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Case Report

Anaesthesia Section

Perioperative Management of Emergency Off-pump Coronary Artery Bypass Grafting in a Patient with Pan-reactive Red Blood Cell Alloantibodies: A Case Report

KIRAN MUTHU RAJAH[1], V RAJESH KUMAR KODALI[2], RANJITH B KARTHEKEYAN[3], KAMALAKANNAN GANAPATHY SAMBANDHAM[4], R KRISHNAMOORTHY[5]

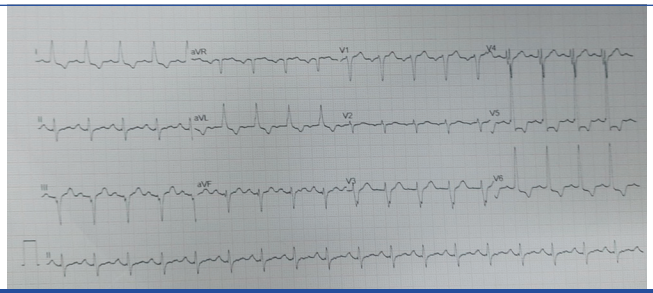
ABSTRACT

Red Blood Cell (RBC) alloimmunisation poses critical challenges in cardiac surgery, particularly during emergency Coronary Artery Bypass Grafting (CABG), due to the risks of haemolytic reactions and incompatible transfusions. This case report details the perioperative management of a 67-year-old female with severe triple-vessel coronary artery disease, left main stenosis, and pan-reactive RBC alloantibodies, who underwent emergency off-pump CABG without allogeneic transfusion. The patient presented with progressive retrosternal chest pain radiating to the left arm, lasting 4 hours, against a background of Type 2 Diabetes Mellitus (T2DM) and systemic hypertension. The electrocardiogram showed ST-segment depression and T-wave inversion in Leads I, aVL, V4, V5, and V6. Coronary angiography revealed ostial left main 80-90% stenosis, proximal left anterior descending artery 80%, mid-segment 90%, proximal ramus intermedius 60-70%, proximal left circumflex artery 80%, and right coronary artery ostial 80-90% with mid-segment 90% lesions. Echocardiography indicated hypokinesia in the basal and mid inferoseptal and inferolateral walls, mild left ventricular systolic dysfunction (ejection fraction 48%), grade 2 diastolic dysfunction, and mild mitral and tricuspid regurgitation, along with mild pulmonary hypertension. The preoperative haemoglobin level was 9.5 g/dL, and the blood group was B positive. A blood sample from the patient was sent for crossmatching for potential intraoperative transfusion. The indirect Coombs test with an 11-cell panel confirmed pan-reactive alloantibodies, rendering all screened units incompatible. The uniqueness of this case lies in the emergent setting with ongoing chest pain and moderate left ventricular dysfunction, where routine crossmatching failed across 20 donor units. This situation necessitated exclusive reliance on intraoperative cell salvage in conjunction with a multidisciplinary team approach—a strategy rarely documented in such high-risk, pan-reactive antibody scenarios in cardiac surgery.

Keywords: Anaemia, Cardiac surgical procedures, Cell salvage, Erythrocytes, Isoantibodies

CASE REPORT

A 67-year-old female presented to the emergency department with retrosternal chest pain of insidious onset, progressively worsening over the preceding 4 hours. The pain radiated to her left arm and was associated with diaphoresis. She had a known history of T2DM (diagnosed 15 years ago) and systemic hypertension (diagnosed 20 years ago), along with a previous COVID-19 infection 3 years ago and a tubectomy. She had two children delivered by normal vaginal delivery without perioperative complications. Her medications included Glibenclamide combined with Metformin (5/500 mg twice daily for diabetes), and Amlodipine (5 mg daily) with Losartan (50 mg daily) for hypertension. The electrocardiogram demonstrated ST-segment depression and T-wave inversion, most prominent in Leads I, aVL, V4, V5, and V6 [Table/Fig-1].



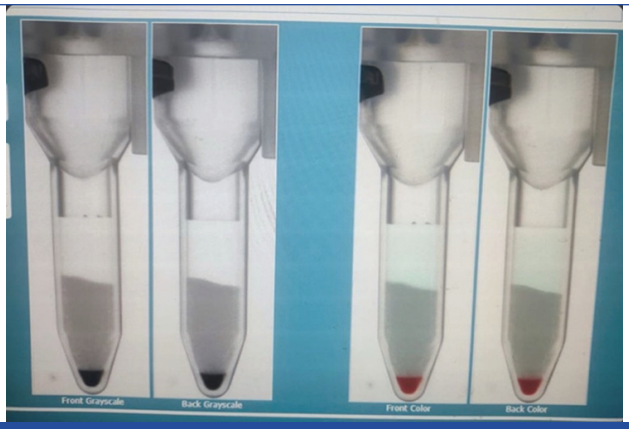
[Table/Fig-1]: Electrocardiogram (ECG) of patient showing anterolateral wall ischaemia (ST segment depression and t wave inversion in lead 1, aVL and V5 and V6).

In the emergency room, the patient received 300 mg of aspirin and 325 mg of clopidogrel. The echocardiogram showed normal chamber dimensions, but the basal and mid-inferoseptal and inferolateral walls were hypokinetic, indicating mild left ventricular systolic dysfunction with Grade 2 diastolic dysfunction (ejection fraction 48%). Additionally, there was mild mitral and tricuspid regurgitation with mildly elevated pulmonary arterial pressure. After the echocardiography, the patient was planned for primary angioplasty.

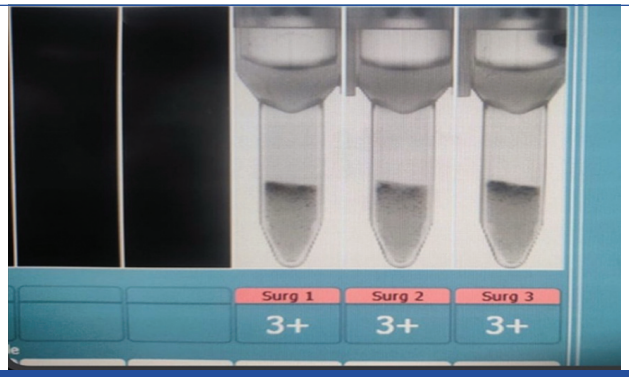
The coronary angiogram revealed coronary artery disease with left main and triple-vessel disease: ostial left main 80-90%, proximal LAD 80%, mid LAD 90%, proximal ramus intermedius 60-70%, proximal left circumflex 80%, and ostial right coronary artery 80-90% with mid RCA 90%. Following a multidisciplinary discussion involving the cardiologist, cardiac surgeon, and anaesthesiologists, the patient was scheduled for emergency CABG.

Prior to the procedure, blood investigations revealed a haemoglobin level of 9.5 mg/dL, total white blood cell count of 4980/cubic mm, platelet count of 3.05 lakh/cubic mm, and serum creatinine of 0.8 mg/dL. Given the low haemoglobin level, the plan was to reserve 4 packed red blood cells for the surgical procedure. A sample was sent for blood grouping and crossmatching for compatibility. Routine preoperative transfusion testing showed blood grouping and Rh typing as B positive. However, crossmatching between the donor and patient sample resulted in incompatibility.

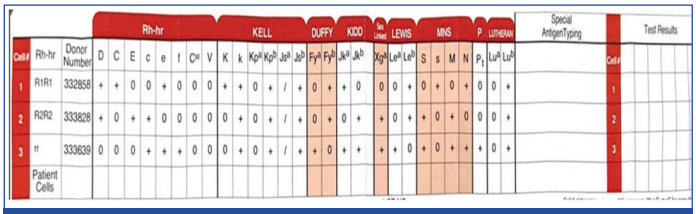
Immunohaematology tests revealed a negative direct Coombs test [Table/Fig-2] (ruling out autoantibodies) and a positive indirect Coombs test with a 3-cell panel [Table/Fig-3,4]. Consequently, further unexpected red cell alloantibody screening was performed using an 11-cell panel, which was reactive with all panel cells, indicating a



[Table/Fig-2]: Direct coombs test: negative.

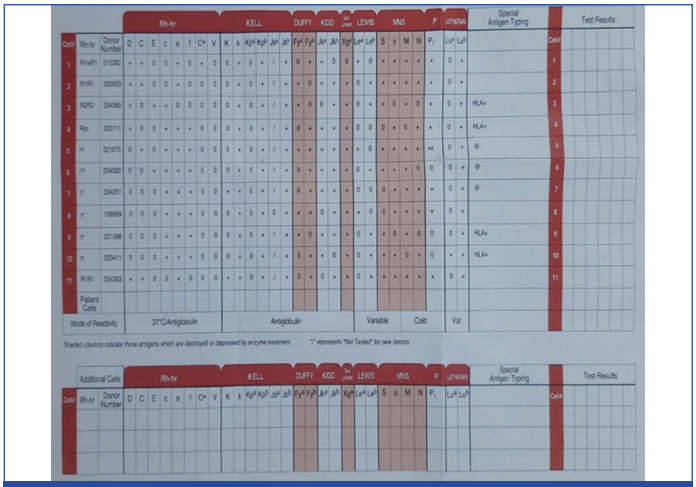


[Table/Fig-3]: Depicts positive indirect coombs test. 3 cell unexpected antibody screening – shows pan reactivity 3+ grading in all three cells.



[Table/Fig-4]: Depicts 3cell panel testing of antigram antigen profile using different reagent red blood cells.

pan-reactive red cell antibody to a high-prevalence antigen [Table/Fig-5]. Screening 20 donor units (10 B positive and 10 O positive) yielded no compatible products.



[Table/Fig-5]: Depicts 11 cell panel testing antigram antigen profile using different reagent red blood cells.

As a result, a multidisciplinary team discussion involving cardiology, cardiac surgery, haematology, and anaesthesiology was conducted. The plan was to use a cell saver (Sorin) during the procedure. With ongoing chest pain and moderate left ventricular dysfunction, high-risk consent was obtained for coronary artery bypass surgery using cell salvage.

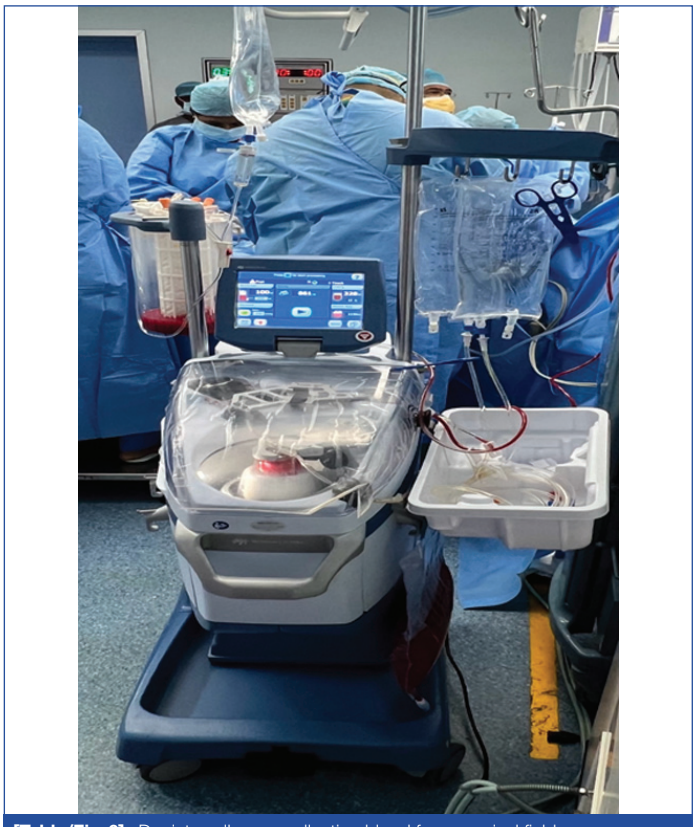
The primary goal of anaesthesia was to maintain a balance between oxygen supply and demand. A nil per oral history revealed that the patient was NPO for 6 hours. Anaesthesia concerns in this case included bleeding, anticoagulation, haemostasis, and management of haemodynamic changes during off-pump CABG.

The patient was shifted to the operating room, and monitors, such as the electrocardiogram and oxygen saturation, were connected. Under local infiltration, a 20-gauge Jelco catheter was inserted into the left radial artery, and a 7 French triple lumen catheter was inserted into the right internal jugular vein. Invasive blood pressure and central venous pressure were monitored before induction. The patient was preoxygenated with 100% oxygen for 3 minutes.

