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Simultaneous Therapeutic Plasma Exchange and Transfusion in children: A case report

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Abstract

Aphaeresis is a technology that takes individual's blood out and separates into blood components. It is used for blood component collection as well as for therapeutic removal of pathological blood components in a variety of disease conditions. SLE nephropathy is an indication for therapeutic plasmapheresis and it is beneficial in paediatric patients as well. Here a paediatric case of SLE nephropathy treated with plasmaphaeresis is presented and during the procedure the patient's haemoglobin level was corrected with minimum use of allogeneic blood. Importantly, the patient gained many benefits over routine blood transfusion in this procedure.

Keywords: Therapeutic plasma exchange, Plasmapheresis, Aphaeresis, Anaemia, Blood Transfusion, Sri Lanka

Introduction

Aphaeresis is a technique that is used for separation of blood components from whole blood. It includes take blood out from an individual, anticoagulation, separation into blood components, removal or collection of the desired component and returning the remainder to the individual. At the blood bank it could be used in blood component collection such as red blood cells, plasma and platelets [1]. Importantly, aphaeresis procedure is beneficial in stem cell collection which is used for autologous and allogeneic stem cell transplantation. Moreover, aphaeresis technology is used as an extracorporeal therapy in which a blood component is removed when a specific blood component causes a disease condition [2]. Removal of cellular component is called therapeutic cytapheresis and it is used as red cell exchange, therapeutic leucocyte reduction and therapeutic platelet reduction in relevant disease conditions. Therapeutic plasmaphaeresis or therapeutic plasma exchange (TPE) is the most commonly used therapeutic aphaeresis procedure, and it removes pathogenic elements with a high molecular in plasma such as immunoglobulin, immune complexes, or inflammatory mediators from plasma. Furthermore, TPE alters the immune function such as activation of T and B cells [3].

Systemic Lupus Erythematosus (SLE) is an autoimmune condition in which autoantibodies affects target organs such as joints, kidneys and skin. There is a type of SLE namely childhood-onset SLE and it is treated with many treatment modalities [4]. Complications of SLE could be managed with TPE, and it is beneficial especially in renal complications [5]. Lupus nephritis is known complication of SLE and in children lupus nephritis causes high morbidity and mortality [6]. TPE is beneficial for rapid recovery of lupus nephropathy. Importantly, it is a straight forward indication to

perform TPE. Immunoadsorption, another extracorporeal treatment modality, has also identified as beneficial for this condition [7].

TPE is currently carried out using automated cell separators, rather manual exchange and different types of aphaeresis machines are available. A sterile disposable kit is always used for each procedure. In paediatric setting it is necessary to precautions to avoid complications related to extracorporeal circulation in TPE because extracorporeal volume is significantly higher comparing to the total blood volume in children. In addition to the saline priming of the disposable kit, the kit is primed with crossmatch compatible blood to avoid the harmful effect of the relative large extracorporeal volume in small children [8]. Routinely this amount is discarded at the end of the procedure to avoid the fluid overload. In this case report, a method of improving haemoglobin level of a paeditric patient, during the TPE procedure is reported.

Case Report

An 8-year-old girl, a diagnosed patient with SLE with lupus nephropathy class IV, was presented to a tertiary care hospital in Sri Lanka, with features of lower respiratory tract infection. On examination, her abdomen was grossly distended. Her blood pressure was 123/83 mmHg which was above 99th centile for her age. Urine examination revealed proteinuria and haematuria. Blood picture showed normochromic normocytic red cells with pencil cells and target cells. It was suggestive of mixed deficiency anaemia which was responding to haematinics and features of Micro Angiopathic Haemolytic Anaemia (MAHA) were also present. Prompt treatment was given for the lower respiratory tract infection. Her serum creatinine level was 137 µmol/L.

Due to the disease progression of SLE, the child was referred for TPE. This scenario met the criteria for TPE [5]. The weight of the child was 15kg and the height was 115cm. For the TPE procedure an 8 FG size vascath was inserted to the right internal jugular vein. The child was admitted to the intensive care unit for the TPE procedure. Her blood group was B Rh D positive. Blood was crossmatched for the procedure and 150mL was separated as a paedipack, to be used for the first cycle of TPE.

When she was referred for TPE, her initial haemoglobin value was 7.0 g/dL. TPE procedure was performed using a continuous flow automated cell separator. The disposable kit was initially primed with normal saline as usual and then normal saline was replaced by packed red cells by 'blood priming' step. Red cell pack was crossmatch compatible with the patient and a paedipack was used to reserve the remainder for the subsequent cycle. TPE was planned on every other day and a total of five TPE cycles were offered.

During the first cycle of TPE, a total volume of 1922mL of whole blood of the patient was processed and 1253mL of patient's plasma was extracted which was replaced by 1000mL of 5% human albumin and 160mL of normal saline. Therefore, a negative fluid balance of 93mL was made. Even though a reinfusion is not performed after blood priming routinely, this negative balance allowed a fluid space for a reinfusion. Therefore, the blood that was remained in the kit was infused to the patient. Prior to the procedure her blood pressure was 114/64 mmHg and it was monitored closely as there was a negative balance during the procedure. The procedure took two hours to complete and it was completed uneventfully. Post-procedure full blood count revealed a haemoglobin value of 9.3 g/dL.

