Sonographic Findings in the Liver, Spleen and Kidney of Sickle Cell Disease patients seen at the University of Benin Teaching Hospital Benin City, Nigeria

***IGHODARO EO, ****AGHOLOR CA**

*Department of Radiology University of Benin Teaching Hospital Benin City, Edo State.
**General Hospital Asaba, Delta State.

Correspondence
Dr. Emmanuel Osaigbovo Ighodaro,
Department of Radiology
University of Benin/University of Benin Teaching Hospital
Benin City, Edo State.
Email: osaigbovo.ighodaro@uniben.edu

ABSTRACT

Background: Sonographic evaluation of the abdomen in sickle cell disease (SCD) plays a vital role in the management of this condition. The objective of this study was to sonographically evaluate the liver, spleen and kidneys in patients with SCD and correlate the findings with age and gender

Methods: This is a prospective and descriptive study of the ultrasound findings in the liver, spleen and kidney of SCD patients, seen at the University of Benin Teaching Hospital, Benin City. 150 SCD patients were examined for abnormalities by abdominal ultrasound scan. 140 patients were homozygous for SCD (HbSS), while 10 patients were heterozygous (HbSC). Their age ranges from 10 months to 51 years and consist of 71 and 79 males and females respectively.

Results: One hundred and eighteen (78.7%), patients had abnormal abdominal ultrasound scan. The pattern of the common ultrasound abnormalities was hepatomegaly (62.0%), autosplenectomy (38.7%), enlarged kidney (22.0%), splenomegaly (20.7%), increased renal echogenicity (11.3%), increased liver echotexture (8.0%), shrunken spleen (5.3%) and multiple punctate splenic echogenic foci (4.0%).

Splenomegaly was seen to be common in the HbSC group and was statistically significant with p value of 0.01. Autosplenectomy was seen to be common in the HbSS group and was statistically significant with p value of 0.01. Hepatomegaly, enlarged kidney, increased renal echogenicity, increased liver echotexture, shrunken spleen was commoner in the HbSS group, but were not statistically significant.

Conclusion: Abdominal ultrasound imaging of SCD patients showed a high prevalence of abnormalities in the liver, spleen, kidneys.

Keywords: Ultrasound, liver, spleen kidney, sickle cell, disease

INTRODUCTION

Sickle cell haemoglobin (HbS) is the most important structural abnormality of the haemoglobin chain (Bookchin & Lew, 1996). The first published account of sickle cell anaemia was by Herrick in 1910, who described the clinical and haematologic manifestations of the disease in a 20-year-old African American dental student from Grenada, Chicago (Herrick, 1910). SCD is believed to have originated in malaria endemic West Africa where it has the highest prevalence (Johnny & Bohrer, 2001). The disease occurs almost exclusively in black-skinned races, especially those in West and Central Africa or their descendants, who are homozygous for the sickling trait (Mitchell & Fupi, 1972; Graham & Serjeant, 2005). The sickle

cell gene is present in about 8% of black Americans; more than 2 million people in the United States nearly all of them of African American ancestry carry the sickle gene (Steinberg, 2008). However, in sub-Saharan Africa the prevalence of sickle cell trait is as high as 30% (Mitchell & Fupi, 1972; Graham & Serjeant, 2005). There are other, much less common abnormal beta-globin chains, which may combine with sickle cell beta chain to produce rarer forms of SCD such as HbSC and HbSD. Overall; HbSS has the severest clinical manifestations of any of the sickle cell variants (Graham & Serjeant, 2005).

SCD is characterized by the typical clinical picture of chronic haemolytic anaemia and vaso-occlusive crisis. It is confirmed when the homozygous HbSS or heterozygous HbS in combination with any other abnormal beta globin chain is demonstrated by haemoglobin electrophoresis. Patients with HbSA are heterozygous carriers and are essentially asymptomatic; however, HbSA is associated with an increased risk of medullary carcinoma of the kidney, which is a rare renal tumour (Davis et al., 1995). Repeated vaso-occlusive crisis accounts for the majority of the clinical manifestations of the disease. The crisis is precipitated by a variety of factors, such as dehydration rate and extent of haemoglobin deoxygenation, high haemoglobin concentration in the cell (the higher the haemoglobin concentration, the more readily sickling will occur), the intracellular haemoglobin composition (the presence of other haemoglobin variants such as fetal haemoglobin (HbF), which may inhibit sickling), pH, and temperature (Bunn, 1999). But in Nigeria and other tropical areas where malaria is endemic there is strong evidence to suggest that one chief factor is malaria infection, thus, anti-malaria drugs are routinely given to patients attending sickle cell haemoglobinopathy clinic (Oniyangi & Omari, 2006).

