

**16 yo Middle Eastern girl, with Sickle Cell Disease and significant snoring, who is scheduled for spinal fusion surgery.**

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**Objectives:**

1. Understand the pathology of hemoglobinopathies, and the implications of severe sickle cell disease (SCD), including organ system involvement.
2. Recognize the presentation and understand the diagnostic criteria for OSA in pediatric patients.
3. Discuss how sickle cell disease and OSA may influence the postop course.
4. Discuss the recommendations on preoperative transfusion/exchange transfusion.
5. Discuss how the sickle cell disease will affect the perioperative management.
6. Understand the implications of using a cell saver.

**Case history**

You are asked to consult on a 16 yo girl from Saudi Arabia who just arrived in the U.S., and is scheduled to undergo correction of a severe thoracic kyphosis in 2 days. An interpreter is present for the patient and her parents. Her medical history is significant for HbS/ $\beta_0$ , and she requires hospitalization several times each year for sickle cell crises.

**Questions**

*What is Sickle Cell disease? Sickle Cell Trait? What is Thalassemia? Discuss the pathology of these hemoglobinopathies. What are the advanced complications of SCD?*

**Case continued**

The patient is hospitalized every 2-4 months for acute pain crises or acute chest syndrome, and in fact her kyphosis is secondary to ischemic compression fractures caused by the sickling. For the past year, her physicians are managing her with monthly prophylactic transfusions. Past surgical history is significant for a splenectomy at 3 yo, cholecystectomy and appendectomy at 7 yo, and placement of a mediport at 15 yo to allow for frequent transfusions.

Her medications include: codeine 30 mg prn, calcium/ Vit D3, folic acid, deferasirox (Exjade), hydroxyurea, medroxyprogesterone/estrogen, albuterol prn

**Questions**

*Discuss the medical management of SCD.*

**Case continued**

The ROS is significant for snoring. She does have a chronic cough and DOE. She has chronic back pain related to kyphosis and intermittent leg pain. She denies any history of strokes or neurological symptoms. Negative cardiac history.

Physical exam shows a shy, tiny teenager (4 ft 8 in, 37 kg). Her thoracic kyphosis is obvious and there is a mediport present. Eyes reveal scleral icterus. Airway is significant for 3+ tonsils. The rest of her exam is unremarkable.

**Questions:**

*What are your specific anesthetic concerns for this patient with SCD for spine surgery?  
What are the potential postoperative complications for this patient?  
What additional preoperative evaluation regarding her SCD would you need to proceed?  
Are there any services that would need to be consulted prior to surgery?  
Would you order a preoperative sleep study? What would you do if it's positive?  
How might a diagnosis of obstructive sleep apnea (OSA) affect her postoperative course?*

**Case continued**

Echo: normal  
PFT's: mod-severe mixed obstructive-restrictive defect: FEV1: 45%, FVC 48%  
Transcranial Doppler: normal  
H/H: 8/25  
Hb electrophoresis: HbA 58%, HbS 35%, HbA2 3%, HbF 4%  
MRI: severe compression T9-T11; diffusely abnormal signal with changes suggestive of infarcts in L4-5  
ENT consult recommends sleep study  
Polysomnography: Apnea hypopnea index (AHI) of 10.4, minimum O2sat of 89%

**Questions**

*Discuss the electrophoresis findings.  
What are the sleep study criteria for OSA?  
What 3 things influence perioperative risk in OSA patients?*

**Case continued**

The ENT surgeon recommends a T&A based on a diagnosis of moderate OSA and enlarged tonsils. He also recommends a 4-week recovery prior to spine surgery. The pt was admitted the night prior and transfused to a Hb of 10. She underwent an uneventful anesthetic and stayed 1 night in the PICU. She returns 4 weeks later for her kyphosis repair.

**Questions**

*How will you manage the pt preoperatively? What are your anesthetic goals?  
Will you use cell saver?  
What is your plan for postoperative analgesia?  
How do you avoid or treat acute chest syndrome postoperatively?*

**Discussion**

Hemoglobinopathies are due to structural defects in the globin chains of the hemoglobin molecule, with sickle cell disease (SCD) and Thalassemia being the most common. It is estimated that 7% of the world's population are carriers of the SCD gene. In the US, 8% of all African Americans are carriers, whereas 0.2% suffer from the disease.

