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Correlation Of Haematological Parameters and Haemoglobin Fractions Across Different Sickle Cell Genotypes in Tertiary Care Hospital of South Gujarat

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ABSTRACT

Background: Sickle cell haemoglobinopathy results due to presence of a mutated form of hemoglobin, hb S (HbS). In this study, correlation of various fraction of Hb and various hematological parameters among different sickle cell genotypes is analyzed.
Methods: Present study analyzes 103 cases of sickle cell hemoglobinopathies which are subjected to HPLC. CBC analysis was done to get various hematological parameters. Correlation of these hematological parameters among sickle cell trait, sickle cell disease and sickle beta thalassemia patients is done by applying one way ANOVA and T test to find out its significance.
Results: Out of 103 patients, most common hemoglobinopathy is SCT, followed by SCD and sickle beta thal. All are found mainly in younger age group. Among three genotypes, red cell indices (MCV, MCH, MCHC), RBC count, WBC count and platelet count, all Hb fractions (HbA2, HbF, HbS) are statistically significant. While Hb and RDW-CV, differences is statistically not significant among three genotypes. In present study, total WBC count is significantly higher in SCD cases in comparison to SCT cases
Conclusions: High index of suspicion should be maintained when hematological parameters are on lower side, especially in population who is prone to have sickle cell disorders such as tribal population of South Gujarat. Knowledge of regional Hb variants and various hematological parameters is crucial for guiding appropriate prevention and therapeutic intervention.

Keywords: HPLC, Hematological parameter, Sickle cell genotypes

INTRODUCTION

Sickle cell haemoglobinopathy is a group of inherited blood disorders which is caused by structural abnormality of haemoglobin, the glutamic acid in the sixth position on β chain is replaced by valine [(1)]. The disease includes homozygous and heterozygous forms having different genotypes. In homozygous state Hb A is totally lacking, having HbSS- Sickle cell Disease. Various heterozygous state having normal Hb A and variant Haemoglobin like Sickle cell trait (HbAS), Sickle beta Thalassemia(Sickle beta Thal), Sickle Hb D (HbSD), Sickle Hb E (HbSE), Sickle Hb C(HbSC), HbS Lepore [(2)]. In India, sickle cell hemoglobinopathy is a major public health problem, particularly in central and western areas like Madhya Pradesh, Maharashtra, Gujarat, Rajasthan, Jharkhand etc [(3)]. Clinical presentation of sickle cell disease is variable, with some patients having a normal life; however, some patients show increased morbidity and mortality due to vaso-occlusive, severe thrombotic, aplastic and sequestration crisis. Initial step of diagnosis is carrying out by complete blood count and sickling test followed by Hemoglobin Electrophoresis and High-Performance Liquid Chromatography (HPLC) to confirm the diagnosis [(4)].

Red blood cell parameters, like haemoglobin concentration, RBC count, Hematocrit(HCT), Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC), serve as essential indicators of anaemia severity and erythropoietic activity in individuals with sickle cell hemoglobinopathy [(5)].

Although sickle cell disease (SCD) pathology is mainly due to RBCs, white blood cells (WBCs) also participate in obstructing blood vessels, a central phenomenon of vaso-occlusive crises in SCD [6].

Haemoglobin fractions—like fetal hemoglobin (HbF), hemoglobin A (HbA), and hemoglobin S (HbS)—play a critical role in modulating disease expression. Elevated HbF levels are associated with reduced hemoglobin S polymerization and milder clinical manifestations [7].

The distribution of haemoglobin fractions and RBC indices varies across different sickle cell hemoglobinopathies, including homozygous sickle cell disease (SCD), compound heterozygous conditions, and sickle cell trait (SCT). In the South Gujarat population, these variations may be further influenced by regional genetic modifiers, co-inheritance of other hemoglobinopathies, nutritional deficiencies, and environmental factors [3]. Understanding of correlation of haematological parameters and haemoglobin fractions across sickle cell haemoglobinopathies in this region is very important for improved disease characterization, prognosis and betterment of clinical management.