The presence of sickle cell trait has some benefits in that it confers on the individual a relative immunity to the severe form of plasmodium falciparum which is a major cause of infant mortality in malaria endemic West and Central Africa (Akinyanju et al., 1987).

Radiological evaluations play a crucial role in the management and follow up of SCD patients. They manifest with a variety of abdominal problems, which include hepatomegaly, splenomegaly, functional autosplenectomy, splenic calcification, splenic abscess, biliary tract abnormalities, renal enlargement and increased renal and pancreatic echogenicity (Lagundoye, 1971; Papadaki et al., 2003). Real time ultrasonography is a standard screening procedure and the first line imaging modality of choice in the assessment of the abdominal manifestations of SCD. It is cheap, readily available, non-invasive and non-ionizing, in addition its sensitivity and specificity in detecting abdominal lesions is good (Gorg et al., 2003).

The objective of this study was to sonographically evaluate the liver, spleen and kidneys in patients with SCD and correlate the findings with age and gender

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MATERIALS AND METHODS

This study was a prospective study of the abdominal ultrasound findings of 150 consecutive confirmed SCD patients of all ages on routine follow up from the sickle cell haemoglobinopathy clinic of the University of Benin Teaching Hospital (UBTH), Benin City. These patients were confirmed to be SCD patients through haemoglobin electrophoresis. Informed written consent was obtained from all patients (and parents/guardian of minors). Demographic data such as age, sex, weight and height were obtained from the patients.

All patients were examined with a B-mode portable ultrasound: Titan (Sonosite Inc, USA.2004) machine with a curvilinear multifrequency transducer 2.5-7.5MHz. All the patients were examined after an overnight fast or after at least a six hour fast. The abdomen was evaluated for the echo texture of the liver, spleen, kidney and for organomegaly. The liver, spleen and the kidney of all the patients were scanned. Evaluation for abnormalities and sizes were done with the patients lying in two or more of the following positions; supine, prone, left posterior oblique, right posterior oblique, left lateral decubitus and semi-erect positions. The organs were examined systematically in the sagittal, transverse, intercostal and the subcostal approaches. The organs were measured at suspended inspiration to minimize masking by the lungs and eliminate morphological variation due to respiration (Saunders et al., 2007). The longitudinal diameter at midclavicular line (Figure 1) of the sagittal scan of the liver with the patient supine was used to assess for hepatomegaly. Midclavicular longitudinal dimensions greater than 15cm was documented as hepatomegaly, for adult patients.[15] The longitudinal dimension taken through the splenic hilum was used to assess for splenomegaly (Figure 2). Longitudinal distance greater than 12cm was documented as splenomegaly for adult (Berman & Wajsbrotkandel, 1997). The

longitudinal dimension of the kidney was used to assess for renal enlargement (Figure 3). Longitudinal dimension greater than 12cm was documented as renal enlargement for adults (Kawamura 1997). Additionally, normal reference values correlating liver, spleen and kidney sizes with age was used to assess for hepatomegaly (America Institute of Ultrasound in Medicine, 2010), splenomegaly (Rosenberg et al 1991) and renomegaly (Rosenbaum, 1983) in the paediatric age group. The echogenicity of the liver. Spleen and kidney were evaluated by comparison at similar dept to adjacent structures. Typically, the pancreas is the most echogenic organ followed by the liver, then spleen and finally the kidneys. The liver was compared to the right kidney and pancreas. There was comparison of the splenic parenchyma echogenicity with that of the left kidney and cortical echogenicity of the kidneys was compared with that of the liver and spleen for the right and left kidney respectively.

RESULTS

One hundred and fifty confirmed SCD patients were recruited into this study. 71 (47.3%) of the patients were males, while 79 (52.6%) were females, with a male to female ratio of 1:1.1 (Table 1). The age range of the patients was 10 months to 51 years. The mean age was 15.24 ± 10.58 years (Table 1). The largest number of patients were in the age group 0-10 years, accounting for 65 (43.3%) of the 150 patients. Patients in the age groups 11-20 years and 21-30 years accounted for 45 (30.0%) and 26 (17.3%) respectively, while those in the age groups 30-40 years and above 40 years each accounted for7 (4.7%) of the 150 patients.

