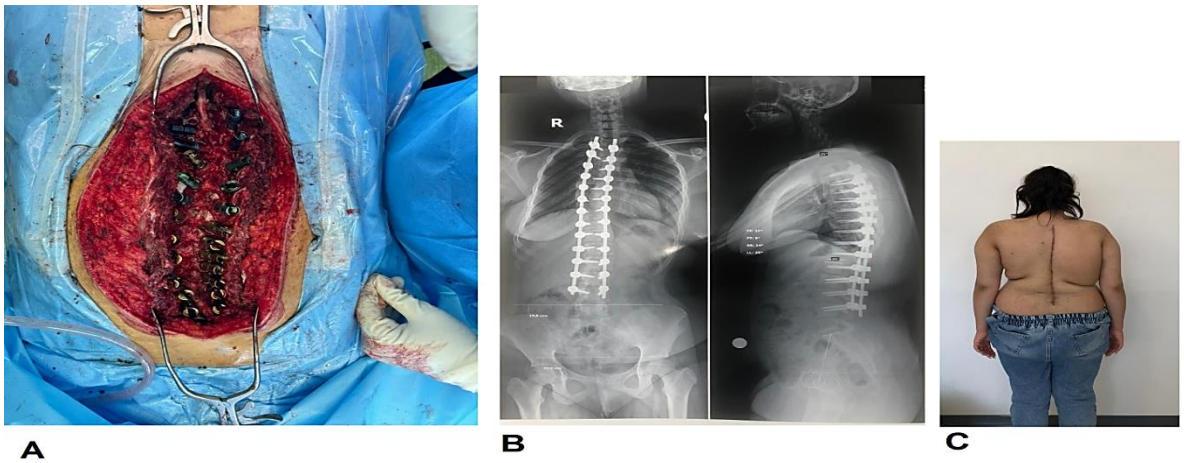

Figure 2. A) Intraoperative photography of surgical site; B) Post-operative radiographies; C) Post-operative photography of the patient

Discussion

FVII deficiency is a rare autosomal recessive bleeding disorder with an estimated prevalence of 1 in 300000 to 500000 individuals (1-19). The severity of the deficiency is categorized based on plasma FVII activity levels: severe (< 10%), moderate (10-20 percent), and mild (> 20%) (8).

While there is a weak correlation between FVII activity levels and clinical manifestations, patients with levels below 1% often experience severe bleeding episodes, including hemarthrosis, soft tissue hemorrhages, or intracranial bleeding (1-13, 17-36). Those with FVII activity ≥ 10% typically present with milder symptoms such as epistaxis or menorrhagia, though life-threatening hemorrhages can still occur in patients with levels ≥20% (1-13, 17-36).

Management of bleeding in FVII deficiency varies depending on the severity and location of hemorrhage, as well as FVII activity levels. Mild bleeding episodes can often be managed with local pressure, antifibrinolytic agents, or fibrin glue. In contrast, severe bleeding may require replacement therapy with FFP, PCC, pdFVII, or rFVIIa (1-62). For mild spontaneous or traumatic hemorrhages, a dose of 5-10 ml/kg FFP is typically sufficient to achieve therapeutic FVII levels of 5-10 percent. In cases of major hemorrhage or surgical interventions, 15-20 ml/kg of FFP is recommended. For preoperative prophylaxis, maintaining FVII levels in the range of 10-15 percent is advised to ensure effective hemostasis (1-62).

rFVIIa, produced via recombinant technology, offers a valuable therapeutic option for preoperative prophylaxis, as it eliminates the risk of infectious disease transmission associated with plasma-derived products. The recommended perioperative dose of rFVIIa is 20 mcg/kg, with repeat dosing every 8 hours in high-risk patients (1-62). Antifibrinolytic agents such as epsilon-aminocaproic acid (EACA) and tranexamic acid can also be used adjunctively to enhance hemostatic efficacy (1-62).

Spinal surgery for the correction of AIS is associated with significant blood loss, which can reach or exceed the patient's estimated total blood volume (TBV) (52). For instance, Kannan et al. reported a median blood loss of 20% of TBV (range: 2-82 percent) in patients with AIS, with higher values observed in those with underlying neuromuscular disorders (78%; range: 25-127 percent) (64). Similarly, Zheng et al. documented a mean intraoperative blood loss of 1073 ± 716 ml and a blood transfusion requirement of 1.04 ± 1.17 units in adult patients undergoing revision surgery for degenerative lumbar spinal stenosis (32). Notably, postoperative bleeding has been reported to exceed intraoperative bleeding in approximately 20% of cases (48).