Normal hemoglobin (HbA) is composed of four protein chains, two alpha and two beta. Sickle cell disease is an autosomal recessive disorder caused by a single amino acid substitution in the  $\beta$  chain. Patients who are homozygous for the mutation (HbSS) have

two sickle genes and more severe symptoms than the heterozygote form, also known as sickle cell trait. Thalassemias, in contrast, result in underproduction of normal  $\alpha$  or  $\beta$  globin proteins. Thalassemias and SCD may overlap as in our patient, who was HbS $\beta^0$ , which is virtually identical to sickle cell disease as the patient is unable to produce any normal beta chains.

HbS is an unstable molecule, which becomes less soluble when deoxygenated, distorting the RBC and leading to sickling. Sickling occurs when oxygen saturations decrease to less than 85%, and is exacerbated by acidosis, hyper/hypothermia, stasis, intracellular dehydration, decreased cardiac output, or hypovolemia. Sickling of the RBC leads to intracellular oxidant injury, cellular dehydration, and irreversible erythrocyte membrane deformity. Interactions between the endothelium and sickle erythrocytes leads to an inflammatory cascade with platelet aggregation, leukocyte adhesion, and coagulation dysfunction with decreased production and increased scavenging of nitric oxide. This cascade promotes vasoconstriction, which locally worsens ischemia and leads to further sickling. This chronic obstructive process in the microvasculature can result in severe tissue ischemia and multisystem organ injury.

Common clinical sequelae of SCD include chronic hemolytic anemia, recurrent episodes of vaso-occlusive pain crises, acute chest syndrome, infection, renal insufficiency, osteonecrosis, splenic sequestration with eventual autosplenectomy, and cholelithiasis. Pulmonary hypertension and stroke are additional causes of significant morbidity and mortality. Acute chest syndrome is the leading cause of perioperative mortality with an incidence of 10% in surgical patients. The clinical presentation is variable, including fever, tachypnea, cough, hypoxemia or pleuritic pain.

Medical therapy for SCD patients is centered on preventing episodes of sickling by avoiding the known triggers. Children from birth to five years of age are prescribed daily penicillin prophylaxis. Patients with a history of strokes or severe disease such as ours may be maintained on a routine transfusion program to maintain a hemoglobin level of 10 g/dl. Our patient's medications included hydroxyurea and deferasirox. Hydroxyurea works by increasing HbF production, and also decreases the leukocyte count helping to decrease the inflammatory response. Deferasirox (Exjade) is a chelating agent indicated for the treatment of chronic iron overload due to blood transfusions

The prevalence of OSA in the SCD population is estimated at > 10%, and is higher than the general pediatric population (2%). OSA can adversely affect disease outcome due to decreased nocturnal O<sub>2</sub> saturation, a trigger for sickling. The gold standard for diagnosing OSA is overnight polysomnography, which is able to diagnose the presence of apnea and whether it is central, obstructive, or mixed. The Apnea Hypopnea Index (AHI) is defined as the number of discrete obstructive events per hour. Severe OSA is defined by greater than 10 events per hour with an O<sub>2</sub> saturation nadir of < 80%. Although our patient had an AHI of > 10, her minimum O<sub>2</sub> saturation was 89% and therefore she was classified as moderate OSA. The ASA offers a risk assessment scoring system for patients with OSA undergoing surgery. The risk is graded by scoring in 3 areas: the severity of OSA, the invasiveness of surgery, and the need for postoperative opioid use. Though our patient had moderate OSA, it was felt that she was at particularly

high risk for postoperative complications because of her combination of severe SCD, severe restrictive-obstructive pulmonary defect, the nature of the surgery, and the expected requirement for high dose opioids postoperatively

In preparation for surgery, it is generally recommended that patients with severe SCD undergo a preoperative RBC transfusion to achieve a Hb of 10 g/dl. SCD patients undergoing lengthy major surgeries like spinal procedures with the potential for significant blood loss are at increased risk for perioperative complications. The goal of preventing sickling is accomplished by close monitoring of arterial oxygenation and administration of supplemental oxygen as needed, maintaining a hemoglobin of 10 g/dl, maintenance of normal body temperature and acid-base balance, and avoidance of hypovolemia, hypotension, or vasoconstriction, and prevention of infection. Particular attention should also be paid to positioning the patient during surgery to avoid areas of pressure and stasis. The use of a cell saver has become routine in many surgeries that involve significant blood loss, but is controversial in patients with SCD. The underlying concern is the risk of administration of sickled cells with the result of further reducing oxygen carrying capacity. However there is a report of its successful use by using a blood smear to verify that the collected blood had minimal sickling.

Our patient did well through both her tonsillectomy and adenoidectomy as well as her kyphosis repair 4 weeks later. Her positive outcome was largely due to aggressive medical management with coordination of orthopedics, anesthesia, hematology, pulmonary, and critical care.

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