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Prevalence of Sickle Cell Disorder In Blood Donors: A Cross-Sectional Study In Tertiary Care Hospital Of Central India

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Abstract

Context: Sickle cell disorder is prevalent in many tribal and ethnic groups in India. Sickle cell trait individuals are unaware of their genetic status, clinically asymptomatic and are easily missed by routine complete blood count and during donor history taking prior to blood donation. These subjects can be found among potential blood donors at blood banks and at donation camps unknowingly.

Aims: The purpose of the study is to determine the prevalence of sickle cell disorders among blood donors. And also, to evaluate risks and complications in SCT donors and in recipients receiving HbS units.

Settings and Design: Prospective cross-sectional study.

Methods and Material: Study was undertaken at a tertiary care centre in Nagpur district of Maharashtra state, India. Healthy donors were randomly selected over a period of 2 years. Donors were screened by solubility test and positive cases were confirmed by Hb electrophoresis.

Results: Of the total 6000 donor samples, 262 solubility positive samples showed AS pattern on Hb-electrophoresis. No complications were reported in sickle trait donors, even after donating for several times and with minimum interval of 3-4 months. Also, no transfusion reactions were found in recipients who received blood from SCT donors.

Conclusions: Prevalence of sickle cell disorder among the blood donors in our study is 4.37 %. There were no complications reported, neither in the SCT donors nor in the recipients. Sickle trait individuals should not be deferred as prospective donors.

Keywords: Sickle cell trait, blood donors, prevalence, blood transfusion

Introduction

Sickle cell disorder, a hereditary hemolytic anemia, is prevalent in many parts of India, with prevalence of heterozygotes varying from 4-40% [1]. More than half (60.64%) are found predominantly in four states Chhattisgarh, Orissa, Maharashtra, & Gujarat in their decreasing order of prevalence [2]. The frequency of Sickle cell trait (SCT) in Central India (including Nagpur district) is 12-13%, which is limited mostly to certain ethnic groups (Scheduled and OBC groups) [3].

Hemoglobin S (HbS) is caused by structural single-point mutation and is characterized by poor solubility in the deoxygenated state, followed by polymerization of HbS molecules inside the red cells leading to RBC shape distortion, rigidity, vaso-occlusive crises, severe pain, damage to vital organs and extravascular haemolysis [4].

SCT (genotype AS) is a heterozygous condition in which the red cells contain HbS around 40% of total haemoglobin, with predominance of HbA (60%) [5].

There are no associated haematological abnormalities and sickling occurs only at low oxygen tension [4,5]. Persons with SCT are usually asymptomatic and are as healthy as any other blood donors, rarely having any health problems related to the sickle hemoglobin [6, 7]. Whereas, individuals with sickle cell anemia (genotype SS) are usually symptomatic, so there is rare possibility of them to come as a blood donor.

Even though SCT is highly frequent in many geographical areas and ethnic groups; they are easily missed by routine complete blood count (CBC) and also during history taking of donor before donation (who have not been screened prior). And therefore, it is not uncommon to encounter persons affected by SCT as prospective blood donors [8].

In Nagpur division of Maharashtra India, there are 25 blood banks in which more than 80000 donors donate blood every year [9]. Individuals with certain medical defects may unknowingly find themselves in the donor population. The potential health risk to SCT donors, quality of the donated HbS blood and the possible complications of transfusing such blood to certain vulnerable recipients encouraged us for this study.

This study was undertaken 1) to evaluate prevalence of sickle cell disorders amongst the Blood Donors; 2) to find out complications or adverse effects in sickle trait donors in relation to frequency of donation and the interval between two donations; 3) to find out transfusion reactions occurring in recipients who had received blood from sickle trait donors.

Materials and methods:

This prospective cross-sectional study was carried out in Blood Bank and Pathology department at a tertiary care centre in Nagpur district of Maharashtra state, India.

Blood samples were obtained from 6000 donors randomly selected from blood bank over a period of 2 years. Voluntary and replacement donors coming to blood bank and also in blood donation camps, fulfilling the donor selection criteria and after informed consent for blood donation were included in the study. Due efforts are taken to conceal the identity of donors. History of frequency of donation and interval between two donations were obtained from each donor.

As a routine, follow up of the donors was kept during and after half an hour of blood donation for immediate complications. Donors were kept in refreshment room and were given juice and packet of biscuits. Trained volunteers looked for signs of discomfort in potential SCT donors where they observed for any local hematoma & pain, as well as for signs of weakness, sweating, dizziness, pallor, slow pulse rate, low BP, cold skin, nausea, vomiting, tetany, low urine output and vaso vagal reaction. Each donor was provided with a card which had the emergency numbers to be contacted in case of any delayed complication. However, no feedback call was made to donors to confirm, if they had delayed complications or not.

Blood samples of these 6000 apparently healthy donors were collected in EDTA bulbs and were screened by solubility test for determination of abnormal hemoglobin. All the solubility positive samples were subjected to hemoglobin electrophoresis on agar gel at pH 8.6 for confirmation and subtyping of sickle cell disorder.

