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OXYHEMOGLOBIN SATURATION IN CHILDREN WITH SICKLE CELL ANEMIA DURING STEADY STATE AND CRISES USING PULSE OXIMETRY IN OMDURMAN PEDIATRIC HOSPITAL- OMDURMAN, SUDAN (FEBRUARY - JULY 2015)

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Keywords:

Oxyhemoglobin, sickle, cell, anemia, Hypoxemia.

Abstract

Background: Patients with sickle cell anemia (SCA) are prone to recurrent crises painful crises due to hypoxemia, which needs to be corrected prevent serious complication.

Objectives: This study, aimed to determine the frequency of hypoxemia in patients with sickle cell anemia during the steady state and during crises, and to assess the difference in oxyhemoglobin saturation between those in steady state and those in crises

Methodology: This is a prospective cross sectional hospital based study where 180 children with SCA y enrolled in this study. Oxygen saturation was measured for all children by pulse oximeter and full blood count was also done.

Results: males were 112 and females were 68, in age group 6 month to 16 years, 120 of them were in sickle cell crises, while 60 in their steady state. Oxygen saturation was determined using pulse oximeter. The overall frequency of hypoxemia (Spo2< 90) was found to be 13.9% and the mean Spo2 was 93.68. The frequency of hypoxemia in pt with steady state was 10 while in those with crises was 15 and there was significant difference (P. value = 0.002. Significant in those with low weight centile (P. value =0.023) . Hypoxemia was found to be not correlated with patient's Hb level (P. value = 0.684), also not significant in HCT level (P. value = 0.384). Hypoxemia was found to be associated with history of number of blood transfusion (P. value = 0.002).

Conclusion: Hypoxemia was significantly higher among children with SCA during vaso-occlusion crises. We recommended that one should have a high index of suspicion and take prompt action in managing these individuals.

Conflict of interest: No Conflict of interest

Introduction

This Autosomal recessive disorder has a widespread distribution in different parts of the world, with variable clinical manifestations. Sickle cell disease occurs in endemic malarial areas, North Africa, Italy, Greece, Central India, and most predominantly in Sub-Saharan Africa (1). In 2013 it resulted in 176,000 deaths from 113,000 deaths in 1990 (2). Among 632 patients attending various clinics at the Khartoum teaching hospital, there were 5.1% with HbAS and 0.8% with HbSS, so sickle cell disease is the major hemoglobinopathy seen in the Khartoum, the capital of Sudan (3). The abnormal sickle cells can block small blood vessels, causing pain and impaired circulation, decrease the oxygen- carrying capacity of the red blood cell, and ultimately decrease the cell's lifespan (4). Anemia developed due to failure to retain the red blood cell in the circulation (RBC) circulation for as long time and hemolytic crises with more burden to bone marrow (5). So prevalent in Africa, WHO reported that 2% of newborns in Nigeria were

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affected by sickle cell anemia, giving a total of 150,000 affected children born every year in Nigeria alone, carrier frequency ranges between 10% and 40% across equatorial Africa, decreasing to 1–2% on the north African coast and <1% in South Africa (6-7). In the Sudan the disease prevalent among Western Sudan Miseries, Central Sudan 30.4 %, 0-5%-16% respectively (8-10). Sickle cell hemoglobin and B-thalassaemia are the two major hemoglobinopathy described in the capital Khartoum (11). Yassin (2004) in his study proved hypoxemia in children with sickle cell anemia (12).

The incidence of sickle cell disease was assessed in five indigenous and two immigrant group in the Sudan. The study reported marked variability in the five Sudanese tribes included in the study (13). The early studies concluded that sickle cell disease is a public health problem in parts of Sudan (west and south).Now the disease is seen in the Center, North and East of Sudan due to the movement and intermarriage of the tribes, but the prevalence is not well reported. This study, aimed to determine the frequency of hypoxemia in patients with sickle cell anemia during the steady state and during crises, and to assess the difference in oxyhemoglobin saturation between those in steady state and those in crises

Patients and Methods

This is a prospective cross-sectional hospital-based study, conducted between Februarys - July 2015 enrolling 180 patients with sickle cell anemia, in Omdurman Pediatric teaching Hospital (OPTH) which is tertiary care level with 320 serving large catchment area for Omdurman town and receiving revered cases from the country at large. All children with sickle cell anemia (SCA) admitted to pediatric wards (sickle cell crises) or come for follow up in the referred clinic (steady state) in Omdurman Pediatric Hospital, the clinic is not just for sickle patients, but all type of patients, it runs every week day except the weekend, with daily attendance of between 20 - 40 patients, it is run by 2 consultant, 8 registrars. Patient stability was based on general look of the patients, brief history, examination and no any complaint.

Inclusion Criteria

Patients already confirmed SCA based on hemoglobin electrophoresis and Age group 6 months to 16 years.