AIMS AND OBJECTIVES

1. To assess haematological parameters and haemoglobin fractions in different genotypes of sickle cell hemoglobinopathy.
2. To correlate haematological parameters (Hb, RBC count, HCT, MCV, MCH, MCHC, RDW-CV (red cell distribution width), total WBC count, platelet count) among SCD, SCT, Sickle–beta thalassemia patients.

MATERIAL AND METHOD

Study design- Descriptive and observational study

Study period- The study is carried out from March 2025 to December 2025 in pathology department in tertiary care hospital of South Gujarat.

Samples for detection of haemoglobinopathies and complete blood count are received in EDTA vacuette in central pathology laboratory. After considering inclusion and exclusion criteria, total 103 patients of different genotypes of sickle cell haemoglobinopathies like SCT, SCD and Sickle beta thalessemia are studied and analysed for their haematological parameters and various haemoglobin fractions. Haematological parameters like Haemoglobin, HCT, MCV, MCH, MCHC, RDW -CV, WBC count and Platelet count are carried out in fully automated five-part haematology analyser YUMIZEN H2500 HORIBA.

Quantification of haemoglobin variants is performed using Bio rad HPLC machine. EDTA whole blood samples are diluted in haemolysis solution and loaded in instrument. The separated haemoglobin fractions are analysed based on retention time and software provides printed reports with chromatogram showing haemoglobin fractions like HbS, HbF, HbA, HbA_2 eluted.

Data Collection- Clinical and laboratory data recorded in a pre-designed proforma.

Statistical Analysis

•Data entered in Microsoft Excel and analyzed using open Epi software.
•Quantitative data expressed as mean ± SD.
•One-way ANOVA and T Test are applied for correlation of hematological parameters in between different sickle cell genotypes.
•p value < 0.05 is considered as statistically significant.

Inclusion Criteria

1. All confirmed cases of SCD, SCT, and Sickle–beta thalassemia by HPLC.

Exclusion Criteria

1. History of Blood transfusion within the last 3 months.
2. Hemolyzed or inadequate samples.

RESULTS

Table 1. Classification of sickle cell hemoglobinopathies based on HPLC findings

HPLC study	No. Of patients	Status of Patient
>50% of HbS, <2% HbF	26(25.24%)	Homozygous state: Sickle Cell Disease (SCD)
<50% of HbS, HbA>50% (HbA>HbS)	65(63.10%)	Heterozygous state: Sickle cell trait (SCT)
>50% of HbS, >2% HbF, HbA2>3.5%	12(11.65%)	Sickle – beta thalassemia (Sickle beta Thal)
	103	

Out of 103 total patients, most common hemoglobinopathy is of SCT (63.10%), followed by SCD (25.24%) and sickle beta thal (11.6%).

Table 2. Age wise distribution of various Sickle cell hemoglobinopathies

Age (in years)	SCD	SCT	Sickle-beta thal	Total (%)
0-10	06	06	03	15(14.56)
11-20	07	14	06	27(26.21)
21-30	12	27	03	42(40.77)
31-40	00	08	00	08(7.76)
41-50	01	03	00	04(3.88)
>50	00	07	00	07(6.79)
Total	26	65	12	103(100)

Table 3. Age and gender wise distribution of different Sickle cell hemoglobinopathies

Age (in years)	SCD		SCT		Sickle-beta Thal		Total
	M	**F**	**M**	**F**	**M**	**F**	
0-10	01	05	03	03	02	01	15
11-20	03	04	04	10	04	02	27
21-30	03	09	04	23	00	03	42
31-40	00	00	03	05	00	00	08
41-50	01	00	02	01	00	00	04
>50	00	00	02	05	00	00	07
Total	08	18	18	47	06	06	103

M=Male, F=Female

According to Table 2 and 3, in present study, most common age group affected in SCD and SCT is 21-30 year (40.77 %), with female predominance. Most common age group affected in sickle beta Thal is 11-20 year with equal gender distribution.

Table 4. Assessment of Haematological parameters among all cases of Sickle cell haemoglobinopathies.