Despite these challenges, most authors agree that hemostatic control during surgery is relatively manageable in patients with FVII deficiency. Some reports even suggest that transfusions should be administered only when necessary, rather than routinely (5, 46, 64). However, in cases of severe FVII deficiency, replacement therapy is generally recommended during and immediately after surgery. For example, Strauss administered 10 ml/kg of plasma every four hours for the first 24 hours postoperatively (59). Falter and Kaufman recommended infusions of factor IX concentrates at least twice daily during surgery, though specific dosing and duration were not specified (2). Marder and Shulman advised sufficient plasma transfusion to achieve FVII levels of 10-20 percent during surgery and in the subsequent days (24).

Some authors advocate for rFVIIa administration every 3 to 4 hours on postoperative days 1 and 2, considering the short half-life of FVII, while others recommend dosing two to three times daily (61). Zimmermann et al. suggested transfusing 10 to 15 units of FVII concentrate per kilogram every six hours for at least the first three postoperative days, noting that their patient experienced no hemostatic complications during surgery (36).

In our case, effective hemostasis was achieved with a single preoperative dose of rFVIIa (20 mcg/kg), without any significant bleeding during or after the operation. This outcome suggests that, for patients with severe FVII deficiency, preoperative administration of rFVIIa can provide safe and effective hemostasis, with additional dosing reserved for high-risk patients with a history of major bleeding.

Conclusion

A comprehensive bleeding history is essential in evaluating patients for hemorrhagic disorders, including FVII deficiency. When clinical assessment suggests a bleeding tendency, appropriate screening tests —such as PT, aPTT, platelet count, and bleeding time —should be performed to assess coagulation status. Although managing hemostasis during corrective surgery for AIS in patients with severe FVII deficiency poses challenges, it can be effectively achieved through meticulous surgical techniques and appropriate preoperative factor replacement therapy.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgements

We would like to express our gratitude to Saeed Besharati for their valuable contributions to this project. This research did not receive any specific funding.

References

1. Mariani G, Herrmann FH, Dolce A, Batorova A, Etro D, Peyvandi F, et al. Clinical phenotypes and factor VII genotype in congenital factor VII deficiency. *Thromb Haemost*. 2005;93(3):481-7. doi: 10.1160/th04-10-0650. [PubMed: 15735798].
2. Falter ML, Kaufman MF. Congenital factor VII deficiency. *J Pediatr*. 1971;79(2):298-300. doi: 10.1016/s0022-3476(71)80118-x. [PubMed: 5560054].
3. Alexander B, Goldstein R, Landwehr G, Cook CD. Congenital SPCA deficiency: a hitherto unrecognized coagulation defect with hemorrhage rectified by serum and serum fractions. *J Clin Invest*. 1951;30(6):596-608. doi: 10.1172/jci102477. [PubMed: 14841260]. [PubMed Central: PMC436294].
4. Perry DJ. Factor VII Deficiency. *Br J Haematol*. 2002;118(3): 689-700. doi: 10.1046/j.1365-2141.2002.03545.x. [PubMed: 12181036].
5. Lane A, Cruickshank JK, Mitchell J, Henderson A, Humphries S, Green F. Genetic and environmental determinants of factor VII coagulant activity in ethnic groups at differing risk of coronary heart disease. *Atherosclerosis*. 1992;94(1):43-50. doi: 10.1016/0021-9150(92)90186-k. [PubMed: 1632858].
6. Fauci A, Longo D, Kasper D, Jameson J, Loscalzo J, Hauser S. Harrison's Principles of Internal Medicine. 21st ed. New York, NY: McGraw Hill Medical; 2022.
7. Silberstein LE, Anastasi J. Hematology: Basic Principles and Practice. 6th ed. Philadelphia, PA: Elsevier Health Sciences; 2017.
8. McPherson RA, Pincus MR. Henry's Clinical Diagnosis and Management by Laboratory Methods. 24th ed. Philadelphia, PA: Elsevier; 2021.
9. Seligsohn U, White G. Inherited Deficiencies of Coagulation

