

Research Article



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Cardiovascular changes in children and adolescents with Sickle cell disease admitted at Tertiary Care Teaching Hospital

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Abstract

Introduction: Sickle cell Disease (SCD) has a high prevalence in India, especially in the central and western regions, and poses a considerable health burden. Chronic anemia in SCD leads to hemodynamic changes to maintain perfusion. Chronic hemolysis and blood transfusion leads to iron overload. These changes are responsible for changes in cardiovascular system.

Methods: Patients between age group of 9 to 18 years with different complications of SCD admitted in Dr BRAM Hospital were enrolled in the study. Data were analysed using SPSS software version 21.0.

Results: Total 90 patients with SCD were included in study. 72.9% patients were having cardiothoracic ratio of less than 0.6. 29.2% patients had prominent bronchovascular marking on chest Xray. On echocardiography 13% patients had increased left ventricular muscle mass index.

Conclusion: Early investigations can detect cardiovascular changes so that progression to cardiomyopathy can be prevented. Further cardiac damage can be prevented by modifying disease progression and treatment.

Key words: Sickle cell Disease, Cardiovascular changes, Cardiothoracic ratio, Brochovascular marking, Echocardiography.

Introduction

Sickle cell disease (SCD) is an important haematological condition resulting from defective mutation in beta globin chain of haemoglobin [1]. This mutated and defective haemoglobin is less soluble and after deoxygenation undergo polymerization causing distortion of shape of (RBCs) Red Blood Cells [2]. SCD has a high prevalence in India, especially in the central and western regions, and poses a considerable health burden [3, 4, 5]. Clinical manifestations of cardiovascular abnormalities in patients with SCD have been previously documented [6, 7, 8]. Interestingly the earliest description of the cardiac manifestations in SCD, has been made by Jammes Herrick, who detected a precordial murmur and cardiac enlargement [9].

Cardiac abnormalities are more frequent with SCD, than in those with other forms of anaemia[10]. Maybe this is attributed to the chronicity and severity of the anaemia especially in homozygous form of the disease [11]. Theoretically, severe anaemia leads to inadequate oxygen delivery to tissues and the circulatory system is strained by sickled erythrocyte's propensity to occlude small blood vessels which in the heart may perhaps cause myocyte dysfunction. It has been described that iron deficiency anaemia can produce left ventricular dysfunction and overt heart failure [12].

The majority of patients with SCA demonstrate signs reflecting hyperdynamic circulatory state such as tachycardia, widened pulse pressure, active pericardium impulse and laterallydisplaced prominent apex usually found [13].

The cardiac size in patients with SCD is almost always enlarged [8,14]. This primarily represents the compensatory dilatation and hypertrophy from the increased venous return. There are no specific features and all chambers tend to be enlarged giving globular appearance [15]. Pulmonary artery segments may be enlarged [10], and pulmonary vasculature may be prominent, occasionally causing confusion with congenital left to right shunt.

There are no specific ECG changes in sickle cell anemia, although ECGs are commonly abnormal. Winsor and Burchdocumented non-specific ECG abnormalities in the majority of 25 patients with SCA [14]. Abnormalities included left ventricular hypertrophy, first-degree atrioventricular block (prolonged PR), and non-specific ST changes. Seven percent had ECG evidence of right ventricular hypertrophy.

Echocardiography provides comprehensive evaluation of the cardiovascular structure, regional and global function, and hemodynamics that be possible to provide comprehensive measurements to fully understand the cardiovascular structure and myocardial function [16,17].

MATERIAL AND METHODS:

Study design: Cross-sectional observational study

Setting: Paediatric OPD and IPD of the Pt.JNMMC and Dr.B.R.A.M.Hospital,Raipur.

Inclusion criteria: Sickle cell anaemia patients with SS pattern between the age group 9 to 16 yrs

Exclusion criteria: Sickle cell disease with known acquired heart disease and congenital heart disease.

