Handheld echocardiographic screening for rheumatic heart disease in rural South Kordofan, Sudan by junior medicals: Supporting task shifting for control of a serious disease

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Abstract

Background

Rheumatic heart disease (RHD) is a major and preventable cause of cardiac mortality in Sudan, particularly in Kordofan. It can be detected early with a handheld echocardiography machine.

Methods

A cross-sectional study was conducted in South Kordofan State, Sudan (as part of a medical convoy organized by Khartoum Medical Students Association). A team of shortly trained medical students and newly graduated doctors conducted a handheld echocardiographic screening using a simplified protocol. All suspected cases were recorded and reviewed later by a senior pediatric cardiologist. Demographic and clinical features of screened subjects were studied. Data analysis was performed using the Statistical Package for Services and Solutions (SPSS 25). Descriptive statistics were presented as “number (%)” or “mean $\pm$ SD”. RHD prevalence was expressed as cases per 1000, and Chi-Square test/Fisher’s Exact test was used to compare RHD findings between different groups.

Results

The disease frequency was found to be 50 per 1000. Out of 452 screened subjects (age 10-25 years), 23 were found to have RHD with a male to female ratio of 1:1.5. Echocardiographic quality was acceptable in 93% of studies. The disease was mild in 70% and moderate or involving 2 valves in 30% of patients. Patients were contacted, advised to start penicillin prophylaxis and referred to cardiologists. Risk factors for the disease included father's occupation and village of residence.

Conclusion

Shortly trained junior medicals can assist in RHD echocardiographic surveillance in remote areas. South Kordofan state is highly endemic for RHD and a control program needs to be implemented. Handheld echocardiography is of value for early detection and management.

Background

Rheumatic Heart Disease (RHD) is a serious condition precipitated by the heart valves damage associated with acute rheumatic fever (ARF) that is a sequelae of group A streptococcal infection. It is estimated to affect 33 million people and leads to 320,000 deaths each year (1). RHD is a disease of poverty, overcrowding, and poor health facilities, therefore, it is a major health problem in low- and middle-income countries where it constitutes the most common cause of cardiovascular diseases in children and young adults.

Although primary and secondary prevention can control the disease, patients often present late with uncurable established disease with a majority denying past ARF history. Therefore, early identification of the subclinical valvular insult and the use of benzathine penicillin prophylaxis constitute a mainstay for disease control (2). Fortunately, The emergence of echocardiography (echo) and the availability of portable and handheld echo (HHE) machines that had proven high sensitivity, resulted in a significant increase in the RHD detection rates with a potential for treatment of the early stage of the disease. (3)(4).

In 2012, the Sudan witnessed launching of an RHD prevention and control program in collaboration with the Federal Ministry of health and Sudan Heart Society. The program goals included early detection of RHD through HHE screening programs, raising public awareness and training health workers (5). Screening programs were initiated in Khartoum, South Darfur, Gazira, and North Kordofan with highest prevalence (60/1000) being detected in the later state. (6)(7)(8). Kordofan States (North, South, and West) were found to have a high burden of severe disease as reported from a hospital-based registry in Khartoum (9). In all these studies, pediatric cardiology residents and fellows were the task force who performed the screening for RHD using HHE machines.

This study is a continuum of the Sudan echo screening project in an area claimed to have a high disease burden and has not been previously screened. In addition, the study aims to investigate the efficacy of involving trained medical students and fresh medical graduates in RHD screening using HHE machines.

Methods

A cross-sectional facility-based study was conducted as part of a medical convoy organized by Khartoum Medical Students Association (KMSA) targeting rural south Kordofan villages. 20 villages were chosen based on health needs, population size and accessibility. In each village a package of free health services was delivered in a setting of integrous medical day setting. Each medical day also included health education programs and events that attracted large numbers of each village's population. The screening accompanied the medical day setting in five villages.

Medical day attendees within the age group of 10-25 years were screened for RHD using 4 HHE machines (V scan- General Electric) (Figure 1). The device has one probe with 1.7-3.4-megahertz frequency, storage capacity, and 2.5 hours lasting battery. Five medical students and two newly graduated doctors were trained for two weeks on HHE machines under the supervision of a senior pediatric cardiologist using a training package that includes lectures, live images, practical training, and a course evaluation test. A simplified "one view" protocol of the parasternal long axis was utilized(10). Four images were recorded, two with and two without color Doppler.

The recorded studies were reviewed later by the senior pediatric cardiologist and the definite diagnosis of RHD was based on the modified World Heart Federation criteria which include morphologic and Doppler criteria of the mitral and aortic valves(11).

Full contact information was obtained for positive cases. In addition, demographic and clinical data were collected for all the studied subjects using interviewed structured questionnaire.

