

The clinical utility of echocardiography as a cardiological diagnostic tool in poor resource settings

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Abstract

Background: There has been a decline in the auscultatory and other clinical skills of physicians especially in developed countries. The advent of echocardiography has revolutionized the diagnosis of cardiovascular diseases and made up for the decline in clinical skills.

Objective: To assess the sensitivity and specificity of auscultatory and clinical skills in the diagnosis of cardiovascular diseases using echocardiography as the gold standard.

Materials and Methods: All the adult echocardiographic studies (321) performed over a 1-year period were collated for analysis. The clinical indications of the studies were compared with the final diagnoses by echocardiography. The sensitivity and specificity of the clinical diagnosis of hypertensive heart disease (HHD), rheumatic heart disease (RHD), and the cardiomyopathies were determined.

Results: Of the 244 (76.0%) clinically diagnosed as HHD, 188 (58.6%) were confirmed by echocardiography. For RHD 9 (2.8%) were diagnosed clinically while on echocardiography, 13 (4.1%) were diagnosed. All the 31 (9.7%) cases of dilated cardiomyopathy were confirmed on echocardiography. No case of ischemic heart disease was confirmed. Seventy-one (22.0%) had normal studies. The sensitivity of clinical diagnosis for RHD was low (41.7%) while for HHD and dilated cardiomyopathy, sensitivity was high, 95.7% and 75.0%, respectively. Specificity was high for all three cardiovascular diseases analyzed.

Conclusion: Auscultatory and clinical skills are still sensitive and specific tools in the diagnosis of cardiovascular diseases in developing countries and should be sustained. However, echocardiography is indispensable in the diagnosis of cases with subtle clinical signs and should be made more available and affordable.

Key words: Cardiovascular diseases, clinical diagnosis, echocardiography

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Introduction

Traditionally a comprehensive history and thorough physical examination have been the mainstay of diagnosis and management of cardiovascular disease but technological advancement in the recent past has provided additional methods to optimize patient care.^[1] This is based on the awareness that physical signs are not

always specific or sensitive. One of these technological tools is echocardiography, an important and relatively cheap noninvasive investigative tool in cardiology. The morphological and hemodynamic parameters it provides usually guides management of patients.^[2]

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While the sensitivity and specificity of clinical examination varies depending on the cardiovascular disease being evaluated, echocardiography is thought to have a high degree of sensitivity and specificity when performed by trained personnel. It is generally assumed that to perform echocardiography, an examiner must be trained and certified, however, for less complex cases it may not be necessary to go to these extremes.^[3] Intraoperator variability has been documented to be low in a study conducted in a center in Nigeria^[4] suggesting it is a reliable cardiac investigative tool. The study is about the only one in Nigerian literature that directly assessed the reliability of echocardiography as a cardiological investigative tool in a poor resource setting.

This study was therefore aimed at assessing the utility of echocardiography in the assessment of the sensitivity and specificity of clinical diagnosis of common cardiovascular diseases in the tropical milieu.

Materials and Methods

All the adult echocardiographic studies done at the University of Calabar Teaching Hospital (UCTH), Calabar between April 2010 and May 2011 were collated and analyzed. Studies were performed by consultants and senior registrars in the cardiology units using ALOKA SSD 4000 [Manufacturer - ALOKA Co. Ltd, Tokyo, Japan] with a 3.5 MHz transducer. All subjects had transthoracic 2-dimensional, M-mode, pulsed wave and continuous wave Doppler echocardiography using standard views and measurements done according to the recommendations of American Society of Echocardiography (ASE) using the leading edge to leading edge convention.^[5]

Statistical analysis

Analysis was done using STRATA version 10, STATA Corp. Texas, USA.

Descriptive statistics of the socio-demographic characteristics of patients were done and the clinical and echocardiographic diagnoses of patients were reported as proportions and percentages.

The student's *t*-test was used to compare the ages of patients by gender.

The sensitivity, specificity, and predictive values of clinical criteria were calculated using echocardiography as gold standard and receiver operating characteristics (ROC) curves were drawn.

The level of statistical significance was fixed at $P < 0.05$.

Results

A total of 321 subjects were recruited, 156 (48.6%)

males and 165 (51.4%) females. Mean age for males was 46.7 ± 18.8 years whereas for females was 46.1 ± 18.5 years. The age difference by gender was not statistically significant ($P = 0.79$)

Figure 1 shows the indication for echocardiography. Echocardiography was requested for the confirmation of the following clinical diagnoses: Hypertensive heart disease (HHD) 244 (76.0%), dilated cardiomyopathy 31 (9.7%), rheumatic heart disease (RHD) 9 (2.8%), endomyocardial fibrosis (EMF) 3 (0.9%), congenital heart disease (CHD) 7 (2.2%), ischemic heart disease (IHD) 7 (2.2%), and others including cor pulmonale and arrhythmias 20 (6.2%).