Factors II, V, VII, X, XI, and XIII and Combined Deficiencies of Factor V and VIII and of Vitamin K–Dependent Factors. In: Lichtman MA, Kaushansky K, Prchal JT, Levi MM, Burns LJ, Linch DC, editors. Williams Hematology. 10th ed. New York, NY: McGraw Hill Medical; 2022. p. 1617-38.
10. Giansily-Blaizot M, Biron-Andreani C, Aguilar-Martinez P, de Moeloose P, Briquel ME, Goudemand J, et al. Inherited factor VII deficiency and surgery: clinical data are the best criteria to predict the risk of bleeding. *Br J Haematol*. 2002;117(1):172-5. doi: 10.1046/j.1365-2141.2002.03408.x. [PubMed: 11918551].
11. Butenas S, Brummel KE, Branda RF, Paradis SG, Mann KG. Mechanism of factor VIIa-dependent coagulation in hemophilia blood. *Blood*. 2002;99(3):923-30. doi: 10.1182/blood.v99.3.923. [PubMed: 11806995].
12. Herrmann FH, Wulff K, Auberger K, Aumann V, Bergmann F, Bergmann K, et al. Molecular biology and clinical manifestation of hereditary factor VII deficiency. *Semin Thromb Hemost*. 2000;26(4):393-400. doi: 10.1055/s-2000-8458. [PubMed: 11092214].
13. Jain S, Donkin J, Frey MJ, Peltier S, Gunawardena S, Cooper DL. Phenotypical variability in congenital FVII deficiency follows the ISTH-SSC severity classification guidelines: a review with illustrative examples from the clinic. *J Blood Med*. 2018;9:211-8. doi: 10.2147/jbm.S157633. [PubMed: 30510462]. [PubMed Central: PMC6250109].
14. Chaudhry R, Killeen RB, Babiker HM. Physiology, Coagulation Pathways. 2025 Jun 2. In: StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing; 2025. [PubMed: 29489185].
15. Carew JA, Pollak ES, High KA, Bauer KA. Severe factor VII deficiency due to a mutation disrupting an Sp1 binding site in the factor VII promoter. *Blood*. 1998;92(5):1639-45. [PubMed: 9716591].
16. Cutler JA, Patel R, Mitchell MJ, Savidge GF. The significance of published polymorphisms in 14 cases of mild factor VII deficiency. *Blood Coagul Fibrinolysis*. 2005;16(2):91-5. doi: 10.1097/01.mbc.0000161561.51517.31. [PubMed: 15741795].
17. Kaushansky K, Lichtman MA, Prchal JT, Levi MM, Press OW, Burns LJ, et al. Williams hematology. 9th ed. New York, NY: McGraw-Hill Education; 2016.
18. Greer MD JP, Foerster J, Rodgers GM, Paraskevas F, Glader BE, Arber DA, et al. Wintrobe's clinical hematology. 12th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2009.
19. Napolitano M, Di Minno MN, Batorova A, Dolce A, Giansily-Blaizot M, Ingerslev J, et al. Women with congenital factor VII deficiency: clinical phenotype and treatment options from two international studies. *Haemophilia*. 2016;22(5):752-9. doi: 10.1111/hae.12978. [PubMed: 27338009].
20. Geng Y, Verhamme IM, Sun MF, Bajaj SP, Emsley J, Gailani D. Analysis of the factor XI variant Arg184Gly suggests a structural basis for factor IX binding to factor XIa. *J Thromb Haemost*. 2013;11(7):1374-84. doi: 10.1111/jth.12275. [PubMed: 23617568]. [PubMed Central: PMC4158700].
21. Yoshida A, Kimoto Y, Ejiri K, Mitani Y, Kawamata T. Anesthetic management of a patient with factor VII deficiency undergoing laparoscopic colectomy: a case report. *JA Clin Rep*. 2016;2(1):30. doi: 10.1186/s40981-016-0059-0. [PubMed: 29492425]. [PubMed Central: PMC5814789].
22. Gruppo RA, Kessler CM, Neufeld EJ, Cooper DL. Assessment of individual dose utilization vs. physician prescribing recommendations for recombinant activated factor VII (rFVIIa) in paediatric and adult patients with congenital haemophilia and alloantibody inhibitors (CHwI): the Dosing Observational Study in Hemophilia (DOSE). *Haemophilia*. 2013;19(4):524-32. doi: 10.1111/hae.12113. [PubMed: 23551918].
23. Blechman S, Fruchtman Y, Perry ZH, Mazar J, Ben Harosh M, Abed A, et al. Clinical and Laboratory Findings in Jewish and Bedouin Patients in Southern Israel Who Were Diagnosed with Factor VII Deficiency. *Isr Med Assoc J*. 2019;21(5):318-21. [PubMed: 31140222].
24. Marder VJ, Shulman NR. Clinical Aspects of Congenital Factor vii Deficiency. *Am J Med*. 1964;37:182-94. doi: 10.1016/0002-9343(64)90004-x. [PubMed: 14206752].
25. Rajpurkar M, Cooper DL. Continuous infusion of recombinant activated factor VII: a review of data in congenital hemophilia with inhibitors and congenital factor VII deficiency. *J Blood Med*. 2018;9:227-39. doi: 10.2147/jbm.S184040. [PubMed: 30568523]. [PubMed Central: PMC6276614].