Statistical analysis:

Data analysis was performed using the Statistical Package for Services and Solutions (SPSS 25). Data were summarized as “number (%)” or “mean $\pm$ SD”. Frequency of RHD was calculated and expressed as proportion per 1,000 individuals. Chi-Square test/Fisher’s Exact test and T test were used to detect the association between different factors and having RHD. Statistical significance was set at a p-Value of < 0.05 .

Results

Subjects’ characteristics:

A total of 452 eligible subjects were screened. Females represented 56.9% (n=257) of the study participants. The majority of the participants were enrolled to primary (69.7%, n=315) and secondary (22.1%, n=100) schools, while 7.1% (n=32) received no education. Other demographic and clinical characteristics are summarized in Table 1.

Table 1
Important Demographic and Clinical Features of RHD and Non- RHD Subjects.

Variable	RHD		p-Value
	positive	negative	
Gender; n (%)			.830
Male	9 (39.1%)	186 (43.4%)	
Female	14 (60.9%)	243 (56.6%)	
Father's occupation; n (%)			.013
Number of residents per house; mean $\pm$ SD	8.4 $\pm$ 2.3	7.8 $\pm$ 3.3	.084
Number of rooms per house; mean $\pm$ SD	2.6 $\pm$ 1.1	2.9 $\pm$ 1.4	.321
Village of residence; n (%)			.033
Alkewaik	4 (17.4%)	81 (18.9%)	
Al-Dashoul	2 (8.7%)	74 (17.2%)	
Tessie Abd-alsalam	7 (30.4%)	76 (17.7%)	
Al-Ehaimer	0 (00%)	79 (18.4%)	
Kileemo	10 (34.5%)	119 (27.7%)	
History of sore throat; n (%)	18 (78.3%)	201 (46.9%)	.004
Lower limb swelling; n (%)	5 (21.7%)	28 (6.5%)	.020
<i>Quantitative data were obtained from HHE scans for 452 subjects in South Kordofan rural villages in the year 2021.</i>			

Echo screening:

Of the reviewed echo records, 93% were classified by the pediatric cardiologist as of acceptable quality. RHD frequency was found to be 50 per 1000 (n=23/452). Of these, 21 had definite and two had borderline RHD. Moderate lesions were detected in three (15%) patients. Table 2 summarizes the valvular lesions identified in definite RHD cases. Figure 2 shows samples of the valvular lesions recorded.

Table 2
Types and Severity of valvular lesions in
definite RHD cases.

Type	n (%)
Mild MR	14 (66%)
Mild MR and Mild AR	3 (14%)
Mild AR	1 (5%)
Moderate MR	1 (5%)
Moderate AR	1 (5%)
Moderate MR and Moderate AR	1 (5%)

Quantitative data were obtained from HHE scans for 452 subjects in South Kordofan rural villages in the year 2021. MR: Mitral regurgitation, AR: Aortic regurgitation.

Factors associated with RHD:

As shown in Table 1, RHD status was significantly associated with father's occupation and the village of residence. In addition, past history of sore throat, and lower limb swelling were also significantly associated. Despite the absence of significant association, it is worth noting the high female to male ratio (1.5:1) in the detected RHD cases.

Case Management:

After the review of echo studies, all confirmed cases of RHD were contacted and referred to cardiology units in North Kordofan and Khartoum states for further investigations and management.

Discussion

This study aimed to map rural areas of South Kordofan for RHD using HHE which is known to have excellent sensitivity in detecting subclinical carditis(12). Medical students are an important sector of the health workforce who have a good potential to participate in delivering health care. Task shifting in echo screening of RHD had been tested before in many countries and proved to be effective in endemic areas (13)(14). Nurse training for 8 weeks has yielded a sensitivity of 84.2% and a specificity of 85.6% for detection of RHD in Fiji (15). In the current study, students and newly graduate doctors were trained in HHE for one week using a simple methodology and they managed to get good quality echo views in 93% of the recorded echo studies. A similar approach with a longer training period can be applied to students as well as other health workers such as nurses and medical assistants. A policy that can potentially be implemented by the Ministry of Health to widen the area of effective RHD surveillance and management.

The frequency of RHD in South Kordofan of 50/1000 is high as compared with Khartoum (0.03/1000), South Darfur (19/1000) and Gezira (2.3/1000) (6)(7). However, a comparably high frequency had been

detected in North Kordofan (60/1000) and this confirms that this area is highly endemic for RHD (8). Moreover, a third of RHD patients had moderate or combined (2 valves) lesions denoting a well-established disease. These findings indicate that the hidden burden of RHD is huge and efforts to implement an extended program for screening and early treatment of RHD is highly needed in Kordofan. This study, therefore, adds to the previous screening projects' findings those support adopting a screen- to – treat policy that had been endorsed by the Ministry of Health.

