

Case Report

Erythrocyte Exchange Transfusion Enabling Simultaneous Bilateral Total Hip Arthroplasty by a direct anterior approach in a Young Patient with Sick Cell Disease

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ABSTRACT

Sickle cell disease (SCD) is a known risk factor for femoral head osteonecrosis, often leading to early joint degeneration. We report a 17-year-old male with homozygous SCD and bilateral femoral head collapse who underwent simultaneous bilateral total hip arthroplasty through a direct anterior approach. Preoperative optimization included erythrocyte exchange transfusion effectively reducing hemoglobin S from 76% to 26%. The procedure was completed without complications, and the patient recovered uneventfully, with no sickling crises or acute chest syndrome. Cemented implants were used due to poor bone quality. The patient regained full, pain-free ambulation by three months. This case supports the safety and feasibility of simultaneous bilateral total hip arthroplasty in selected SCD patients when preceded by targeted erythrocyte exchange transfusion and managed by a multidisciplinary team.

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Introduction

Sickle cell disease (SCD) is an inherited hemoglobin disorder leading to the production of hemoglobin S (HbS) and is a major risk factor for femoral head osteonecrosis, often leading to end-stage joint degeneration in over 40% of affected patients at a young age [1]. Surgical management is complex due to increased perioperative risks, including vaso-occlusive crises, acute chest syndrome, infection, and thromboembolic events [2]. Total hip arthroplasty (THA) has shown favorable outcomes in SCD patients, but simultaneous bilateral THA (SBTHA) is rarely performed due to the increased surgical burden. While SBTHA is traditionally indicated for younger, healthier individuals with lower anesthetic risk—classified as American Society of Anesthesiologists Physical Status I or II—recent evidence from observational cohorts and

national registry data suggests that this approach may also be feasible in carefully selected American Society of Anesthesiologists III patients, provided that clinical conditions and perioperative risks are thoroughly evaluated [3,4]. Optimal perioperative transfusion strategies for SCD patients remain debated [5].

Erythrocyte exchange transfusion (EET) exchange involves the replacement of a patient's red blood cells (RBCs) with HbS with donor RBCs with Hemoglobin A and can be performed manually or via automated apheresis. Automated RBC exchange uses apheresis technology to selectively remove patient RBCs while infusing donor RBCs and colloid or crystalloid solutions. Modern apheresis systems calculate exchange volumes based on individual parameters such as body weight, height, sex, age, initial and target hematocrit, and fluid balance [6]. These systems also enable quantification of the residual fraction of patient erythrocytes, which is essential for monitoring the efficacy of the procedure. The principal clinical benefit of RBC exchange lies in the rapid and controlled reduction of sickled erythrocytes without increasing overall hematocrit. However, the procedure is limited by higher

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cost, the need for specialized equipment and trained staff, and the difficulty of securing adequate vascular access [6]. EET is proposed as a means of improving oxygenation and reducing HbS concentration, with the aiming to minimize complications during major procedures [7–9]. A HbS target below 30% and a hemoglobin concentration between 10–12 g/dL are considered ideal [10].

The direct anterior approach (DAA) offers several advantages, including muscle-sparing dissection, reduced blood loss, and supine patient positioning, which facilitates intraoperative imaging and simultaneous procedures without intraoperative repositioning [11].

We report the case of a 17-year-old male with homozygous SCD who underwent SBTHA via DAA following preoperative EET.

Case history

A 17-year-old male with homozygous SCD presented with severe bilateral hip pain and limited ambulation. Radiographs revealed advanced bilateral femoral head osteonecrosis with collapse (Fig. 1). A multidisciplinary team—including clinical hematologists, pediatricians, blood bank specialists, anesthesiologists, and orthopaedic surgeons—met to review the patient's case and establish a therapeutic strategy. Key factors considered included the patient's transfusion history (including the presence of red cell alloantibodies and any adverse transfusion reactions), history of vaso-occlusive crises, anesthetic risk, surgical risk, and anticipated recovery time.

Based on this evaluation, the team agreed on a perioperative erythrocyte exchange transfusion followed by a simultaneous bilateral THA. This decision was supported by the patient's lack of prior transfusion-related complications, history of acute chest syndrome, the benefit of reducing anesthetic and surgical exposure to a single time, and the patient's preference for an expedited return to school.

Preoperative optimization

Erythrocyte exchange transfusion was performed 1 week prior to surgery, reducing HbS from 76% to 26% and maintaining hemoglobin at 12.0 g/dL. No transfusion-related adverse events occurred.