Liver

Hepatomegaly was the most frequent abdominal ultrasound finding and was seen in 93 (62.0%) of the 150 patients (Table 2). The liver was enlarged in 88 (62.8%) of 140 patients in the HbSS group and in 5 (50.0%) of the 10 patients in the HbSC group, this finding was more commonly seen in the HbSS group but was not statistically significant (Table 3). In addition, hepatomegaly was seen in 36 (55.4%), 29 (64.4%), 17 (65.4%), 5 (71.4%) and 6 (85.7%) of patients in 0-10, 11-20, 21-30, 31-40, and >40 age groups respectively (Table 4). The prevalence of hepatomegaly was seen to increase with increasing age, although not statistically significant (Table 4 and Figure 4). Increased liver echogenicity was seen in 12 (8.0%) of 150 patients. This consist of 11 (7.3%) of 140 and 1 (10.0%) of 10 patients in the HbSS and HbSC group respectively (Table 3).

In addition, increased liver echogenicity was seen in 2 (4.4%) of 45, 3 (11.5%) of 26, 3 (42.9%) of 7 and 4 (57.1%) of 7 patients in the age groups 11-20, 21-30, 31-40 and >40 years respectively (Table 4). This finding was not seen in any of the patients in the 0-10-year age group. Also, the prevalence of increased liver echogenicity was slightly more common in females 7 (8.9%) of 79 patients as against 5 (7.0%) of male patients and was not statistically significant (Table 5).

Table I: Demographic data

Heamatologic genotype	Number of patients	Sex M/F	Mean age ± SD (years)
Haemoglobin SS	140 (93.3%)	66/74	14.72 ± 10.40
Haemoglobin SC	10 (6.7%)	5/5	23.01 ± 11.40
Total	150	71/79	15.24 ± 10.58

M: Male; F: Female; SD: Standard deviation

Spleen

The spleen was absent (autosplenectomy) in 58 (38.7%) patients. Autosplenectomy was seen in 56 (40.0%) 140 patients in the HbSS group which was significantly higher than that seen in HbSC group 2 (20.0%) of 10 patients as shown in table 3.

Autosplenectomy was seen in 11 (16.9%) of 65, 24 (53.3%) of 45, 16 (61.5%) of 26, 3 (42.8%) of 7 and 4 (57.1%) of 7 patients in the 0-10, 11-20, 21-30, 31-40 and >40 age groups respectively (Table 4). This finding occurred most commonly in the 21-30 years age group.

More female patients 31 (39.2%) of 79, had autosplenectomy compared with 27 (38.0%) of 71 male patients, but was not statistically significant (Table 5).

Splenomegaly was a common finding and was seen in 31 (20.7%) of 150 patients. 27 (19.2%) of 140 and 4 (40.0%) of 10 patients in the HbSS and HbSC groups respectively had splenomegaly. This finding was more common in the HbSC group and was statistically significant (Table 3).

Furthermore, splenomegaly was seen in 22 (33.8%) of 65, 8 (17.8%) of 45, 1 (3.9%) of 26 patients in the age groups 0-10, 11-20 and 21-30, years

respectively (Table 4). This finding was observed to decrease with increasing age and was statistically significant (Table 4).

Splenomegaly was more common in female patients seen in 17 (21.5%) of 79 and 14 (19.7%) of 71 female and male patients respectively (Table 5). However, this was not statistically significant.

A shrunken spleen was seen in 8 (5.7%) of patients, all of whom were in the HbSS group (Table 3).

This finding was seen in 1(1.5%) of 65, 3 (6.7%) of 45, 2 (7.7%) of 26, 1 (14.3%) of 7 and1 (14.3%) of 7 patients in the age groups 0-10, 11-20, 21-30, 31-40 and >40 years respectively. The prevalence of shrunken spleen was seen to be increasing with increasing age and was statistically significant (Table 4 and figure 1).

Additionally, shrunken spleen was slightly more frequent in male patients being seen in 4 (5.6%) of 71 and 4 (5.1%) of 79 male and female patients respectively (Table 5).

Multiple punctate splenic echogenic foci were seen in 6 (4.0%) of 140 patients in the HbSS group and not in any of the patients in the HbSC group (Table 3).

Furthermore, this finding was seen in 1 (1.5%) of 65, 3 (6.7%) of 45, 1 (3.8%) of 26 and 1 (14.3%) of 7 patients in the age groups 0-10, 11-20, 21-30 and 31-40 years respectively and was not seen in any of the patients >40 years (Table 4).