Haematological parameters	No. of cases
Hb(gm/dl) Anaemia	
≤ 7 (severe)	34
7.1 - 10 (Moderate)	36
≥10.1 (Mild)	33
MCV (femtoliter)	
< 80	75
80-100	24
>100	4
MCH (picogram)	
<27	76
27-33	21
>33	6
MCHC (gm/dl)	
<33	67
33-36	24
>36	12
RDW (% co efficient of variation)	
<11.6	0
11.6-14	3
>14	100
HCT (%)	
<40	100
40-50	3
>50	0
RBC (millions/cumm)	

<4.5	69
4.5-5.5	29
>5.5	5
WBC (x1000/cumm)	
<4	9
4 -10	57
>10	37
Platelet count (Lakhs/cumm)	
<1.5	27
1.5-4	65
>4	11

Most of the patients in our study show moderate anemia, while 34 cases show severe anemia and 33 cases show mild anemia. Most of the cases show low MCV, MCH, MCHC, HCT and RBC count, while 5 cases show increase RBC count. Most of the cases show increased RDW- CV. Most of the cases show normal WBC count, while 9 cases show leucopenia and 37 cases show leukocytosis. Most of the cases show normal platelet count, while 27 cases show thrombocytopenia and 11 cases show thrombocytosis.

Table 5. Correlation of haematological parameters and HPLC patterns in different genotypes of Sickle cell haemoglobinopathies.

Parameters					**Mean and SD**			**P value**	**Significance**
		SCD	**SCT**	**Sickle - beta Thal**	**SCD**	**SCT**	**Sickle- beta Thal**		
Hb	min	2.1	2.8	4.3	7.56±2.44	8.98±2.95	7.95±2.41	0.07	Not significant
	max	11.4	14	12.9					
MCV	min	54	38.6	51.9	81.55±14.97	69.65±13.5	65.77±5.96	<0.05	Significant
	max	121.3	103.6	74.2					
MCH	min	17	10.7	16.3	27.93±5.51	22.65±5.27	20.92±2.37	<0.05	Significant
	max	42.4	35.7	24.7					
MCHC	min	29.2	22.8	29.8	34.45±5.84	32.34±2.69	31.78±2.11	<0.05	Significant
	max	59.6	39.5	37.9					
RBC count	min	0.7	1.5	2.31	2.78±0.93	4.04±1.23	3.73±0.84	<0.05	Significant
	max	4.7	6.2	5.3					
RDW- CV	min	14.1	13	14.7	23.07±5.81	20.39±5.43	21.51±3.64	0.1	Not significant
	max	34.9	33	27.2					
HbA2	min	1	2.5	4.1	2.45±0.91	3.16±0.39	5.08±0.72	<0.05	Significant
	max	5	4.3	6.4					
HbF	min	0.8	0.8	3.5	17.98±8.2	1.03±0.55	14.13±9.12	<0.05	Significant
	max	36	3.4	38.5					
HbS	min	22.6	15.1	52.4	62.87±13.88	29.01±5.4	68.35±9.14	<0.05	Significant
	max	80.5	38.6	85.3					
WBC count	min	3.6	1.27	4.5	12.47±9.87	8.57±4.55	13.28±8.3	<0.05	Significant
	max	48	21.9	32					
Platelet count	min	50	30	81	195.53±129.91	275.8±141.1	186.5±103.8	<0.05	Significant
	max	474	877	435					

SD = Standard deviation

Above table compares three genotypes: SCD – Sickle Cell Disease, SCT – Sickle Cell Trait, Sickle beta thalassemia. It analyses haematological parameters and Hb fractions, along with p-values and statistical significance.

Hemoglobin is lowest in SCD, compare to sickle beta thalassemia and SCT cases. Although Hb is clinically lower in SCD, the difference is not reached statistical significance in this study because p value is 0.07. Red Cell Indices like

MCV, MCH, MCHC are significantly lower in sickle beta thalassemia, while SCT shows relatively preserved indices. Among three genotypes, red cell indices are statistically significant as p value is <0.05. RBC count is higher in sickle beta thalassemia and lower in SCD. Difference among all three genotypes, RBC count is statistically significant. In typical of thalassemia syndromes, RBC count is high despite anaemia. RDW-CV is raised in all genotypes and differences is not statistically significant. WBC count and platelet count shows statistically significant difference among three genotypes.