Surgical procedure

The patient underwent SBTHA using the DAA in the supine position with a conventional operating table. This setup allowed a single-stage procedure without patient repositioning or redraping (Fig. 2). Closure of the first hip proceeded while the contralateral

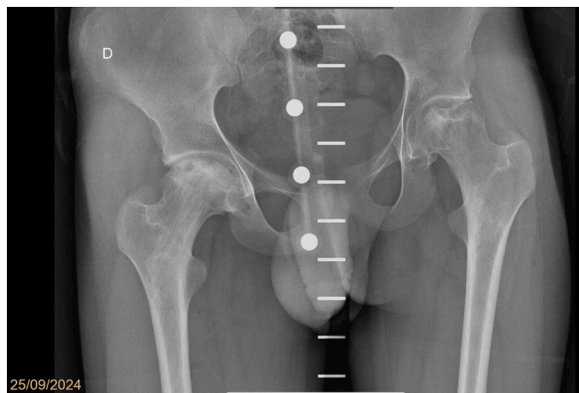


Figure 1. Preoperative pelvic radiograph confirming advanced bilateral osteonecrosis with femoral head collapse.

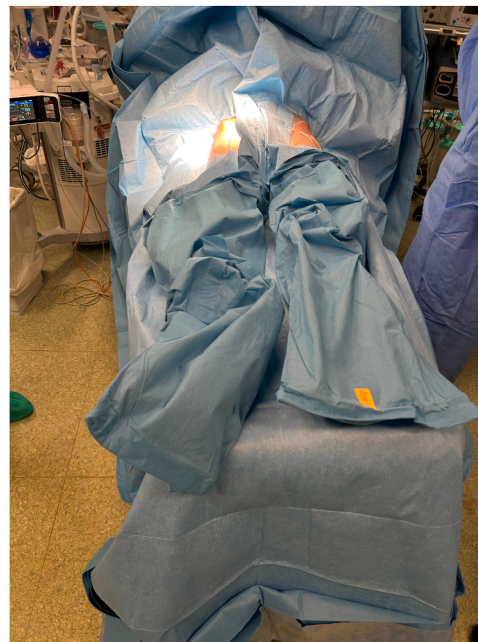


Figure 2. Patient in the supine position after draping, both hips are draped simultaneously.

arthroplasty was initiated (Fig. 3), optimizing operative efficiency. Total surgical time was 140 minutes.

Regarding implant selection, cemented Exeter stems (following a fourth-generation cementation technique) and X3 rimfit cups (Stryker, Kalamazoo, MI), along with BIOLOX delta ceramic heads (CeramTec, Plochingen, Germany), were used bilaterally with antibiotic-loaded cement. Blood loss was within expected limits and managed with tranexamic acid; no intraoperative transfusions



Figure 3. Members of the surgical team can be seen closing the right hip while surgical procedure has started on the left hip.

were required. Intraoperative fluoroscopy was used to confirm proper component alignment.

Postoperative course

The immediate postoperative course was uneventful. Hemoglobin dropped to 7.7 g/dL without clinical decompensation. At 1 month, HbS had returned to 55.5%, and hemoglobin recovered to 8.6 g/dL. There were no vaso-occlusive events or pulmonary complications.

The patient received low-molecular-weight heparin for thromboprophylaxis for a month. Mobilization began on postoperative day one. Radiographs confirmed appropriate implant positioning (Fig. 4).

At the 3-month follow-up, the patient reported full, pain-free ambulation and return to daily activities. Radiographs showed stable implants without signs of loosening or complications (Fig. 5). No additional clinical changes or radiographic changes were seen at 9-month follow-up visit.

Discussion

THA in SCD patients is associated with significant perioperative risks. Surgical procedures and anesthesia carry an elevated risk of acute complications in SCD patients, largely due to vascular dysfunction triggered by either acute or chronic inflammation. Intraoperative factors—including hypotension, local hypoxia, acidosis, and systemic inflammatory responses—can promote erythrocyte sickling, resulting in vaso-occlusive crises in up to 20% of patients and a 30-day all-cause postoperative mortality rate estimated at 1.1% [12]. There is general agreement that RBC transfusion should be considered in patients with SCD scheduled for elective surgery. The Transfusion Alternatives Preoperatively in Sickle Cell Disease trial [13] demonstrated that preoperative RBC transfusion significantly lowers the incidence of SCD-related perioperative complications, reducing risk by approximately threefold. Two transfusion strategies exist: conservative (simple transfusion) and aggressive (EET) [1,10]. While evidence comparing the 2 is limited, some studies favor EET due to fewer sickle-related complications [5,14,15].

EET requires more extensive preoperative testing including a complete blood count, coagulation studies, calcium and magnesium levels, Hb S percentage, and extended red cell phenotyping (Rh, Kell, Kidd, Duffy, and Ss systems), and genotyping when available. Red cell units with specific phenotypes (lacking antigens already identified as clinically relevant) are requested in advance.

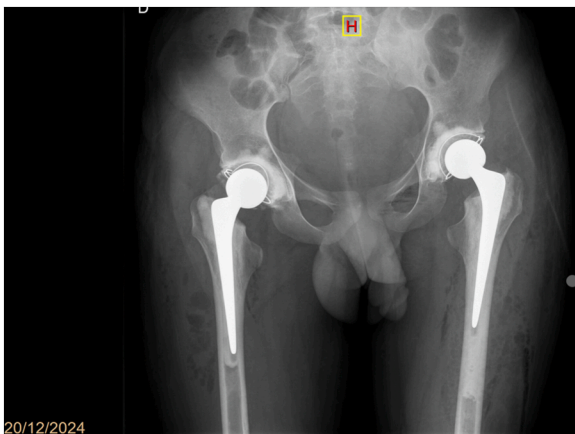


Figure 4. Immediate postoperative radiographs of the pelvis.