Multiple punctate splenic echogenic foci were slightly more frequent in male patients and was seen in 3 (4.2%) of 71 and 3 (3.8%) of 79 male and female patients respectively (Table 5).

The other findings in the spleen, include increased echotexture 4 (2.7%), hypoechoic parenchymal lesions 3 (2.0%) and coarse echotexture 2 (1.3%) as shown in table 2. These findings were only seen in the HbSS group.

Table 2: Frequency of abdominal ultrasound findings

Ultrasound findings	Frequency	Percentage
Hepatomegaly	93	62.0
Absent spleen	58	38.7
Renal enlargement	33	22.0
Splenomegaly	31	20.7
Increased renal echogenicity	17	11.3
Increased liver echogenicity	12	8.0
Shrunken spleen	8	5.3
Multiple punctuate splenic echogenic foci	6	4.0
Increased splenic echogenicity	4	2.7
Hypoechoic splenic parenchymal lesion	3	2.0
Increased pancreatic echogenicity	3	2.0
Multiple hypoechoic areas in the periphery of the kidney	3	2.0
Coarse splenic echotexture	2	1.3
Hydronephrosis	2	1.3
Renal cyst	1	0.7
Renal stone	1	0.7
Hypoechoic renal mass	1	0.7

NB: Some patients had multiple findings.

Table 3: Common ultrasound findings: Distribution according to haematologic genotype.

		Haematologic Genotype			
		HbSS n (%)	HbSC n (%)	Chi-square (χ^2)	P-value
Hepatomegaly	93	88 (62.9)	5(50.0)	0.655	0.06
Autosplenectomy	58	56(40.0)	2(20.0)	1.574	0.01
Renal enlargement	33	31(22.1)	2(20.0)	0.025	1.000
Splenomegaly	31	27(19.3)	4(40.0)	2.443	0.01
Increased renal echogenicity	17	16(11.4)	1(10.0)	0.019	1.000
Increased liver echogenicity	12	11(7.9)	1(10.0)	0.058	0.577
Shrunken spleen	8	8(5.7)	0(0.0)	0.604	1.000
Multiple punctate splenic echogenic foci	6	6(4.3)	0(0.0)	0.446	1.000
Increased splenic echogenicity	4	4(1.4)	0(0.0)	0.294	1.000

Kidney

Renal enlargement was seen in 33 (22.0%) patients (Table 2). This consists of 31 (22.1%) and 2 (20.0%) patients in the HbSS and HbSC group respectively (Tables 3). In addition, 23 of the patients had bilateral renal enlargement, while 6 and 4 patients only had right sided and left sided renal enlargement respectively (Table 6).

Furthermore, renal enlargement was seen in 1 (1.5%) of 65, 8 (17.8%) of 45, 15 (57.7%) of 26, 5 (71.4%) of 7 and 4 (57.1%) of 7 patients in the age groups 0-10, 11-20, 21-30, 31-40 and >40 years respectively (Table 4). This finding was most commonly seen in the 31-40 years age group (Table 4). 18 (22.8%) of 79 females had renal enlargement which was slightly higher than was seen in males 15 (21.1%) of 71 patients (Table 5).

Increased renal echogenicity was seen in 17 (11.3%) patients (Table 2). This consist of 16 (11.4%) and 1 (10.0%) of patients in the HbSS and HbSC group respectively (Table 3).

Additionally, increased renal echogenicity was seen in 2 (4.4%) of 45, 7 (26.9%) of 26, 4(57.1%) of 7 and 4 (57.1%) of 7 patients in the age groups 11-20, 21-30, 31-40 and >40 years respectively (Table 4). This finding was seen to increases with increasing age and was statistically significant (Table 4 and Figure 4).

Multiple hypoechoic areas in the periphery of the kidney, was seen in 3 (2.0%) of patients and was only seen in the HbSS group (Table 2). Other findings in the kidney include 2 (1.4%) cases of hydronephrosis, 1 (0.7%) case of renal cyst, renal stone and a large hypoechoic mass respectively; all of which were only observed in the HbSS group (Table 2).