26. Friederich PW, Henny CP, Messelink EJ, Geerdink MG, Keller T, Kurth KH, et al. Effect of recombinant activated factor VII on perioperative blood loss in patients undergoing retropubic prostatectomy: a double-blind placebo-controlled randomised trial. *Lancet*. 2003;361(9353):201-5. doi: 10.1016/s0140-6736(03)12268-4. [PubMed: 12547542].
27. Toret E, Ay Y, Karapinar TH, Oymak Y, Kavakli K, Vergin RC. Evaluation of Bleeding Phenotype of Inherited Factor VII Deficiency in Children With a Bleeding Assessment Tool and Global Assays. *J Pediatr Hematol Oncol*. 2020;42(6):e527-e30. doi: 10.1097/mph.0000000000001564. [PubMed: 31343480].
28. Ludlam CA. The evidence behind inhibitor treatment with recombinant factor VIIa. *Pathophysiol Haemost Thromb*. 2002;32(Suppl 1):13-8. doi: 10.1159/000057294. [PubMed: 12214140].
29. Zantek ND, Hsu P, Refaai MA, Ledford-Kraemer M, Meijer P, Van Cott EM. Factor VII assay performance: an analysis of the North American Specialized Coagulation Laboratory Association proficiency testing results. *Int J Lab Hematol*. 2013;35(3):314-21. doi: 10.1111/ijlh.12083. [PubMed: 23590660].
30. Yorke AJ, Mant MJ. Factor VII deficiency and surgery. Is preoperative replacement therapy necessary? *JAMA*. 1977;238(5):424-5. [PubMed: 577560].
31. Napolitano M, Siragusa S, Mariani G. Factor VII Deficiency: Clinical Phenotype, Genotype and Therapy. *J Clin Med*. 2017;6(4):38. doi:10.3390/jcm6040038. [PubMed: 28350321]. [PubMed Central: PMC5406770].
32. Zheng F, Cammisa FP, Jr., Sandhu HS, Girardi FP, Khan SN. Factors predicting hospital stay, operative time, blood loss, and transfusion in patients undergoing revision posterior lumbar spine decompression, fusion, and segmental instrumentation. *Spine (Phila Pa 1976)*. 2002;27(8):818-24. doi: 10.1097/00007632-200204150-00008. [PubMed: 11935103].
33. Mathews N, Rivard GE, Bonnefoy A. Glanzmann Thrombasthenia: Perspectives from Clinical Practice on Accurate Diagnosis and Optimal Treatment Strategies. *J Blood Med*. 2021;12:449-63. doi: 10.2147/jbm.S271744. [PubMed: 34149292]. [PubMed Central: PMC8205616].
34. Seligsohn U. [Inherited bleeding disorders common in Jews]. *Harefuah*. 2010;149(5):298-303, 35. [PubMed: 20929069].
35. Ramezanpour N, Zaker F, Biswas A, Dorgalaleh A. Inhibitor in Congenital Factor VII Deficiency; a Rare but Serious Therapeutic Challenge-A Systematic Literature Review. *J Clin Med*. 2021;10(2):211. doi: 10.3390/jcm10020211. [PubMed: 33435610]. [PubMed Central: PMC7827513].
36. Zimmermann R, Ehlers G, Ehlers W, von Voss H, Göbel U, Wahn U. Congenital factor VII deficiency. A report of four new cases. *Blut*. 1979;38(2):119-25. doi: 10.1007/bf01007952. [PubMed: 760871].
37. Siboni SM, Biguzzi E, Mistretta C, Garagiola I, Peyvandi F. Long-term prophylaxis in severe factor VII deficiency. *Haemophilia*. 2015;21(6):812-9. doi: 10.1111/hae.12702. [PubMed: 25952977].
38. Pinotti M, Toso R, Girelli D, Bindini D, Ferraresi P, Papa ML, et al. Modulation of factor VII levels by intron 7 polymorphisms: population and in vitro studies. *Blood*. 2000;95(11):3423-8. [PubMed: 10828024].
39. Bernardi F, Patracchini P, Gemmati D, Ferrati M, Arcieri P, Papacchini M, et al. Molecular analysis of factor VII deficiency in Italy: a frequent mutation (FVII Lazio) in a repeated intronic region. *Hum Genet*. 1993;92(5):446-50. doi: 10.1007/bf00216448. [PubMed: 8244334].
40. Bos MHA, van Veer C, Reitsma PH. Molecular biology and biochemistry of the coagulation factors and pathways of hemostasis. In: Kaushansky K, Lichtman MA, Prchal JT, Levi MM, Press OW, Burns LJ, et al. Williams Hematology. 9th ed. New York, NY: McGraw Hill Medical; 2015. p. 1409-34.
41. Ferraresi P, Balestra D, Guittard C, Buthiau D, Pan-Petesh B, Maestri I, et al. Next-generation sequencing and recombinant expression characterized aberrant splicing mechanisms and provided correction strategies in factor VII deficiency. *Haematologica*. 2020;105(3):829-37. doi: 10.3324/haematol.2019.217539. [PubMed: 31273093]. [PubMed Central: PMC7049351].
42. Logan AC, Yank V, Stafford RS. Off-label use of recombinant factor VIIa in U.S. hospitals: analysis of hospital records. *Ann Intern Med*. 2011;154(8):516-22. doi: 10.7326/0003-4819-154-8-