Hb Fractions HbA_2 is highest in sickle beta thalassemia, normal/slightly raised in SCT and low in SCD. HbF is markedly increased in SCD and sickle beta thalassemia and lower in SCT. HbF elevation correlates with disease severity and chronic haemolysis. HbS is highest in SCD and sickle beta thalassemia while lower in SCT which confirms genotype-based distribution of HbS. All Hb fractions are statistically significant among three genotypes.

In present study, comparison of haematological parameters is also done between SCT and SCD, SCT and Sickle beta Thal and SCD and Sickle Beta Thal cases and T test is applied.
Total sickle cell haemoglobinopathies cases are divided in three groups,
Group A. Sickle cell trait (SCT),
Group B. Sickle cell Disease (SCD) and
Group C. Sickle beta Thalassemia (Sickle beta Thal).
Their correlation of haematological parameters and HPLC fractions is as below.

Table 6. Correlation of haematological parameters and HPLC fractions in different groups of sickle cell haemoglobinopathies.

	Groups	HbF	HbA0	HbA2	HbS	Hb	HCT	RBC	WBC	PC	MCV	MCH	MCHC	RDW
T-test with p value	A and B	<0.05	<0.05	<0.05	<0.05	0.29	0.77	0.12	<0.05	0.66	0.81	0.75	<0.05	0.6
	B and C	0.63	<0.05	0.42	0.14	1.01	0.53	0.74	0.55	0.42	<0.05	<0.05	<0.05	0.10
	A and C	<0.05	0.12	<0.05	<0.05	0.47	0.38	0.16	<0.05	0.25	<0.05	<0.05	0.38	0.14

In present study, significant difference is found in MCHC levels, Hb-S, HbA0, HbA2 and Hb-F between SCD (group B) and SCT (group A) groups. However, the difference in MCV, MCH, RDW- CV, platelet count, HCT, RBC count, Hb are not statistically significant between SCD and SCT cases. In present study, total WBC count, Hb-S and Hb-F are found to be significantly higher in cases with SCD compared to the SCT group.
Between SCD (group B) and Sickle beta thalassemia (group C), significant difference is observed in MCV, MCH, MCHC, and Hb A0. No significant difference is found in Hb, HCT, RDW-CV, HbF, HbA2, HbS, platelet count, RBC count and WBC count.
Between SCT (group A) and Sickle beta thalassemia (group C), significant difference is observed in MCV, MCH, WBC count and Hb S, HbA2, Hb F. No significant difference is observed in Hb, HCT, MCHC, RDW-CV, platelet count, RBC count and Hb A0.

DISCUSSION

Out of 103 total patients, most common hemoglobinopathy is of SCT (63.10%), followed by SCD (25.24%) and Sickle beta Thal (11.6%).

In present study, most common age group affected in SCD and SCT is 21-30 year (40.77 %), with female predominance, which is similar as study done by Neelayadaxi et al [8]. Most common age group affected in Sickle beta Thal is 11-20 year, with male predominance in present study. Study by Javarkar A et al [9] also found 81.2% patients of SCT were below 40 year and 18.8% were above 40 years, while in SCD 97.6% patients were below 40year and 2.4% were above 40y. Most common age group in SCD was 13-30year study by Chabhadiya MA et al [10], Thakkar CC et al. [11] and Akinbami A et al. [12]

In present study, predominantly females are affected among patients of SCT and SCD, while as study done by Neelayadaxi et al [8], in SCD, more male (9/14) and in SCT, (19/31) more female were affected. Javarkar A et al [9] study showed male predominance in both SCT and SCD. SCD is more common in male in study by Chabhadiya MA et al [10], and Thakkar CC et al [11]. It shows varying gender distribution among various genotypes of sickle cell hemoglobinopathies.

Present study shows, lower mean MCV and MCH (65.77±5.96, 20.92±2.37) in Sickle beta Thal patients compared to SCD patients, which is similar as study done by Titilope Adeyemo et al [13], where the mean MCV and MCH in Sickle beta Thal was (69.7±5.3,21.6±1.7) respectively. In Study by Titilope Adeyemo et al [13], mean HBA2(5.14±1.3) of Sickle beta Thal was significantly higher than SCD (3.76±2.53). Present study also shows HBA2 of Sickle beta Thal (5.08±0.72) higher than SCD (2.45±0.91).