Table 4: Ultrasound findings: Distribution according to age*

		Age (years)					P-value
Ultrasound Findings		0-10 n(%)	11-20 n(%)	21-30 n(%)	31-40 n(%)	>40 n(%)	
Hepatomegaly	93	36 (55.4)	29 (64.4)	17 (65.4)	5 (71.4)	6 (85.7)	0.544
Autosplenectomy	58	11 (16.9)	24 (53.3)	16 (61.5)	3 (42.8)	4 (57.1)	<0.0001
Renal enlargement	33	1 (1.5)	8 (17.8)	15 (57.7)	5 (71.4)	4 (57.1)	<0.0001
Splenomegaly	31	22 (33.8)	8 (17.8)	1 (3.9)	0 (0.0)	0 (0.0)	0.007
Cholelithiasis	24	3 (4.6)	5 (11.1)	8 (30.8)	4 (57.1)	4 (57.1)	<0.0001
Increased gall bladder wall thickness	18	2 (3.1)	7 (15.6)	4 (15.4)	2 (28.6)	3 (42.9)	0.004
Increased renal echogenicity	17	0 (0.0)	2 (4.4)	7 (26.9)	4 (57.1)	4 (57.1)	<0.0001
Increased liver echogenicity	12	0 (0.0)	2 (4.4)	3 (11.5)	3 (42.8)	4 (57.1)	<0.0001
Shrunken spleen	8	1 (1.5)	3 (6.7)	2 (7.7)	1(14.3)	1 (14.3)	0.053
Multiple punctate splenic echogenic foci	6	1 (1.5)	3 (6.7)	1 (3.8)	1(14.3)	0 (0.0)	0.264
Increased splenic echogenicity	4	0 (0.0)	2 (4.4)	1 (3.8)	1 (14.3)	0 (0.0)	0.120
Total		65(43.3)	45(30.0)	26(17.3)	7(4.7)	7(4.7)	

*=More than one finding in a patient

Table 5: Distribution of ultrasound findings according to sex*

Ultrasound Findings	Total	Male n(%)	Female n(%)	P-value
Hepatomegaly	93	43 (60.6)	50 (63.3)	0.861
Autosplenectomy	58	27 (38.0)	31 (39.2)	1.000
Renal enlargement	33	15 (21.1)	18 (22.8)	0.962
Splenomegaly	31	14 (19.7)	17 (21.5)	0.944
Inceased renal echogenicity	17	8 (11.3)	9 (11.4)	1.000
Increased liver echogenicity	12	5 (7.0)	7 (8.9)	0.914
Shrunken spleen	8	4 (5.6)	4 (5.1)	1.000
Multiple punctate splenic echogenicity	6	3 (4.2)	3 (3.8)	1.000
Total		71 (47.3)	79 (52.7)	

*=More than one finding in a patient

Table 6: Table showing the distribution of renal enlargement

Renal enlargement	Frequency (n)	Percentage (%)
Both kidneys	23	69.7
Right kidney only	6	18.2
Left kidney only	4	12.1
Total	33	100