201104190-00002. [PubMed: 21502649]. [PubMed Central: PMC4011398].
43. Eikenboom JC, Bos CF, Briët E. Peri-operative replacement therapy with factor VII concentrate in a patient with severe factor VII deficiency. *Thromb Haemost*. 1992;67(2):285-6. [PubMed: 1621254].
44. Gorkom BL, Holme PA, Joch C, Rogosch T, Feussner A, McKeand W, et al. Pharmacokinetics and pharmacodynamics of a recombinant fusion protein linking activated coagulation factor VII with human albumin (rVIIa-FP) in patients with congenital FVII deficiency. *Hematology*. 2020;25(1):17-25. doi: 10.1080/16078454.2019.1700329. [PubMed: 31852380].
45. Monroe DM, Hoffman M, Oliver JA, Roberts HR. A possible mechanism of action of activated factor VII independent of tissue factor. *Blood Coagul Fibrinolysis*. 1998;9(Suppl 1):S15-20. [PubMed: 9819024].
46. Giansily-Blaizot M, Schved JF. Potential predictors of bleeding risk in inherited factorVII deficiency. Clinical, biological and molecular criteria. *Thromb Haemost*. 2005;94(5):901-6. [PubMed: 16363229].
47. Guay J, Haig M, Lortie L, Guertin MC, Poitras B. Predicting blood loss in surgery for idiopathic scoliosis. *Can J Anaesth*. 1994;41(9):775-81. doi: 10.1007/bf03011583. [PubMed: 7954993].
48. Kuperman AA, Barg AA, Fruchtman Y, Shaoul E, Rosenberg N, Kenet G, et al. Primary prophylaxis for children with severe congenital factor VII deficiency - Clinical and laboratory assessment. *Blood Cells Mol Dis*. 2017;67:86-90. doi: 10.1016/j.bcmd.2016.12.008. [PubMed: 28038846].
49. Ludlam CA, Smith MP, Morfini M, Gringeri A, Santagostino E, Savidge GF. A prospective study of recombinant activated factor VII administered by continuous infusion to inhibitor patients undergoing elective major orthopaedic surgery: a pharmacokinetic and efficacy evaluation. *Br J Haematol*. 2003;120(5):808-13. doi: 10.1046/j.1365-2141.2003.04173.x. [PubMed: 12614214].
50. Mannucci PM, Duga S, Peyvandi F. Recessively inherited coagulation disorders. *Blood*. 2004;104(5):1243-52. doi: 10.1182/blood-2004-02-0595. [PubMed: 15138162].
51. Mayer SA, Brun NC, Begtrup K, Broderick J, Davis S, Diringer MN, et al. Recombinant activated factor VII for acute intracerebral hemorrhage. *N Engl J Med*. 2005;352(8):777-85. doi: 10.1056/NEJMoa042991. [PubMed: 15728810].
52. Kolban M, Balachowska-Kosciolek I, Chmielnicki M. Recombinant coagulation factor VIIa–a novel haemostatic agent in scoliosis surgery? *Eur Spine J*. 2006;15(6):944-52. doi: 10.1007/s00586-005-1004-5. [PubMed: 16133083]. [PubMed Central: PMC3489422].
53. Lisman T, Moschatsis S, Adelmeijer J, Nieuwenhuis HK, De Groot PG. Recombinant factor VIIa enhances deposition of platelets with congenital or acquired alpha IIb beta 3 deficiency to endothelial cell matrix and collagen under conditions of flow via tissue factor-independent thrombin generation. *Blood*. 2003;101(5):1864-70. doi: 10.1182/blood-2002-09-2761. [PubMed: 12411291].