In present study, total WBC count is significantly higher in SCD patients in comparison to SCT patient. Significant difference is found in MCHC levels among SCD and SCT groups. Study by Neelayadakshi et al [8] and Emmanuelchide O et al [14] also found significant difference in WBC count and MCHC level between SCD and SCT.

The findings in the studies done by Akinbami A et al [12], Thakkar CC et al [11] and Antwi-Boasiako C et al [15] showed increased total WBC count and increased platelet count in patients with SCD. However, in present study, only total WBC count is significantly higher in the SCD group compared to the SCT group, while the difference in platelet count between the 2 groups is not statistically significant same as observed by Neelayadakshi et al [8]study.

In present study, the difference in MCV, MCH, RDW-CV, platelet count, HCT, RBC count, Hb are not statistically significant between SCD and SCT. While Study by Neelayadakshi et al [8] also showed no significant difference in MCV, MCH, RDW-CV, platelet count but show significant difference in Hb and RBC count which is lower in SCD. In present study, in HPLC, Hb-S and Hb-F are found to be significantly higher in patients with SCD compared to the SCT group, which was comparable to the results of the studies conducted by Jawarkar A et al [9] and Neelayadakshi et al [8]. The difference in Hb-A2 level is statistically significant between the two groups in present study similar as study conducted by Jawarkar A et al [9].

Comparison of haematological parameters among SCT and SCD groups of present study with other studies is as below.

Studies	Hb (g/dl)	RBC /cumm	HCT%	MCV (fl)	MCH (pg)	MCHC(g/dl)	WBC (cells/cumm)
Kar et al [16] SCD	8.7±1.7	3.3±0.8	-	83.6±9.4	26.6±3.6	31.5±3.6	-
Roy et al [17] SCT	11.5±1.8	4.5±0.6	33.7±5.8	73.6±9.9	25±4	33.8±1.8	8700±3000
Roy et al [17] SCD	8.1±1.4	3±0.6	27.1±6.3	78.6±9	27±3.7	33.1±5.8	13700±5600
Vasundhara M et al [18] SCD	7.8±2.5	3.1±0.7	27.5±5.6	72.5±8.1	23.4±2.5	27.6±2	7500±2300
Vasundhara M et al [18] SCT	9.4±1.8	3.8±0.8	33.8±6.5	77.4±7.8	26.8±3.7	30±2.3	6700±3400
Neelayadakshi et al [8] SCT	11.79±3.18	5.04±1.13	-	73.31±10.95	23.43±4.38	31.68±2.22	10204.83±4663.35
Neelayadakshi et al [9] SCD	7.43±2.5	2.91±0.99	-	74.69±8.89	25.5±3.75	34.11±2.13	18418.57±13452.09
Present study SCD	7.56±2.44	2.78±0.93	-	81.55±14.97	27.93±5.51	34.45±5.84	12470±9870
Present study SCT	8.98±2.95	4.04±1.23	-	69.65±13.5	22.65±5.27	32.34±2.69	8570±4550

CONCLUSION:

Among total 103 cases of different genotypes of sickle cell hemoglobinopathy, cases of SCT are most commonly found followed by SCD and sickle beta thalassemia.In all cases, younger age group is mostly affected. Apart from appearance of HbS on HPLC, low levels of HbA and high levels of HbA2 should raise suspicion for presence of Sickle cell hemoglobinopathy. Among three genotypes, MCV, MCH, MCHC, RBC count, WBC count and platelet count, all Hb fractions (HbA2, HbF, HbS) are statistically significant, while parameters like Hemoglobin and RDW-CV, differences are not statistically significant.

In present study, total WBC count is significantly higher in SCD patients in comparison to SCT patients. Between SCD and SCT groups, there is statistical difference in levels of MCHC and WBC count and no statistical difference in level of Hb, RBC count, MCV, MCH, RDW-CV, HCT and platelets count.

High index of suspicion should be maintained when these parameters are on lower side, especially in population who is prone to have sickle cell disorders such as tribals. These findings highlight the importance of various hematological and

HPLC parameters in the diagnostic work-up of disease sequelae as well as their crucial role in prevention and therapeutic intervention.