Diagnoses at echocardiography are shown in Figure 2. At echocardiography, 188 (58.6%) were diagnosed as having HHD, 13 (4.1%) as RHD, 31 (9.7%) as dilated cardiomyopathy, 2 (0.6%) as EMF, 7 (2.2%) as CHD, and a large proportion 71 (22%) had normal studies. No case of IHD was confirmed on echocardiography as wall motion abnormalities suggestive of the condition were not detected.

Using Echocardiography as the gold standard, the sensitivity and specificity of clinical diagnosis in respect of HHD, RHD, and cardiomyopathies were assessed [Table 1].

For HHD, the sensitivity was 95.7% and specificity 53.4%. Positive predictive value (PPV) was 74.4% whereas the negative predictive value (NPV) was 89.9%, the ROC curve indicated an area under the ROC curve [AUC] of 0.7456 [Figure 3].

The sensitivity and specificity were 41.7% and 99.7% respectively for RHD. PPV was 83.3% while the NPV was 97.8%. The ROC curve indicated an AUC of 0.7067 [Figure 4].

In the case of the cardiomyopathies (dilated cardiomyopathy and EMF) shown in Figure 5, the sensitivity was 75.0% and specificity 97.6%. The PPV was 77.4% and NPV was 97.2%. The ROC curve indicated an AUC of 0.7067.

Discussion

The most common clinical indication for echocardiography in this study was HHD accounting for 76.0% of cases. This finding is similar to that reported in other studies in Nigeria. In these studies, which were done in various parts of the country, frequencies ranging from 32.7% to 61.4% were reported.^[2-4,6-10] This confirms hypertension as the most prevalent cardiovascular risk factor in Nigeria.

In contrast, Ike^[11] working in Enugu documented valvular heart disease as the most common indication for echocardiography in his series. The author attributed this

Table 1: Sensitivity, specificity, and predictive values of clinical diagnosis

| Clinical diagnosis | Sensitivity (%) | Specificity (%) | Positive predictive value (PPV) (%) | Negative predictive value (NPV) (%) |
|----------------------------|-----------------|-----------------|-------------------------------------|-------------------------------------|
| Hypertensive heart disease | 95.7 | 53.4 | 74.4 | 89.9 |
| Rheumatic heart disease | 41.7 | 99.7 | 83.3 | 97.8 |
| Cardiomyopathies | 75.0 | 97.6 | 77.4 | 97.2 |

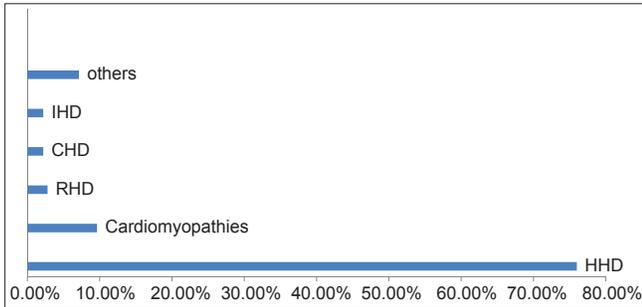


Figure 1: Clinical indications for echocardiography

HHD = Hypertensive heart disease; RHD = Rheumatic heart disease; CHD = Congenital heart disease; IHD = Ischemic heart disease

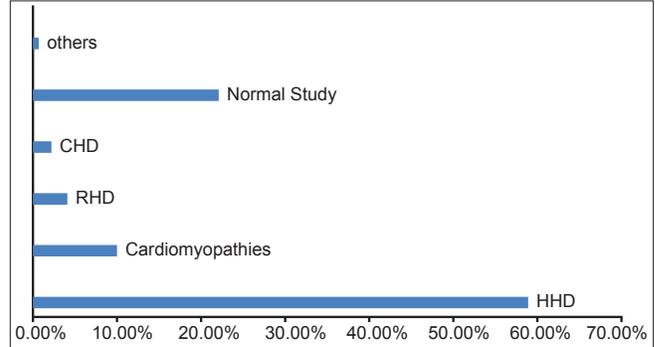


Figure 2: Echocardiographic diagnoses

HHD = Hypertensive heart disease; RHD = Rheumatic heart disease; CHD = