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Study of Automated Red Cell Exchange in Nine Cases of Sickle Cell Disease in Tertiary Care Hospital

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Abstract: ***Background: Red cell exchange is a very effective yet underutilized therapy for both acute and chronic complications of SCD. RCE is performed by removal of patient's red cells and replacement with allogenic red cells. The exchange prevents sickle cells from participating in vaso - occlusive events by decreasing the blood viscosity and increasing oxygen carrying capacity. Methods: This Retrospective study was conducted in tertiary care centre in Baroda medical college, Gujarat, India. Here we shared our experience by analyzing 09 RCE procedures performed in patients of SCD on F. KABI Machine of Apheresis system. Discussion & Result: Out of 09 patients who underwent RCE for SCA, one patient was admitted for hip joint replacement due to avascular necrosis of head of femur. The remaining patients were admitted for complaints of Vaso - occlusive crisis and others. The average range of pre - HbS levels was between 75% to 89% & post RCE was brought down to 24 to 35%. This was achieved by a single sitting of RCE in all these cases by improving the oxygen carrying capacity. Conclusions: RCE is a very safe & clinically effective therapeutic procedure with minimal to nil side effects. It is helpful to reduce iron overload due to top up transfusion. This procedure is underutilized due to various reasons like inadequate awareness/technical expertise, lack of equipments & facilities to identify the clinical conditions.***

Keywords: Automated Red cell Exchange (aRCE), Sickle cell disease (SCD), Red Cell Exchange (RCE), Sickle Cell Anemia (SCA), Apheresis Machine.

1. Introduction

Sickle Cell Disease is an inherited autosomal recessive blood disorder. It is a chronic disorder having qualitative defect in globin chain caused by a single mutation & substitution of valine with glutamic acid at sixth position in beta globin gene resulting in abnormal hemoglobin HbS.

Red cell transfusion increase tissue oxygen delivery & decrease the proportion of sickle RBCs in the circulation, so it is a key intervention in both chronic as well as acute complication of sickle cell disease. Automated RCE is also considered for other indications, like history of acute chest syndrome (ACS), recurrent painful crises (RPC) and Avascular necrosis of Hip bone.

Automated red cell exchange is performed through an apheresis system by removal of abnormal red blood cells from the patient's blood & replacing it by normal allogenic donors red blood cells.

This process requires specialist staff & equipment. It reduces the HbS level rapidly, avoiding iron loading and chronic transfusions in Sickle cell disease patients.

2. Methods

This Retrospective Study was conducted at tertiary care centre of Baroda medical college & S. S. G Hospital, Gujarat in between 2021 to 2023. This Study analyze the clinical outcome, effectiveness & side effects of this procedure in 09 patients during the study period.

Automated red blood cell exchange:
Automated red cell exchange (RCE) was performed through double - lumen 16F catheter on apheresis machine Com. Tec (Fresenius Kabi, Germany). The standard PL1kit (Fresenius Kabi) was used to perform all the 09 RCE procedures. The main goal of this procedure is to reduce hemoglobin S (HbS) levels by automated red cell exchange in patients with sickle cell disease or its variants to below 30%. By this method, we reduce the number of manual exchange transfusion, likelihood of infectious diseases, risk of allo - immunization from exposure to more allogenic blood products.

The machine has in - built software program (Version - 04.03.08, Com. Tec) for performing red blood cell exchange. As a part of pre - procedure requirements, demographic details of the patients along with hematologic parameters including hematocrit (HCT) and HbS concentration were entered in the software. The American Society for Apheresis (ASFA) guidelines state that RBC volume to be exchanged depends on target HbS level. According to the patient's body volume, 100% RBC replacement and target HbS level <30%, the RBC volume to be exchanged is calculated by the software.

The Blood Volume and hematocrit of each RBC bags were entered in the 'RBC calculator' of software for RBC exchange. The software predicted post procedure HCT as >35% and HbS as <30%. During this procedure, the patients

vitals including pulse rate, blood pressure, oxygen saturation, and respiratory rate were monitored.

In RCE procedure, fresh bags less than 7 days old with packed red cells suspended in additive solution (SAGM) and leukoreduced by pre storage leuko filtration were used. Donor units transfused were crossmatch compatible units negative for sickle cells by sickle solubility test.

3. Results

Among the Nine sickle cell disease patients who underwent red cell exchange (RCE) procedure, 01 was female and 08 were males. All nine patients were admitted in S. S. G Hospital, Baroda, for various complaints related to sickle cell disease as described in **Table: 1.** Age group of patients was between 18 to 45 years with a mean age of 26.77 years.

- Haematological Parameters
  The average range of initial HbS level was between 73 - 85% and post RCE, it was brought down to 22 - 35% which is explained in **Figure: 01**. HbA levels were maintained between 60% to 75% with target hematocrit of approximately 34%. In all cases confirmation of HbA% was done through HPLC test. Target Hb% was achieved by single sitting in all the cases.
- Allo - immunization
  Two patients were known to have alloantibodies before commencing aRCE. But new alloantibody was not developed by any patient.

4. Discussion and Conclusion

RCE is an effective treatment modality that can be used safely in a large number of conditions. Its efficacy is well defined in many conditions' clinical trials.

The major advantage of RCE in SCD is that it reduces iron overload, since the removed HbS has just as much iron as the administered HbA. Several studies have demonstrated stable iron levels after RCE. Treatment of SCD patients with bone marrow necrosis and multi - organ failure is mainly supportive. RCE is effective in management of both acute and chronic complications of sickle cell disease.