After preoxygenation, the patient was induced with intravenous fentanyl (150 mcg), intravenous etomidate (12 mg), and vecuronium (8 mg). The patient was ventilated for 3 minutes, and endotracheal intubation was performed using a 7.5 mm endotracheal tube. After induction, a bilateral pectointercostal fascial plane block was administered with 30 ml of 0.25% bupivacaine and 1 mcg/kg dexmedetomidine. Intravenous tranexamic acid (10 mg per kilogram) was administered as a bolus, followed by a continuous infusion of 3 mg per kg per hour, starting prior to sternotomy [1].

Anaesthesia was maintained with 0.7-1 MAC sevoflurane to titrate the bispectral index between 40-60%, 50% oxygen, and intermittent doses of fentanyl and vecuronium every 30-45 minutes. The surgical incision began with sternotomy, and the left internal mammary artery was dissected while the saphenous vein was harvested. The patient was heparinised with 1.5 mg/kg of unfractionated heparin. Three minutes after heparinisation, the Activated Clotting Time (ACT) was measured. During the procedure, the ACT was maintained between 250-350 seconds.

The cell saver was connected, and the collected blood was washed in the cell saver and stored in a blood bag [Table/Fig-6]. The surgery was performed with 4 grafts. After the surgical procedure, ACT was measured at 260 seconds. An intravenous dose of 0.7 mg/kg protamine was administered, resulting in a post-protamine ACT of 160 seconds. Haemoglobin levels in arterial blood gas were noted at induction (9.5 g/dL), before grafting (8.5 g/dL), and after protamine administration (7.7 g/dL).



[Table/Fig-6]: Depicts cell saver collecting blood from surgical field.

After the sternal wires were placed for closure, the blood collected in the cell saver was processed and administered back to the patient. After the transfusion, ACT was monitored again. The patient was then transferred to the Intensive Care Unit (ICU) for elective ventilation and was extubated after 5 hours. The patient's haemoglobin on the first postoperative day was 8.5 g/dL. On the third postoperative day, 1 g of intravenous iron was administered, and the patient was transferred to the postoperative ward with stable haemodynamics.

DISCUSSION

The CABG is a major surgery where atheromatous blockages in the patient's coronary arteries are bypassed using harvested venous or arterial conduits [2]. CABG is one of the surgical procedures that require intraoperative heparinisation, hemodilution, and coagulopathy due to cardiopulmonary bypass. The nature of the intervention also leads to perioperative blood loss and increased requirements for blood transfusion compared to other non cardiac surgeries [3]. Preoperative blood conservation strategies such as acute normovolemic haemodilution and preoperative erythropoietin supplementation, as well as intraoperative use of antifibrinolytics, cell salvage techniques, and adequate haemostasis, along with point-of-care coagulation tests, may reduce the need for blood transfusion during the perioperative period [4].

Red cell alloimmunisation occurs when a person lacks a particular antigen and is exposed to that antigen during pregnancy or multiple transfusions [5]. These antibodies may be clinically significant, leading to delayed haemolytic or serologic transfusion reactions. Complications from RBC alloantibodies are a leading cause of transfusion-associated mortality [6,7]. For perioperative blood transfusions, cross-matching and compatibility are essential to prevent haemolytic reactions [8]. In addition to ABO grouping and Rh typing, perioperative physicians should be aware of other antigens, including Kell, Duffy/Lewis, Lutheran, Kidd, and others that may cause red cell alloimmunisation [8,9].

Literature on similar cases is sparse, emphasising the novelty of this report. A comparable instance involved a patient with rare anti-Ok^{a} antibodies undergoing cardiac surgery with cardiopulmonary bypass, where cell salvage, autologous donation, and limited allogeneic units were employed to manage incompatibility [10]. Similar to this case, no haemolytic events occurred; however, it was elective surgery and involved on-pump bypass, potentially increasing transfusion needs. Both instances underscore the importance of multidisciplinary planning, although our pan-reactive profile and off-pump technique uniquely avoided any allogeneic exposure.