54. Logan AC, Goodnough LT. Recombinant factor VIIa: an assessment of evidence regarding its efficacy and safety in the off-label setting. *Hematology Am Soc Hematol Educ Program*. 2010;2010:153-9. doi: 10.1182/asheducation-2010.1.153. [PubMed: 21239786].
55. Benlakhal F, Mura T, Schved JF, Giansily-Blaizot M. A retrospective analysis of 157 surgical procedures performed without replacement therapy in 83 unrelated factor VII-deficient patients. *J Thromb Haemost*. 2011;9(6):1149-56. doi: 10.1111/j.1538-7836.2011.04291.x. [PubMed: 21486425].
56. Barletta JF, Ahrens CL, Tyburski JG, Wilson RF. A review of recombinant factor VII for refractory bleeding in nonhemophilic trauma patients. *J Trauma*. 2005;58(3):646-51. doi: 10.1097/01.ta.0000154561.97961.ad. [PubMed: 15761369].
57. Di Minno MND, Napolitano M, Dolce A, Mariani G. Role of clinical and laboratory parameters for treatment choice in patients with inherited FVII deficiency undergoing surgical procedures: evidence from the STER registry. *Br J Haematol*. 2018;180(4):563-70. doi: 10.1111/bjh.15055. [PubMed: 29235093].
58. Greene WB, McMillan CW. Surgery for scoliosis in congenital factor VII deficiency. *Am J Dis Child*. 1982;136(5):411-13. doi: 10.1001/archpedi.1982.03970410029005. [PubMed: 7081158].
59. Strauss HS. Surgery in patients with congenital factor VII deficiency (congenital hypoproconvertinemia) experience with one case and review of the literature. *Blood*. 1965;25:325-34. [PubMed: 14263207].
60. Szczepanik A, Wiszniewski A, Oses-Szczepanik A, Dąbrowski W, Pielaciński K, Misiak A. Surgery in patients with congenital factor VII deficiency - a single center study. *Pol Przegl Chir*. 2018;90(5):1-5. doi: 10.5604/01.3001.0012.0668. [PubMed: 30426948].
61. Kim SH, Park YS, Kwon KH, Lee JH, Kim KC, Yoo MC. Surgery in patients with congenital factor VII deficiency: A single center experience. *Korean J Hematol*. 2012;47(4):281-5. doi: 10.5045/kjh.2012.47.4.281. [PubMed: 23320007]. [PubMed Central: PMC3538800].
62. Laurian Y. Treatment of bleeding in patients with platelet disorders: is there a place for recombinant factor VIIa? *Pathophysiol Haemost Thromb*. 2002;32(Suppl 1):37-40. doi: 10.1159/000057300. [PubMed: 12214146].
63. Bauer KA. Treatment of factor VII deficiency with recombinant factor VIIa. *Haemostasis*. 1996;26(Suppl 1):155-8. doi: 10.1159/000217259. [PubMed: 8904192].
64. Kannan S, Meert KL, Mooney JF, Hillman-Wiseman C, Warrier I. Bleeding and coagulation changes during spinal fusion surgery: A comparison of neuromuscular and idiopathic scoliosis patients. *Pediatr Crit Care Med*. 2002;3(4):364-9. doi: 10.1097/00130478-200210000-00007. [PubMed: 12780956].