Exclusion Criteria

Patient refused to participate, Patient underwent exchange transfusion in the last 3 months, Patient with cardiac or pulmonary problem that cause hypoxia. Data was collected by self –administered questionnaire that containing personal data, history, examination and investigation, it was completed for all patient by interviewing parents or the care givers. Full history, examination and investigation and other relevant data collected. Oxygen saturation was determined using a pulse oximeter (Jumper) which allow none-invasive measurement of arterial hemoglobin saturation without the risks associated with arterial puncture, the finger tip or big toe in young children were used for this measurement. using and appropriate sized pediatric sensor, the oximeter measurement was recorded after stabilization of the reading for about one minute, and should not be performed when the patient is crying or moving because it reduces the quality of the signal and the accuracy of the test (14). Oximeter testing may miss hypoxia because of interference from ambient light, partial probe detachment, electromagnetic interference, poor perfusion at site of measurement and the presence of dyshemoglobinemias (15). The use of clinical signs as alternative to pulse oximeter has limited application as no clinical signs have been shown to be a reliable predictor of hypoxemia (16), frank cyanosis does not develop until the level of deoxy hemoglobin reaches 5 g/dl, which correspond to an arterial oxygen saturation of around 67% (17), furthermore ,the threshold at which cyanosis becomes apparent is affected by multiple variables including peripheral perfusion, skin pigmentation and hemoglobin concentration (18).
Normal blood oxygen readings using pulse oximeter range from 95 to 100% at the sea level (19). Hypoxemia was defined as oxygen saturation of less than 90% in line with WHO recommendation (20). Statistical Package for Social Science (SPSS) version 16 was used for data entering. The results obtained were presented in tables and figures. P. value less than 0.05 was considered significant. The significance between the variables was determined using Chi-square test. Statistical Package for Social Science (SPSS) version 16 was used for data entering. The results obtained were presented in tables and figures. P. value less than 0.05 was considered significant. The significance between the variables was determined using Chi-square test. Ethical approval was obtained from ethical committee of Sudan Medical Specialization Board and informed verbal consent taken from care givers.

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Results

Most of children studied 74 (41.1%) between 1- 5 years The majority of patients 86 (47.8%) were diagnosed for the first time at age of 6 month - < one year, Most of the cases 96 (53.3%) had less than 5 times blood transfusion in their life , 153 (85%) had hemoglobin concentration between 5 – 10 gm/dl, 23 (12.8%) of cases had < 5 gm/dl , while only 4 (2.2%) of cases had hemoglobin concentration > 10 gm/dl (Table 1). Most of the hypoxemic patients (13) were between age of 5 – < 10 years P. value =323), there was a significant correlation between hypoxemia and weight of patients (P. value = 0.023), while there was insignificant correlation with height (P. value = 0.300) , Most of the hypoxemic patients 22 out of 25 had hemoglobin concentration 5 – 10mg /dl, while 3 hypoxemic patients had hemoglobin <5 mg /dl, and no hypoxemic patient had hemoglobin concentration more than 10 gm /dl. There was insignificant difference (P. value =0.684), Most of hypoxemic in the study 14 out of 25 had hematocrit of less than 20%, there was insignificant differences (P. value =0.384) , Most of the hypoxemic patients 10 out of 25 were in steady state, while 15 patients were in sickle cell crisis which significant difference (P = 0.002) , Nine out of 74 who were presented with pain full crises were hypoxemic, while 6 out of 64 cases with hemolytic crises were found to be hypoxemic, without significant difference (P =0.978) (Table 2). There was significant relationship between hypoxemia and number of blood transfusion (P =0.002) (Table 2). The mean of oxyhemoglobin saturation (93.68%) (Table 1).

Discussion

In this current study Male to female ratio was 1.6: 1, 47.8% of children were diagnosed before age of one year, 91(50.6%) of patients had low hematocrit concentration (<20%) , The mean of oxyhemoglobin saturation (93.68%), The prevalence of hypoxemia (13.9%), there was significant correlation between hypoxemia and weight percentiles for age of patients.

Sickle cell disease has predominance to male which in agreement in previous studies in Sudan by Nagwa (2007) (21). Since inheritance is Autosomal recessive so any gender can dominate. Most of the patients were diagnosed before age of one year, this was similar to result obtained by Yassin Haj (2004) (12). Most probably this age of less than one year is age where immune system is not well developed and children exposed to infection. The low hematocrit concentration 50.6%of due the chroncity and hemolytic nature of the disease. The mean of oxyhemoglobin saturation for all patients was (93.68%) and this was similar to study done by Ogah et al., study by Yaseen (22-23). This agreement in the oxyhemoglobin is expected because the path physiology is the same. The prevalence of hypoxemia among SCA children in this current paper was similar to Chinawa et al (24), this is attributable to the chronic anemic state and micro-vascular occlusion of the circulation by sickled hemoglobin, but lower than what was found by Yassin et al (12) and Ogah et al., (22) this difference may be because they consider hypoxemia when Spo2 was less than 95% by both authors and also because Ogah et al. did his study in high altitude area. The lowest oxygen saturation was associated with increasing age in this current work, but no significant correlation between hypoxemia and age group. This consistent with Ogah et al. Rachoff et al, (22,25). This due to pulmonary complications from recurrent sickling that is commoner with increasing age. Regarding hypoxemia and growth parameters, there was significant correlation between hypoxemia and weight percentiles for age of patients, but no significant with height, and this agree with Yassin et al., study (12) in which he stated that hypoxemia is related to the weight for age percentiles.