In this study, RHD affected more females than males, findings similar to the literature (1). The fact that RHD is a disease of childbearing age emphasizes the burden on pregnant women where it can be a major contributor to maternal mortality. In South Africa, a systematic review found that RHD accounted for about 80% of antenatal heart disease (16). Pregnant women with RHD as well as their fetuses and newborns have major complications including perinatal mortality and fetal loss especially for those with severe disease (17). Unfortunately, RHD can be silent and unmasked only at the time of the increased cardiac demands of pregnancy and labor. Therefore, echo screening can have an important role in early detection and treatment of pregnant women at high risk for RHD. Such programs had been implemented and revealed a large burden of undiagnosed RHD (18).

Many patients with RHD in this study reported no history of relevant symptoms a fact that makes a major hurdle for implementation of primary and secondary prevention policies. Although not fully understood, it is thought to be partly due to health illiteracy including poor health seeking behavior as well as the low socioeconomic status and deficiency of the local healthcare settings. This could be well explained by the location of this area which has been a subject for war and displacement in the past years. These challenges could be overcome by improving public awareness as well as strengthening primary health care systems.

The study was limited by the small number of screened subjects due to technical and electricity shortcomings, in addition to the limited time given for data collectors by the military forces to ensure their safety.

Conclusion

A team of medical students and young doctors managed to screen for RHD using HHE in South Kordofan state and found a high frequency of established disease. These results need to be endorsed to the local and federal health administrators in order to implement control programs in this area.

Abbreviations

RHD

Rheumatic Heart Disease.

ARF

Acute Rheumatic Fever.

Echo
Echocardiography.
HHE
Hand-Held Echo.
KMSA
Khartoum Medical Students Association.
SPSS
Statistical Package for Services and Solutions.
MR
Mitral regurgitation.
AR
Aortic regurgitation.

Declarations

Ethics approval and consent to participate:

The study was approved by the Ethics Research Committee of the University of Khartoum - Faculty of Medicine as part of the Sudan Echo Screening Program. The study was carried out in accordance with the declaration of Helsinki. Administrative approval from South Kordofan State Ministry of Health was obtained. Informed consent for study participation was obtained from all subjects (if subjects are under 16, consent was taken from a parent or legal guardian).

Since written consent was hard to obtain due to illiteracy of the majority of the population, informed verbal consent was taken after explaining the research objectives and all relevant details, as this method was approved by the Ethics Research Committee of the University of Khartoum - Faculty of Medicine. Moreover, personal information obtained from patients was anonymized for confidentiality purposes.

Consent for publication:

Consent for publication was obtained from the research author appearing in figure 1. In addition, informed verbal consent for publication was taken from the guardian of the child appearing in the same figure.

Availability of data and materials:

All data generated or analyzed during this study are included in this published article as a supplementary file.

Competing interests:

The authors declare that they have no competing interests.

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The study received no funding.

Authors' contribution:

All the listed authors contributed equally to this research work, hence are all first authors and ordered alphabetically.

AME participated in conception of the idea, preparing the proposal, drafting the manuscript, and approving it for submission. AMA participated in conception of the idea, approving the proposal, data collection, reading and approving the manuscript for submission. AAA participated in conception of the idea, approving the proposal, data collection, reading and approving the manuscript for submission. EAH participated in conception of the idea, approving the proposal, data analysis, revising and editing the manuscript, and approving it for submission. HAA participated in conception of the idea, approving the proposal, data collection, data analysis, reading and approving the manuscript for submission. HAAA participated in conception of the idea, preparing the proposal, data analysis, drafting the manuscript, and approving it for submission. IMIA participated in conception of the idea, approving the proposal, data analysis, revising and editing the manuscript, and approving it for submission. MYA participated in conception of the idea, preparing the proposal, drafting the manuscript, and approving it for submission. MAA participated in conception of the idea, approving the proposal, data collection, reading and approving the manuscript for submission. MMS participated in conception of the idea, approving the proposal, data analysis, revising and editing the manuscript, and approving it for submission. RSA participated in conception of the idea, preparing the proposal, data analysis, drafting the manuscript, and approving the manuscript for submission. SSA participated in conception of the idea, approving the proposal, data collection, reading and approving the manuscript for submission. SMM participated in conception of the idea, approving the proposal, data collection, reading and approving the manuscript for submission. SKM participated in conception of the idea, approving the proposal, training the data collectors, drafting the manuscript, reading and approving the manuscript for submission. WE participated in conception of the idea, preparing the proposal, drafting the manuscript, and approving it for submission.

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Figures

Figure 1

Medical student performing HHE in an open area.

[A]

[B]

Figure 2

Handheld echo parasternal long axis view. A: Shows two Jets of aortic regurgitation (arrow) due to RHD; B: Shows a large jet of mitral regurgitation (arrow).

Supplementary Files

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