Participants: Sickle cell anaemia patients with SS pattern between the age group 9 to 18 yrs

Variables: Age, Sex, Bronchovascular markings, ECG changes, Chest X-ray,

Data Source: - Purposing sampling was used to recruit the study participants.

Bias: Observation bias

Chest xray finding		Mild		Moderate		Severe		Total	
		No.	%	No.	%	No.	%	No.	%
Left Ventricular Hypertrophy	No	54	87.1	10	50	3	37.5	67	74.4
	Yes	8	12.9	10	50	5	62.5	23	25.6
Cardiothoracic Ratio	<0.6	48	77.4	8	20	4	50	60	66.7
	>0.6	14	22.6	12	60	4	50	30	33.3
Prominent Bronchovascular markings	No	46	74.2	9	45	3	37.5	58	64.4
	Yes	16	25.8	11	55	5	62.5	32	35.6

Study size: 90 children were included in the study.

Statistical methods: Measurement of central tendency and dispersion

Result-

A total of 90 children with homozygous sickle cell anemia were evaluated for cardiovascular changes.

Table 1- Distribution of study subjects according to age and gender

Age(Yrs)	Male		Female		Grand Total	
	No.	%	No.	%	No.	%
9-11	19	51.4	23	43.4	42	46.7
12-14	12	32.4	17	32.1	29	32.2
15-18	6	16.8	13	24.5	19	21.1
Grand total	37	100	53	100	90	100

There is higher number of females with SCD (58.8%) as compared to males. Mean Age group of participants is 12.4 ± 2 yrs.

Table 2- Distribution of cases according to severity of SCD (Vaso-occlusive crisis/year)

S.No.	Severity of SCD	Case =90	
		No	%
	Vaso-occlusive crisis/year		
1	Mild SCD (<4/year)	62	71.1
2	Mod SCD (4-6/year)	20	22.2
3	Severe SCD (>6/year)	8	8.9

Around 71% children had Mild SCD. Only 9% children had severe SCD.

Table 3 -Distribution of cases according to cardiovascular findings and severity of SCD

In mild SCD only 14% children had Left Ventricular Hypertrophy (LVH). The percentage of LVH in Moderate and Severe SCD were 50 and 62.5% respectively. Cardiothoracic ratio (CT

ratio) were increased (>0.6) in 14% cases of Mild SCD while in moderate and severe SCD increased CT ratio were present in 60 and 50% children respectively

Table 4 – Distribution of Abnormal ECG according to severity of SCD

ECG	Mild		Moderate		Severe		Overall	
	No.	%	No	%	No	%	No	%
Normal	42	68.8	8	20	1	12.5	51	56.7
Abnormal	20	31.2	12	60	7	87.5	39	43.3

In severe SCD 87.5% cases had abnormal ECG while in mild and moderate SCD 31.2% and 60% cases had abnormal ECG. Overall 43.3% cases had abnormal ECG.

Table 5 - ECG abnormality according to severity of disease

ECG abnormality	Mild	Moderate	Severe	Total	Percentage
Prolonged P-R interval	15	6	4	25	27.7
Prolonged QTc interval	0	1	2	3	3.3
S-T segment changes	10	5	4	19	21.1
Axis deviation	10	10	4	24	26.7
Arrhythmia	0	1	2	3	3.3

Discussion

In our study total 90 children with homozygous sickle cell anemia were evaluated for cardiovascular changes. Around half of the children (46.7%) were in the age group of 9-11 yrs. Around 55.6% children were received less than 20 blood transfusions. Around 9% children had more than 6 vaso-occlusive crises per year. Children were classified into three categories according to number vaso-occlusive crisis per year. Those who are having less than 4 crisis per year were classified as Mild SCD. Those children with 4-6 crisis per year were labelled as Moderate SCD and those with more than 6 crisis per year labelled as Severe SCD. These children were evaluated by ECG, Chest x-ray and 2D- Echo.

In this study we found cardiovascular abnormalities as assessed by ECG, Chest x-ray and 2D-echo. Of total 90 cases with homozygous SCD 39 (43.3%) had ECG abnormality. The percentage of ECG abnormality increases with severity of disease. In mild SCD only 31.2% cases had abnormal ECG as compared to 87.5% abnormal ECG in severe SCD.