For the second TPE procedure, a paedipack of red cells prepared from the same red cell pack was used for blood priming. So that, the donor exposure is minimized. The procedure was similar to the first cycle and the parameters were also more or less same as for the first cycle. At the end of the second cycle, the achieved negative balance was used to reinfuse the blood volume in the kit. Post procedure investigations showed that after the second cycle, the haemoglobin value has been improved to 10.1 g/dL.

During the subsequent cycles, similar values were achieved for procedure parameters. In each cycle approximately 150mL of red cells was transfused by making a negative fluid balance similar to the first two cycles. After the third and the fourth cycles the haemoglobin values were 10.9 g/dL and 12.1 g/dL. respectively.

After five cycles of TPE a significant clinical improvement was observed and also serum creatinine level showed a drastic reduction to 56 µmol/L. Hence, the disease condition has been improved significantly during the five TPE cycles. As far as the haemoglobin value is considered, it was 12.8 g/dL after the final TPE cycle. The patient was exposed only to three blood donors due to preparation of paedipacks from the red cell units.

Discussion

TPE is an accepted therapeutic method in modern medical practice and it is beneficial in a range of clinical conditions. Many nephrological conditions are managed with TPE out of which some could be lifesaving. Lupus nephropathy is a such condition and it affects children as well. When clinical and laboratory criteria are met, the patients with lupus nephropathy are offered TPE. In current practice, TPE is performed using automated cell separators. There are various kind of machines; however, the technology is similar in operation. Routinely the disposable kits used in machines are primed with normal saline to remove air in the system. In children who are weigh less than 25kg this is primed again with crossmatch compatible blood. This is called 'blood priming' or 'custom priming'. This step avoids the consequences of the extracorporeal blood volume which is significantly high compared to the child's total blood volume. As the primed blood is infused to the patient initially, this is considered as an exposure to allogeneic blood. Usually around 150mL of blood is used to achieve this priming and one adult blood unit is used for two consecutive procedures when separated using a sterile connecting device.

The risks of exposing to allogeneic blood are similar to the risks of blood transfusion because adverse effects of blood transfusion could occur during this exposure. Those include ABO incompatible transfusion, transmission of infectious diseases, development of alloantibodies to red cells antigens, allergic reactions, and febrile reactions [9]. The incidence of those reactions is increased with repeated transfusions, especially the formation of red cell antibodies. Red cell alloantibody formation commonly occurs in repeatedly transfused patients [10]. This more common in patients with Sickle Cell disease; however, in Sri Lanka the most prevalent transfusion dependent condition is Thalassaemia Major. Formation of red cell antibodies subsequent red cell crossmatches more difficult and could lead to delayed haemolytic transfusion reactions due to minor red cell antibodies [10]. Simultaneous TPE and blood transfusion reduces the recurrent exposure of the patient to allogeneic blood. By using the red cell pack that is used to prime the kit, the number of exposing events are reduced. Hence, the probability of making antibodies could be decreased. In addition to red cell antibodies, other important aspect is formation antibodies against Human Leucocyte

Antigens (HLA) [11]. HLA antibodies play a critical role in organ transplantation, as presence those antibodies is a known cause for allograft rejection. So, reduction of formation of HLA antibodies is beneficial if the patient is awaiting a renal transplantation. There are several measures to reduce the incidence of developing HLA antibodies, including minimize the donor exposure.

Another adverse event of blood transfusion is transmission of infectious agents such as human immune deficiency virus (HIV), hepatitis viruses and *Treponema pallidum* [12]. Even though the donated blood is tested for common infections, the transmission cannot be eliminated completely due to the unavoidable window period of infectious agents. The probability of this event is also increased with repeated donor exposure. As the primed blood has been already exposed to the patient, reinfusion of the remaining blood has an added advantage of reducing donor exposure. Furthermore, this method allows an effective fluid balance in children especially in renal diseases. In children, Transfusion Associated Circulatory Overload (TACO) is a common possibility [13]. A negative fluid balance that is made during the TPE procedure, has an advantage of minimizing the risk of TACO. However, the negative fluid balance should be made with caution, with close monitoring of vital parameters including blood pressure. In addition, simultaneous TPE and blood transfusion allows the maximum utilization of blood products as blood is a scarce resource. If the remaining blood in TPE kits are discarded, new units of blood may be necessary from the blood stock for the haemoglobin increment in the patient. Therefore, this method could reduce that wastage. Moreover, it reduces wastage of blood bank consumables as well as human resources. During a blood transfusion the patient must be closely monitored. TPE is carried out at a high dependacy unit and during the TPE procedure the patient is intensively monitored. Therefore, transfusion during the TPE makes monitoring easier. It is important to note that the haematocrit of the red cell pack is higher than the value of the patient. This also aids in rapid correction of haemoglobin value in the patient. This method is more beneficial for practice as anaemia is a common condition in chronic diseases such as SLE [14].

Conclusion

Considering all above facts, this case proves that the simultaneous TPE and blood transfusion in children is feasible and it is effective in improving the haemoglobin level. This procedure has several advantages over routine blood transfusion especially in renal diseases.

Author declaration

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Author contribution

SS: Concept, design, and writing of the manuscript

Conflict of interest

The author declares that there is no financial and non-financial conflict of interest.

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Ethics statement

Written informed consent was obtained for participation and publication.

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