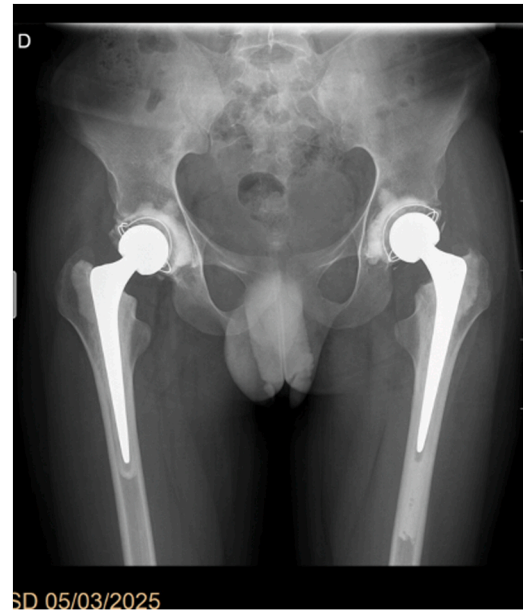


Figure 5. Radiographs of the pelvis at 3 months postoperative.

The EET is usually performed 1 or more days prior to surgery and can be done on an outpatient basis. At the end of the procedure, a new blood count and Hb S percentage are obtained to evaluate the effectiveness of the EET [6].

Studies comparing SBTHA and staged bilateral THA have shown that, in appropriately selected patients, the single-stage approach is associated with fewer major systemic complications, a reduced risk of deep venous thrombosis, shorter overall operative time, faster rehabilitation, and a shorter hospital stay [16,17]. Additionally, patients benefit from undergoing a single anesthetic and surgical event, which is especially important in the SCD cohort due to its inherent risks, as previously mentioned.

A previously published cohort of 18 patients with SCD undergoing simultaneous bilateral THA via a direct lateral approach in the lateral decubitus position—with intraoperative repositioning and redraping—reported encouraging outcomes [15]. Patients were managed with simple transfusions only when hemoglobin levels dropped below 8 g/dL. Despite the occurrence of sickle cell crises in 2 patients, the authors concluded that simultaneous bilateral arthroplasty was feasible, with a complication rate comparable to their staged THA cohort in SCD patients and the added benefit of accelerated rehabilitation [15].

Hernigou et al. [5] reported a cohort of patients with SCD undergoing THA. Those with a prior history of acute chest syndrome (ACS) were managed perioperatively with EET, and notably, none of these patients developed ACS in the perioperative period. In contrast, 4 patients without a prior history of ACS who did not receive EET experienced an episode postoperatively. Therefore, perioperative management with EET is recommended for patients with a history of ACS undergoing THA [5]. In our case, by managing the patient with EET, we were able to successfully perform simultaneous bilateral THA without triggering sickling crises or acute chest events.

Regarding implant selection, the decision to use cemented implants was guided by 2 main considerations. First, the use of antibiotic-loaded cement may reduce the risk of postoperative infection, which is of particular concern in these patients. Second, the presence of poor bone quality and extensive areas of sclerotic and necrotic avascular bone in these patients due to bone infarcts

increased the risk of inadequate fixation and impaired osteointegration if uncemented implants were used [18].

Our case supports the use of EET in reducing HbS levels preoperatively, potentially lowering complication rates. Additionally, the DAA offers a safe, efficient option for SBTHA, especially when paired with real-time fluoroscopy and a supine position to improve workflow and accuracy.

Summary

Simultaneous bilateral THA via the DAA is feasible and safe in selected SCD patients when combined with multidisciplinary perioperative care and preoperative EET. This approach may improve outcomes by reducing HbS burden and avoiding repositioning during surgery.

Informed patient consent

The author(s) confirm that written informed consent has been obtained from the involved patient(s) or if appropriate from the parent, guardian, power of attorney of the involved patient(s); and, they have given approval for this information to be published in this case report (series).

CRediT authorship contribution statement

Enrique Alberto Vargas Meouchi: Writing – review & editing, Writing – original draft, Data curation, Conceptualization. **Ricard Llovera González-Adrio:** Writing – review & editing, Writing – original draft, Data curation. **David Beneitez Pastor:** Visualization, Validation. **Veronica Pons:** Writing – review & editing. **Marta García Bernal:** Writing – review & editing. **Victor Manuel Barro Ojeda:** Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration.

Conflicts of interest

The authors declare there are no conflicts of interest.

For full disclosure statements refer to <https://doi.org/10.1016/j.artd.2025.101909>.

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