Cardiovascular abnormalities in SCD are multifactorial. Most important among these is chronic anaemia which is sine qua non of SCD [18,19]. Other factors contributing to cardiovascular

abnormalities include increased pulmonary vascular resistance, iron deposition in myocardium and peripheral vascular disease [20, 21].

Major ECG abnormalities are prolonged P-R interval, S-T segment changes and Axis deviation. Around 28% children had prolonged P-R interval and 27% had axis deviation. A study involving adult Nigerians found significant ECG abnormalities. Mean QTc interval is higher in SCD group. Prolonged PR interval was present in 23% cases as compare to 27.7% in our study [22]. Uzsoy reported prolonged P-R interval in 29% cases [23]. In another study prolonged QT interval is present in pediatric sickle cell disease [24].

In our study 26% children had left ventricular hypertrophy (LVH) as assessed by 2-D echocardiography. Prevalence of LVH increases with the severity of SCD. In mild SCD around 13% children had LVH while in moderate and severe SCD 50% and 62.5% respectively. This finding is similar to other studies in which LVH is the most frequent electrocardiographic abnormality [25]. The compensatory response of chronic anemia in Sickle cell disease results in increase left ventricular stroke volume leading to increase cardiac output. This results in left ventricular dilation and left ventricular hypertrophy.

In our study prominent bronchovascular marking is present in 26 % cases of mild SCD while in severe SCD prominent bronchovascular marking is present in 62.5 % cases. Acute pressure overload along with chronic pulmonary hypertension appears to be cause of prominent bronchovascular marking. However sickle cell disease patients without pulmonary hypertension were reported to have dilated right heart chambers [26-27].

Conclusion

In our study cardiovascular abnormalities are common in patients with sickle cell disease. Chances of cardiovascular abnormalities increase with severity of SCD. Common abnormalities are prolonged P-R interval, Axis deviation, Left ventricular hypertrophy and prominent bronchovascular markings. These abnormalities represent chronic vasculopathy and hemodynamic changes. Cardiovascular study in the form of chest xray, ECG and echocardiography is required particularly in severe SCD. Hence early diagnosis and intervention in SCD can prevent cardiomyopathy and heart failure.

Bibliography -

- 1) Modell B, Darlison M. Global epidemiology of haemoglobin disorders and derived service indicators. Bull World Health Organ 2008; 86 : 480-7.
- 2) R. B. Francis Jr. and C. S. Johnson, "Vascular occlusion in sickle cell disease: current concepts and unanswered questions," Blood, vol. 77, no. 7, pp. 1405–1414, 1991.
- 3) Kate SL, Lingojar DP. Epidemiology of sickle cell disorder in the state of Maharashtra. Indian J Hum Genet 2002; 3: 161-7.
- 4) Urade BP. Incidence of sickle cell anemia and thalassemia in Central India. Open J Blood Dis 2012; 2 : 71-80.
- 5) Patra PK, Chauhan VS, Khodiar PK, Dalla AR, Serjeant GR. Screening for the sickle cell gene in Chhattisgarh state, India: an approach to a major public health problem. J Community Genet 2011; 2: 147-51.
- 6) Covitz, W., Espeland, M., Gallagher, D., Hellenbrand, W., Leff, S. & Talner, N. 1995.
- 7) The Heart in Sickle Cell Anemia: The Cooperative Study of Sickle Cell Disease (CSSCD). Chest, 108, 1214-1219.
- 8) NG, M. L, Liebman, J, Anslovar, J. & Gross, S. 1967. Cardiovascular Findings in Children with Sickle Cell Anemia. CHEST Journal, 52, 788-799.