Blood units from sickle trait donors were issued to recipients with various pathologic conditions, selected randomly from patients admitted in different departments of the hospital. Each recipient received single unit transfusion of sickle trait blood.

Post transfusion follow up of the recipients was kept, as a routine procedure, for any immediate or delayed transfusion reaction during their hospital stay (3 days to 2 weeks). Recipients of SCT blood were observed for hemolytic transfusion reaction, febrile nonhemolytic transfusion reaction, allergic reactions or anaphylactic reactions. As per the standard operating procedure manual in the blood bank, in case of suspected blood transfusion reaction (BTR) or potential complication arising due to blood transfusion, transfusion should be discontinued immediately, and blood unit along with recipient's blood sample should be sent to blood bank for complete workup of BTR.

Results:

Out of total 6000 donor samples screened by solubility test; positive result was found in 262 (4.37%) samples. On hemoglobin electrophoresis, all the 262 solubility positive samples showed AS pattern.

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The blood donors in the study were from the age group of 18 to 60 years, and out of 262 SCT blood donors, maximum donors 177 (67.56%) belonged to the age group of 18 – 30 years **(Table no.1).** Out of 262 SCT blood donors, 243 (92.75%) were male donors and 19 (7.25%) were female donors. There were 189 (72.14%) voluntary SCT donors and 73 (27.86%) replacement SCT donors.

Out of 262 SCT blood donors, maximum were first time donors 232 (88.55%), and 30 (11.45%) were repeated donors. Out of 30 repeated SCT donors, 15 (50%) donors donated blood for second time, 5 (16.67%) donors donated each for the third- & fourth-time, 3 donors (10%) donated for sixth time, 1 (3.33%) donor donated each for seventh- & ninth-time. Also, out of 30 repeated SCT donors, 4 (13.33%) donors had donated blood at a shortest interval of 3 months**.**

Donor complications: No complications were found in any sickle trait donors even after donating for several times (ie. 7^{th} and 9^{th} time) **(Table no.2)**; and with minimum interval of 3-4 months **(Table no.3)**.

While doing routine testing for various Transfusion Transmitted Diseases (TTDs), 47 units out of total 6000 units were positive for TTDs and were discarded. It was found that among these 47 TTD positive units; 5 units (1.91%) out of 262 units of sickle trait donors were positive for TTDs; of which 2 units (0.76%) were HIV reactive, 2 (0.76%) were HBsAg positive and 1 unit (0.38%) was HCV positive. These 5 units were discarded and were not used for transfusion.

Of the total 262 units of blood from sickle trait donors, 257 units were issued to recipients who were selected randomly. **Table no.4** summarizes the pertinent data of the recipients. There were no sickle cell disease recipients who received blood from SCT donors, in the present study.

No transfusion reactions were found in any recipients who had received blood from sickle trait donors, neither at the time of transfusion nor throughout their hospital stay.

Table No.1: Age wise distribution of SCT blood donors (n=262).

S.N.	Age (yrs)	SCT donors
1	18 - 30	177 (67.56%)
2	31 - 40	57 (21.75%)
3	41 - 50	25 (9.54%)
4	>51	3 (1.15%)
	Total	**262 (100%)**

Table No.2: Complications in relation to frequency of donation in repeated SCT donors (n=30)

Frequency of donation	Repeated SCT donors	Complications
Second time	15 (50%)	Nil
Third time	5 (16.67%)	Nil

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Fourth time	5 (16.67%)	Nil
Sixth time	3 (10.0%)	Nil
Seventh time	1 (3.33%)	Nil
Ninth time	1 (3.33%)	Nil
Total	**30**	**Nil**

Table No.3: Complications in relation to Interval between previous donations in the repeated SCT donors (n=30)

Interval between two donations	No. SCT donors	Complications
3 months	4 (13.33%)	Nil
4 months	3 (10.0%)	Nil
1 year	10 (33.33%)	Nil
2 years	4 (13.33%)	Nil
> 2 years	9 (30.0%)	Nil
Total	**30**	**Nil**

Table No.4: Summary of 257 recipients of SCT blood units.

S.N	Department	No. of blood bags issued	Transfusion Reactions in recipients
1	Medicine	79 (29.86%)	None
2	Surgery	64 (24.43%)	None
3	Orthopaedic	42 (18.10%)	None
4	Gynaecology	49 (17.65%)	None
5	Paediatric	23 (29.86%)	None

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	Total	**257**	**None**

Table no.5: Prevalence of SCT donors in the various studies from different geographical regions:

S.N.	Authors	Region	Donors screened	SCT donors (%)
1	**Kaufman M et al [16]**	New York, USA	300	14 (4.7%)
2	**Wanessa LP Vivas [17]**	Sergipe, Brazil	1345	55 (4.1%)
3	**Gonçalves LB et al [18]**	Cape Verde	104	(3.9%)
4	**Omisakin CT et al [19]**	Nigeria	314	82 (26.11%)
5	**Alabdulaali MK et al [8]**	Riyadh, Saudi Arabia	1150	23 (2%)
6	**Present Study**	**Nagpur, Central India**	**6000**	**262 (4.37%)**

Discussion:

Sickle-cell disorder is common among people whose ancestors come from sub-Saharan Africa, Saudi Arabia, India and Mediterranean countries [10]. India is one of the most prone regions of the world, and the disease is prevalent in various communities and ethnic groups of Vidarbha region of Maharashtra where there are more than 5000 cases of sickle cell anemia [11, 12].