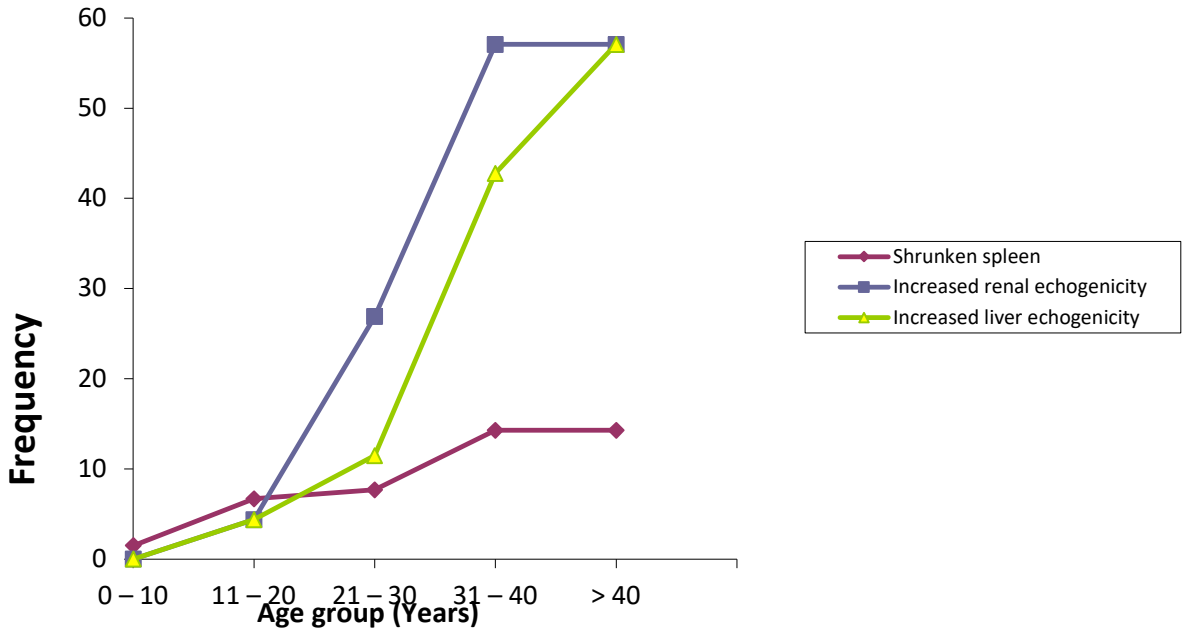

Figure 4: Graph showing increasing shrunken spleen, increased renal echogenicity and increased liver echogenicity with age.

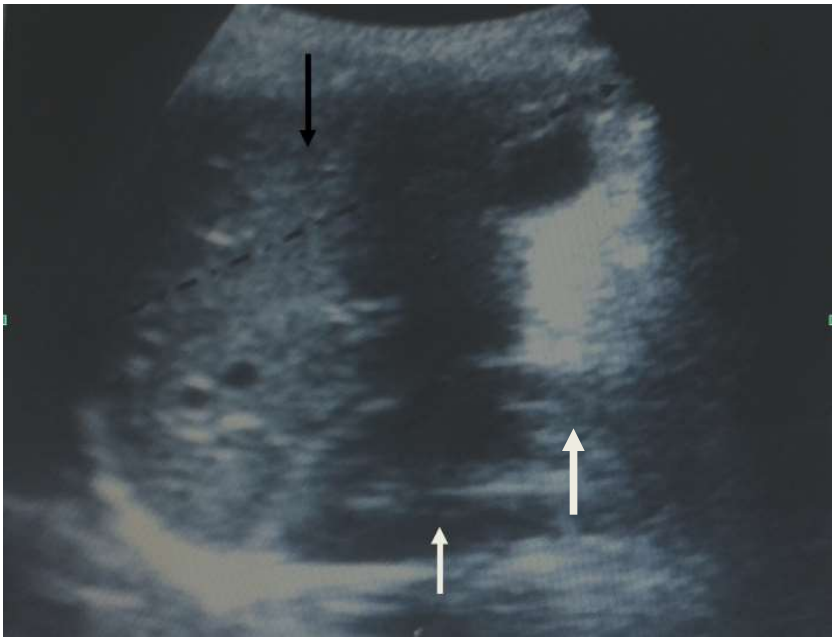

Figure 1: Sonogram showing longitudinal dimension of the liver at the midclavicular line (dashed arrow). Black arrow point to the liver, white arrow point to the right kidney. The hypoechoic bands across the liver were due to rib shadows.

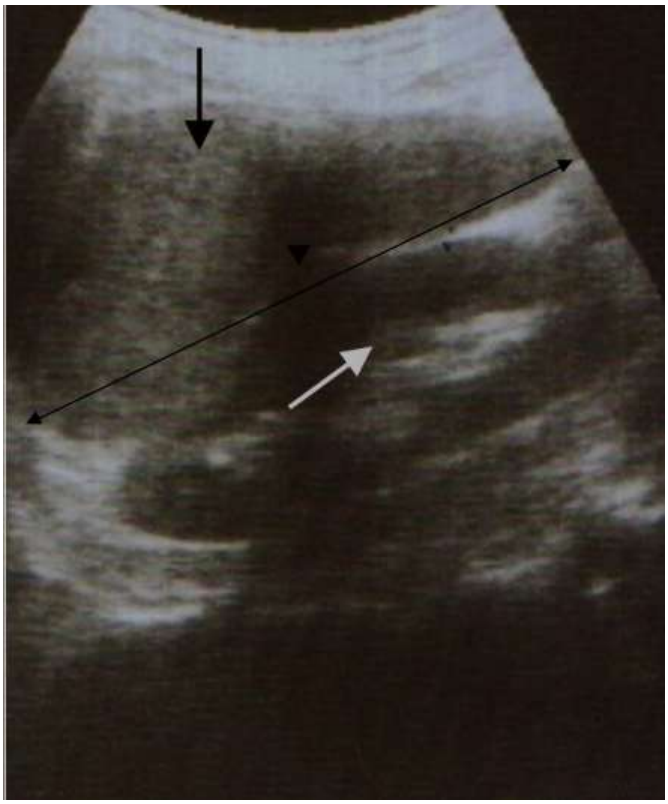

Figure 2: Sonogram showing the assessment of splenomegaly using the longitudinal dimension through the splenic hilum. Black arrow point to spleen, black arrow head point to splenic hilum, white arrow point to left kidney.

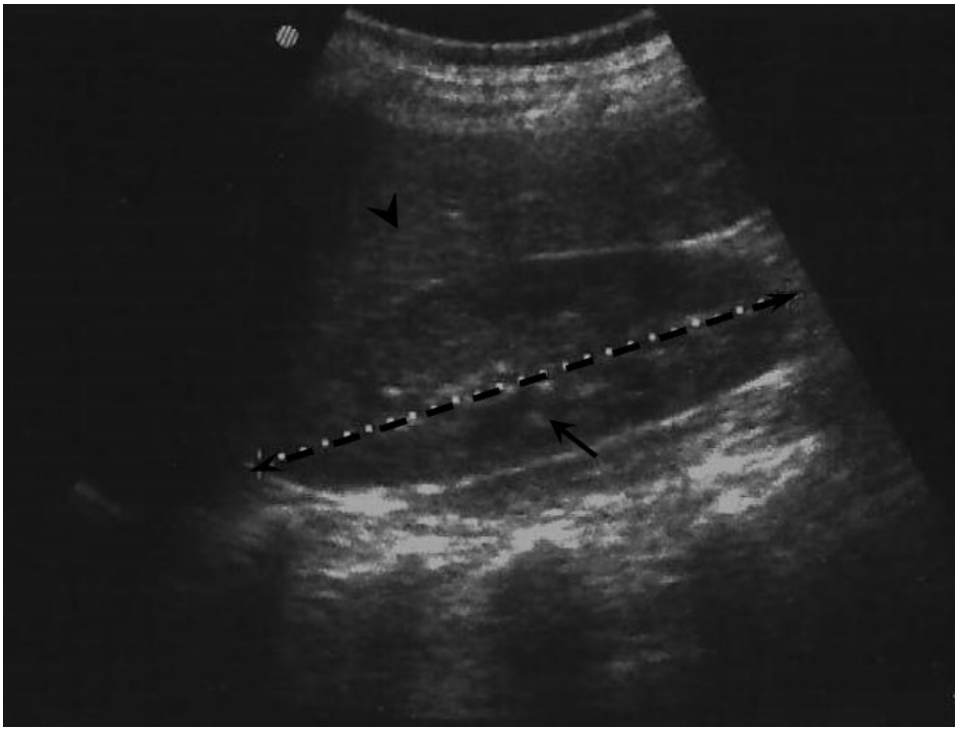

Figure 3: Sonogram showing the assessment of renal size using the longitudinal dimension. Black arrow head point to liver, while black arrow point to right kidney.

DISCUSSION

SCD is one of the most common inherited haemoglobinopathies (Graham & Serjeant,2005). It is a global problem with about 5% of the World population being carriers of the gene responsible for the disease. In Nigeria, the prevalence of SCD is about 20 per 1000 live births. This means that in Nigeria alone, about 150,000 infants are born annually with SCD (WHO, 2011). The disease constitutes a formidable problem to national health care with high socio-economic burden.

The present study is on 150 SCD, comprising 140 (93.3%) homozygous (HbSS) and 10 (6.7%) haemoglobin SC (HbSC). This indicates that HbSS predominates (constituting about 93%), a finding that agrees with previous studies in Nigeria (Bunn, 1999; Oniyangi & Omari, 2006).

Most of the patients 110(73.3%) were 20 years and below, this may not be unrelated to the shortened life span associated with SCD. Abdominal ultrasound imaging of patients with SCD revealed a high prevalence of abdominal abnormalities, especially in the solid organs. A previous study of 102 Turkish SCD by Balci *et al* (2008) showed a high prevalence of about 80% of abnormal abdominal ultrasound findings. These findings include hepatomegaly 71.6%, renal enlargement 30.4%, autosplenectomy 33.3%, and splenomegaly 17.4%. Additional findings include increased renal echogenicity 15.7%, a bright liver 5.9%, and splenic punctate echogenic foci 4.9%. Similarly, Attalla (2010) reported about 91% prevalence of abnormal ultrasound findings among Sudanese SCD patients at Khartoun Paediatrics hospital.