- 9) Uzsoy N. K. 1964. Cardiovascular findings in patients with sickle cell anemia. *Am J Cardiol*, 13, 320-8.
- 10) Herrick J. B. 1910. Peculiar elongated and sickle shaped red blood corpuscles in a case of severe anemia. *Arch.Int.Med*,6: 517-521.
- 11) Lindsay J. 1974. The cardiovascular manifestations of sickle cell disease. *Archives of Internal Medicine* 1974;133:643-651.
- 12) Varat, M. A, Adolph, R. J, Fowler, N. O. 1972. Cardiovascular effects of anemia. *Am Heart J*,83, 415-426.
- 13) 12. Hegde N, Rich M. W, Gayomali C. 2006. The cardiomyopathy of iron deficiency. *Tex Heart Karayalcin G, Rosnerf, Kim KY*.
- 14) 13. Sickle cell anaemia. Clinical manifestations in 100 patients and review of literature. *Am J Med Sci* 1975; 269: 51-68. *Inst J*,33, 340-4.
- 15) 14.Winsor T, Burch G E. The electrocardiogram and cardiac state in active sickle disease. *Am Heart J* 1945; 29: 685-696.
- 16) 15. Falk HF, Hood WB. The heart in sickle cell anaemia. *Arch Intern Med* 1982; 142: 1680-6
- 17) 16.Thomas J. D, Popovic Z. B. Assessment of Left Ventricular Function by Cardiac Ultrasound. *J Am Coll Cardiol*. 2006 ;48: 2012-2025.
- 18) 17. Lamers L, Ensin G, Pignatelli R, Goldberg C, Bezold L, Ayres N, Gajarski R. Evaluation of Left Ventricular Systolic Function in Pediatric Sickle Cell Anemia Patients Using the End-Systolic Wall Stress-Velocity of Circumferential Fiber Shortening Relationship. *J Am Coll Cardiol*.2006.
- 19) 18. J. Lindsay Jr., J. C. Meshel, and R. H. Patterson, "The cardiovascular manifestations of sickle cell disease," *Archives of Internal Medicine*, vol. 133, no. 4, pp. 643–651, 1974.
- 20) 19. W. Covitz, M. Espeland, D. Gallagher, W. Hellen-brand, and S.Leff, "The heart in sickle cell anaemia: the cooperative study of sickle cell disease (CSSCD)," *Chest*, vol. 108, no. 5, pp. 1214–1219, 1995.
- 21) 20. L. A. Callahan, K. F. Woods, G. A. Mensah, L. T. Ramsey, P. Barbeau, and B. Gutin, "Cardiopulmonary responses to exercise in women with sickle cell anemia," *American Journal of Respiratory and Critical Care Medicine*, vol. 165, no. 9, pp. 1309– 1316, 2002.
- 22) 21.D. S. Darbari, P. Kple-Faget, J. Kwagyan, S. Rana, V. R. Gordeuk, and O. Castro, "Circumstances of death in adult Sickle cell disease patients," *American Journal of Hematology*, vol. 81, no. 11, pp. 858–863, 2006.
- 23) 22. Electocardiographic findings in adult Nigerians with sickle cell anaemia. Oguanobi NI1, Onwubere BJ, Ike SO, Anisiuba BC, Ejim EC, Ibegbulam OG. *Afr Health Sci*. 2010 Sep;10(3):235-41
- 24) 23. Uzsoy NK. Cardiovascular findings in patients with sickle cell anaemia. *Am J Cardiology*. 1964; 13:320-328.
- 25) 24. B. U. Mueller, K. J. Martin, W. Dreyer, L. I. Bezold, and D. H. Mahoney, "Prolonged QT interval in pediatric sickle cell disease," *Pediatric Blood and Cancer*, vol. 47, no. 6, pp. 831–833, 2006.
- 26) 25. E. Voskaridou, D. Christoulas, and E. Terpos, "Sickle-cell disease and the heart: review of the current literature," *British Journal of Haematology*, vol. 157, no. 6, pp. 664– 673, 2012.
- 27) 26. V. Sachdev, R. F. Machado, Y. Shizukuda et al., "Diastolic dysfunction is an independent risk factor for death in patients with sickle cell disease," *Journal of the American College of Cardiology*, vol. 49, no. 4, pp. 472–479, 2007.