60 million sickle cell carriers & 1,20,000 homozygotes are added every year in the world as per WHO report [13]**.** There are over 50,00,000 carriers and two lakhs homozygous cases among tribals in India [14, 15].

Prevalence of SCT in Blood Donors in different geographical regions across world (Table no. 5): –

Prevalence of SCT among blood donors in the **present study** from Central India is 4.37 %, this correlates well with the study by **Kaufman M et al [16]** (4.7%), study by **Wanessa LP Vivas et al [17]** (4.1%) and study by **Gonçalves LB et al [18]** (3.9%).

Prevalence was found higher in the studies from African countries like Nigeria (26.1%) which is an area for sickle cell disease [19]. Nigeria is known to be one of the countries with highest burden of Sickle cell disease in general population, with carrier rate of sickle cell in Southern Nigeria and Northern Nigeria being 25% and 19 – 32.6% respectively [20, 21].

Whereas, lower prevalence was reported by **Alabdulaali MK et al [8]** from Riyadh, Saudi Arabia (2%) compared to the present study.

In present study SCT donors (even those above age of 50 years) were apparently healthy, not aware of their sickle cell status and they donated blood

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unknowingly several times. No complications were found in SCT donors in our study. Similar finding was found in the study by **Batina-Agasa S** [22] and **G. Lippi et al** [23], who stated that most blood donors did not have knowledge of their sickle cell carrier status.

Mild transfusion reactions (urticaria or fever with chills) were found in only 10 (0.2%) recipients who received blood from of non-sickler donors and no transfusion reaction was found in any recipients who received SCT blood in the present study. Although there was no sickle cell disease (SS) recipient who received blood from SCT donors in our study; but each year SCT blood is being given on hundreds of occasions in blood bank without the knowledge of donor's sickle status. If any untoward reactions occur, they must be extremely rare.

From our data, the inherent danger of SCT erythrocytes does not appear to be clinically significant when used for transfusion to patients with low hemoglobin and diminished blood volume, as no transfusion reactions due to SCT blood were reported in our study. Sickle trait blood is safe to transfuse in these clinical situations due to dilution of 1 unit of HbS containing RBCs from SCT donor in a large volume of normal HbA in the recipient. The likelihood of sickling is with the concentration of HbS in RBC, which is below the sickling threshold in SCT, except under extreme hypoxic conditions [5].

Previous study by **Ray R N et al** [24] indicated that RBCs from SCT donors had normal survival time in-vivo and in-vitro and produce no adverse effects when transfused in recipients. Their study concluded that SCT blood has no undesirable or unusual properties and can be used for transfusion. However, there were no recipients with serious pathological conditions like severe infections, acidosis, hemoglobinopathies (SS and Thalassemia) rapidly hemolyzing own red cells and low oxygen tension, which was similar to the present study. Under these conditions, transferred cells theoretically would be exposed to conditions, which could produce the sickling phenomenon [4,5].

It is recommended by WHO that SCT blood can be given in all recipients, but should be avoided in patients with sickle cell disease as it may exacerbate sickling of red cells, and it is also not suitable for leucodepletion, for intrauterine transfusion and for exchange transfusion in neonates [25]. We also support the WHO recommendations.

We did not find related study in Indian blood donors, so we could not match our prevalence with other Indian study. More studies should be performed on blood donors for longer duration to determine prevalence of HbS in blood banks and donation camps across India, so that the data can be used for formulation and implementation of policies regarding –

1. Whether to accept / defer SCT donors?
2. Whether to make it mandatory to screen all blood units for Sickle cell trait or whether to screen only those units which will be transfused to Sickle Cell Disease or high-risk recipients like neonates?

Conclusion:

A random screening of 6000 donor samples revealed prevalence of SCT in 4.37% (262 donors) in the present study. Thus, recipients in this hospital have almost a 1 in 25 chance of receiving SCT blood. As we found no complications in sickle trait donors as well as in recipients of SCT blood, hence we feel that screening of all donor units for HbS should not be made mandatory in blood banks.

Countries like India have shortage of voluntary blood donors, and deferring SCT blood donors may deliver wrong message to the general population, may cause shortage of blood donors and lead to scarcity which may affect blood bank inventory. SCT individuals should be accepted as a donor, provided they meet selection criteria for blood donation. As per WHO guidelines, only those individuals can be deferred where whole blood is required for apheresis procedure and only those units can be tested which are being transfused to sickle cell disease (SS) patients or neonates requiring exchange transfusion [25].

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