Various abnormal abdominal ultrasound findings were seen in about 78.7% of the 150 patients recruited into this study. The abnormalities detected include hepatomegaly 62.0%, autosplenectomy 38.7%, renal enlargement 22.0%, splenomegaly 20.7%, increased renal echogenicity 11.3% and increased liver echotexture 8.0%. Uncommon findings include shrunken spleen 5.3%, multiple splenic echogenic foci 4.0%, increased splenic echogenicity. These common and uncommon abdominal ultrasound findings were comparable to those documented by Balci *et al (2008),* Attalla (2010) and Walker & Serjeant, *(1993)*

Hepatomegaly was the commonest abdominal ultrasound finding and was seen in 70.5% of 105 Greek SCD in a study carried out by Papadaki *et al (2003)*. This is similar to the findings reported by Mohanty *et al. (2004)* where hepatomegaly was seen in 72.0% of 50 Indian SCD patients. These findings are comparable with the findings in the current study where hepatomegaly (62.0%), was the commonest abdominal ultrasound finding.

In the series by Attalla (2010) on 90 Sudanese SCD patients, the prevalence of hepatomegaly was seen to increase with age. Similarly, in this study, hepatomegaly correlated with age as it was seen to increase with age and was most commonly seen in the above 40 years age group. Also, the prevalence of hepatomegaly was found to be significantly higher than normal controls in Benin City (Ogoinja, 2006).

Balci *et al (2008) reported* a 6.0% in their study in Turkey. This is consistent with the findings in this study in which increased liver echotexture was seen in (8.0%). This finding was seen to increase with age and was statistically significant with a p value of 0.0001 hence, correlating with age.

Attalla (2010) reported 47.8% absent spleen (autosplenectomy) in their study, while Balci *et al. (2008)* reported 42.9%. These findings are in accordance with the findings in this study where the spleen was absent in 38.7% of patients. The prevalence of autosplenectomy was seen to increase with increasing age ($p < 0.0001$). Hence, this finding correlated with age.

Balci *et al (2008)* reported 17.9% prevalence of splenomegaly in Turkey. This is comparable to the findings in the current report where splenomegaly was seen in (20.7%). Splenomegaly was more common (40.0%) among the HbSC patients than the HbSS group (18.0%). Thus, splenomegaly was seen to correlate with haemoglobin genotype. Also, the prevalence of splenomegaly was observed to be significantly higher than that seen in normal controls in Benin City (Ogbeide, 2005).

The frequency of splenomegaly was seen to decrease with increasing age group. This finding may not be unrelated to the increased incidence of autosplenectomy with increasing age observed in this and previous reports (Walker & Serjeant, 1993; Balci et al., 2008; Attalla, 2010).

A common cause of splenomegaly in SCD patients is acute splenic sequestration which is characterized by rapid pooling of blood in the splenic sinusoids (Adekile *et al., 1988)*. In Nigeria, Adekile *et al (1988)* demonstrated that the splenomegaly found among SCD was due to response to malarial antigens signified by the high level of antimalarial IgM.

Attalla (2010) reported a 6.6% prevalence of renal enlargement among Sudanese SCD patients. However, this is less than the 22.0% prevalence of renal enlargement seen in this study. Renal enlargement was seen to positively correlate with age as the prevalence increased with increasing age which was statistically significant ($p< 0.0001$).

The higher prevalence of renal enlargement compared to that by Attalla (2010) may be due to the involvement of adult patients in this study compared to the 6 months to 16 years age range in their study. Renal enlargement has been shown to increase with age in this and previous studies,[30] the prevalence of renal enlargement among sickle cell disease patients in this report was significantly higher than normal controls in Benin City and South East Nigerians (Okoye et al., 2005; Nkemchor, 2009)

An 8.4% prevalence of diffuse increased renal echogenicity among Jamaican sickle cell disease patients was documented by Walker *et al. (1993)*. Similarly, Balci *et al. (2008)* reported a 9.5%. Their findings correspond with the current study where diffuse increased renal echogenicity was seen in 11.3%. Increased renal echogenicity was seen to increase with age and was statistically significant ($p < 0.0001$). Hence, increased renal echogenicity positively correlated with age.

The diffusely increased renal echogenicity may be due to the generalized glomerular and interstitial changes that occur in SCD (Banerjee et al., 2001).

CONCLUSION

In conclusion this study revealed a high prevalence of abnormalities in the liver, spleen and kidneys on abdominal sonographic examination of SCD patients. The early detection of these changes will herald prompt intervention measures, reducing morbidity and mortality associated with SCD thus prolonging their life expectancy. Further future research is recommended to establish optimal beneficial age of ultrasonographic screening and intervention for both homozygous and heterozygous types.

CONFLICT OF INTEREST: The authors hereby submit that there is no conflict of interest.

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