Faraoni D and DiNardo JA described RBC alloimmunisation in congenital cardiac surgery but focused on transfusion triggers rather than salvage strategies [11]. However, a multidisciplinary approach mitigated these concerns, in contrast to studies showing increased morbidity (e.g., renal failure, low output) resulting from incompatible transfusions. Incompatible transfusions can lead to acute haemolysis, renal failure, disseminated intravascular coagulation, low cardiac output, and mortality rates of up to 1-4 per 10,000 units [6,12,13]. Broader cardiac surgery cohorts reveal alloimmunisation rates of 2-6%, often against Rh/Kell antigens, complicating emergencies [6]. The target haematocrit in this case was set at 8 g/dL.

Anaesthesiologists should be knowledgeable about the management of red cell alloimmunisation and the transfusion guidelines or recommendations provided by the Association for the Advancement of Blood and Biotherapies (AABB) and the European Association of Cardiothoracic Surgeons and Anaesthesiologists (EACTS/EACTAIC) for patients undergoing coronary artery bypass grafting [14,15].

The AABB emphasises using group O Rh(D)-positive RBCs for Rh(D)-negative patients in haemorrhagic emergencies when Rh(D)-negative units are unavailable. This approach balances alloimmunisation risks (21-26% in hospitalised patients) against the imperative to stabilise haemodynamics [14,16].

EACTS/EACTAIC 2024 recommendations, based on the Consensus on perioperative blood management, include:

1. Preoperative optimisation: Correcting anaemia (iron supplementation for ferritin <100 ng/mL) and managing coagulopathies.
2. Intraoperative strategies: Utilising antifibrinolytics (tranexamic acid 10–30 mg/kg), cell salvage, and point-of-care viscoelastic testing to guide transfusion.
3. Modification of surgical techniques: Implementing off-pump CABG and minimising cardiopulmonary bypass circuits to reduce haemodilution and transfusion needs in high-risk patients [15].

In this case, the use of antifibrinolytics, cell salvage, and the modification of surgical technique to off-pump CABG successfully avoided blood transfusion during the perioperative period. Postoperatively, the patient's haemoglobin was 8.5 grams per deciliter, and 1 gram of intravenous iron was administered on the third postoperative day. The patient was transferred to the postoperative ward on the third postoperative day.

Routine screening for red cell alloimmunisation may be recommended for patients scheduled for cardiac surgery or any major surgery involving blood transfusions to prevent haemolytic reactions and other complications, such as acute kidney injury, thereby reducing morbidity. Emerging concepts include the use of universally pathogen-reduced red blood cells or cryopreserved O-negative red blood cells for patients with multiple alloantibodies to mitigate blood transfusion reactions.

CONCLUSION(S)

Due to the complexity of this patient's immunohaematologic profile, intraoperative cell salvage played a crucial role in maintaining appropriate haemoglobin levels and eliminating the need for incompatible allogeneic transfusion. Close perioperative monitoring, including serial assessments of haemoglobin and coagulation status, was essential to guide clinical decisions and optimise outcomes. The multidisciplinary approach, involving real-time collaboration among surgical, anaesthesia, and haematology teams, facilitated careful management of haemostasis and minimised perioperative risks, highlighting its critical role in similar high-risk cases. The development of institutional protocols for incompatible transfusion was beneficial during the perioperative period.

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PARTICULARS OF CONTRIBUTORS:
1. Senior Resident, Department of Cardiac Anaesthesiology, Sri Ramachandra Institute of Higher Education and Research (SRIHER), Chennai, Tamil Nadu, India.
2. Professor, Department of Anaesthesiology, Sri Ramachandra Medical College, Chennai, Tamil Nadu, India.
3. Professor, Department of Cardiac Anaesthesiology, Sri Ramachandra Medical College, Chennai, Tamil Nadu, India.
4. Associate Professor, Department of Cardiac Anaesthesiology, Sri Ramachandra Medical College, Chennai, Tamil Nadu, India.
5. Professor, Department of Transfusion Medicine, Sri Ramachandra Medical College, Chennai, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. V Rajesh Kumar Kodali,
Flat No. F30, SRMC Staff Quarters, Porur, Chennai-600116, Tamil Nadu, India.
E-mail: vrajesh.kodali@gmail.com

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