REFERENCES:

1. McPherson, R. A., & Pincus, M. R. (Eds.). (2021). Henry's clinical diagnosis and management by laboratory methods (24th ed., p. 611). Elsevier.
2. Greer, J. P., Arber, D. A., Glader, B., Means, R. T., List, A. F., Appelbaum, F. R., & Rodgers, G. M. (Eds.). (2023). Wintrobe's clinical hematology (15th ed., p. 833). Wolters Kluwer.
3. Colah, R., Mukherjee, M., Martin, S., & Ghosh, K. (2015). Sickle cell disease in India.Current Opinion in Hematology, 22(3), 215–223
4. Hoffbrand, A. V., Pettit, J. E., & Moss, P. A. H. (2011). Essential haematology (6th ed.). Wiley-Blackwell.
5. Bain, B. J. (2015). Blood cells: A practical guide (5th ed.). Wiley-Blackwell.
6. Mombo, L. E., Mabioko-Mbembo, G., Bisseye, C., Mbacky, K., Thiam, F., & Edou, A. (2019). Haematological values in steady-state sickle cell anaemia patients and matched haemoglobin AA controls in a rural area of Eastern Gabon. Nigerian Postgraduate Medical Journal, 26, 13–17.
7. Steinberg, M. H., et al. (2014). Fetal hemoglobin in sickle cell anemia. Blood, 123(4), 481–485.
8. Neelayadakshi, N., Rajeshwar, R., Yogalakshmi, Y., Vimal Chander, V., & Venkat Raghavan, V. (2023). Sickle cell disease: Correlation between HPLC pattern and hematological parameters in homozygous and heterozygous patients—A retrospective study. International Journal of Scientific Research, 12(6).
9. Jawarkar, A., & Bhatia, V. (2018). A study of HPLC patterns in patients of sickle cell anemia with analysis of red cell parameters. International Journal of Research in Medical Sciences, 6(7), 2390–2394.
10. Chabhadiya, M. A., Patel, H. A., Patel, K. A., Patel, M., & Goswami, H. M. (2024). Study of sickle cell disease by hematological parameters and HPLC at a tertiary care center. International Journal of Clinical and Diagnostic Pathology, 7(3), 83–86.
11. Thakkar, C. C., & Sailaja, I. (2022). Study of implication of WBC and platelet count among sickle cell disease patients in Waghodia region, Vadodara, Gujarat. Journal of Pharmaceutical Research International, 34(36B), 42–47.
12. Akinbami, A., Dosunmu, A., Adediran, A., Oshinaike, O., Adebola, P., & Arogundade, O. (2012). Haematological values in homozygous sickle cell disease in steady state and haemoglobin phenotypes AA controls in Lagos, Nigeria. BMC Research Notes, 5(1), 1–6.
13. Adeyemo, T., et al. (2014). Evaluation of high-performance liquid chromatography pattern and prevalence of beta-thalassaemia trait among sickle cell disease patients in Lagos, Nigeria. Pan African Medical Journal, 18, 71.
14. Emmanuelchide, O., Charle, O., & Uchenna, O. (2011). Hematological parameters in association with outcomes in sickle cell anemia patients. Indian Journal of Medical Sciences, 65(9), 393–399.
15. Antwi-Boasiako, C., Ekem, I., Abdul-Rahman, M., Sey, F., Doku, A., & Dzudzor, B. (2018). Hematological parameters in Ghanaian sickle cell disease patients. Journal of Blood Medicine, 9, 203–209.
16. Kar, B. C., Satapathy, R. K., Kulozik, M., et al. (1986). Sickle cell disease in Orissa state, India. The Lancet, 327(8482), 1198–1201.
17. Roy, B., Dey, B., & Balgir, R. S., et al. (1996). Identification of sickle cell homozygotes using haematological parameters. Journal of Indian Anthropological Society, 31, 191–199.
18. Vasundhara, M., Ramdas, R., Bhagya Lakshmi, A., Satish Kumar, S., & Subash, R. (2016). Study of sickle cell anaemia with clinical and hematological correlation. International Journal of Research in Medical Sciences, 4, 246–251.