Both groups of patients in the steady state and in crisis had hypoxemia 40.0% and 60.0% respectively and there was insignificant difference between the two groups in respect to hypoxemia, which is more in those with crisis. This similar to result obtained by Chinwa et al., (24) in which hypoxemia was higher among the patients with crisis state (23.8%), compared to 13.0% for those in steady state. There was statistically insignificant correlation between hypoxemia and hemoglobin concentration nor hematocrit of the patients in study group. This disagreed with Yassin study (12) who found significant correlation between hypoxemia and hemoglobin concentration and hematocrit. Conclusion: Sickle cell anemia more common among male, usually diagnosed before age of one year, had low hematocrit concentration (<20%), The mean of oxyhemoglobin saturation (93.68%), The prevalence of hypoxemia was significant correlated with increasing age and low weight percentiles for age of patients.

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Limitation of the study
Use of pulse oximeter instead of blood gas analysis [which is the gold standard] to measure the PO2. but blood gas analysis is expensive, painful, technically difficult and not available to us.

Strength
Pulse oximeter is non invasive, cheep, simple to carryout and available. Recommendations: Large size multi-centre or community based study are recommended and using more advance techniques for oxygen saturation. Regular screening for any couples before marriage and regular screening for hypoxemia is recommended.

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Table 1: Patient's characteristics

Characteristics	**No**	**%**
Age group (month)		
6-11	29	16.1
12-60	74	41.1
61-119	63	35
120 and more	14	7.8
Gender	No	%age
Male	112	62.2
Female	68	37.8
Total	180	100%
Age at time of presentation		
6-11	64	35.6
12-60	86	47.8
61-119	25	13.9
120 and more	5	2.5
Total	180	100
Age at the time of diagnosis		
Less than 6 month	64	35.6
>6 month - < one year	86	47.8
>1 year- <5 years	25	13.9
> 5 years	5	2.8
Total	180	100
No blood transfusion		
Less than 5 times	96	53.3
More than 5 times	84	47.7
Total	180	100
Level of Hemoglobin		
5 – 10 gm/dl	153	85
< 5 gm/dl	23	12.8
10 gm/dl	4	2.2
Total	180	100
Oxygen saturation percentage		
75-90	25	13.9
91-95	70	38.9
96-100	85	47.2
Total	180	100
The mean of oxyhemoglobin saturation		**93.68%**

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Table 2 Hypoxemia profile among sichelers (n=180)

Correlation between hypoxemia and hemoglobin					
Hemoglobin level	Oxygen saturation			**Total**	P value =684
	90-75	95-91	100-96		
< 5mg/dl	3	11	9	23	
5.1 – 10 mg/dl	22	58	73	153	
>10 .1 mg/dl	0	1	3	4	
Correlation between hypoxemia and hematocrit					
Hematocrit	Oxygen saturation			**Total**	
	90-75	95-91	100-96		
< 20	14	37	40	91	
20 - < 25	10	30	33	73	
26- < 30	0	3	7	10	
31- <35	1	0	5	6	
Correlation between hypoxemia and diagnosis					
Diagnosis	Oxygen saturation			**Total**	
	90-75	95-91	100-96		
Steady state	10	29	21	60	
Sickle cell crises	15	41	64	120	
Correlation between hypoxemia and type of crisis					
Type of crisis	Oxygen saturation			**Total**	
	90-75	95-91	100-96		
Painful crises	9	25	40	74	
Hemolytic crises	6	16	24	46	
Correlation between hypoxemia and number of blood transfusion					
Number of blood transfusion	Oxygen saturation			**Total**	
	90-75	95-91	100-96		
< 5 times	8	40	48	96	
> 5 times	10	19	19	48	**P value = 0.002**
regular transfusion	6	3	3	12	
No transfusion	1	8	15	24	
Distribution of the study population according to weight and height percentile					
Weigh Centile	Oxygen saturation				
	90-75	95-91	100-96	**Total**	
< 3rd	7	25	18	50	
3rd - <5th	4	12	32	48	**P value = 0.023**
5th - <25 th	3	15	18	36	
25 th - <50 th	4	10	10	24	
50 th - <95 th	7	8	7	22	
Height Centile	Oxygen saturation				
	90-75	95-91	100-96	**Total**	
< 3rd	7	25	18	50	
3rd -< 5th	4	12	32	48	**P value = 0.300**
5th - < 25 th	3	15	18	36	
25 th -< 50 th	4	10	10	24	
50 th –95th	7	8	7	22	