However, American society for apheresis advises RCE to be used as a first line or as adjunctive second line therapy for cerebrovascular accidents and acute chest syndrome. The role of RCE in multiorgan failure is not yet established and should be used on case to case basis.

Most of the RCE in present study were uneventful except for few allergic and febrile reactions. None of the patients had reactions due to citrate toxicity, as the anti - coagulant used during these procedures gets metabolized in the liver within minutes and the ratio of anti - coagulant used is generally 1: 12, which is very low.

None of these patients showed the presence of any allo or auto antibodies during antibody type and screen except one sickle cell patient who had anti - D allo - antibody. Studies suggest that SCD patients may benefit from extended antigen matching, especially in patients who have already made allo - antibodies or patients with warm reacting auto - antibodies. No comparable studies regarding RCE and avascular necrosis of the head of femur in SCD was found in literature search. Most of the studies have the patients who underwent the procedure presented with acute chest syndrome either during or after RCE.

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Declarations
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Conflict of interest: This being Government College and Government affiliated hospital, there are no conflicts of interest.
Ethical approval: Not required.

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Table 1: Demographic details, chief complaints of 9 patients undergoing RCE.

Pt's name	Age - Sex/Wt	No. of bags prepared	DAT/ IAT	Total Exchange of Volume	Past Medical History	Presenting Symptoms	Clinical course	Outcome
01	20 yr Female/ 43 kg	05	Negative	1500ml	Avascular necrosis, Recurrent VOC	Hip pain (VOC), Respiratory symptoms	Severe	Favorable
02	21 yr Male/ 50 kg	04	Negative	1400ml	Retro Sternal Chest Pain, Cardiac remodeling	VOC low oxygen saturation, B/L LL palsy, V1 - V3 (Sinus Tachycardia), Generalised body ache, Headache	Severe	Favorable
03	18 yr Male/ 35 kg	04	Negative	1600ml	Splenomegaly, Mild VOC	Generalise body ache, Joint pain, Mild pallor, Severe VOC	Severe	Favorable
04	22 yr Male/ 42 kg	04	Negative	1750ml	K/C/O SCD Since 17 yrs, Recurrent VOC	Lower Back Ache, Chest Pain, Right Shoulder pain	Severe	Favorable
05	22 yr Male/ 42 kg	03	Negative	1000ml	Hip pain, Respiratory symptoms	VOC, Fever, Lower back pain, Hip joint pain	Moderate	Favorable
06	46 yr Male/ 59 kg	07	Negative	1300ml	Breathing Difficulty, Minor VOC	Hemolytic crisis, Body - ache	Mild	Favorable, Dischared against medical advice
07	32 yr Male/ 60 kg	05	Negative	868ml	Acute chest syndrome	Generalise body ache, Yellowish discoloration on skin, VOC	Mild	Favorable
08	35 yr Male/ 42 kg	05	Negative	1400ml	Asthma, Respiratory &GI Symp	Acute chest pain, Breathlessness	Severe	Favorable
09	25 yr Male, 55 kg	05	Negative	1235ml	Acute chest syndrome, B/L Hip joint pain	Abdominal pain, Back pain, VOC	Severe	Favorable

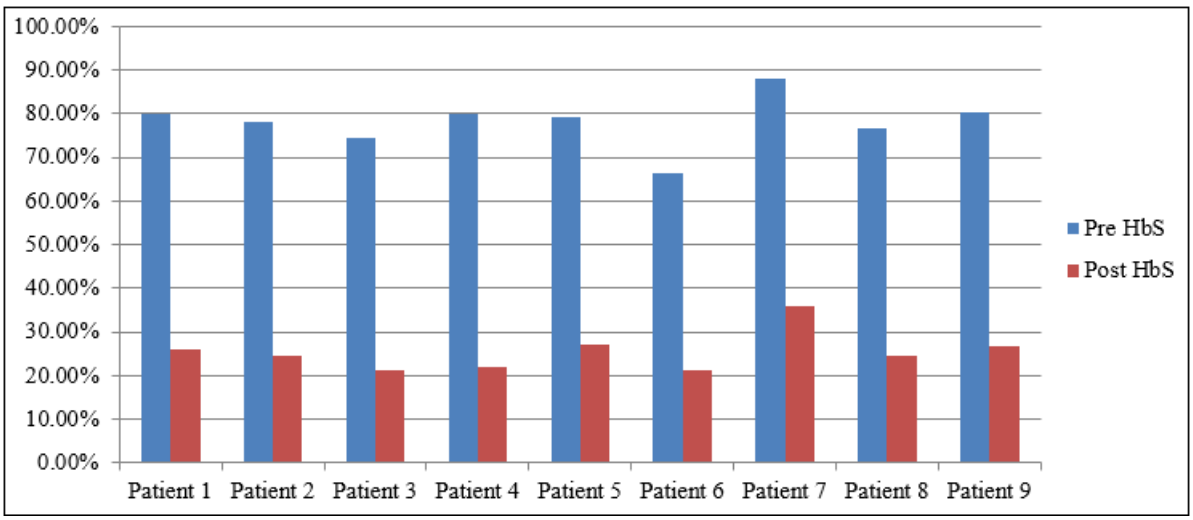

Figure 1: Haematological Parameters of pre - HbS and post - HbS Comparison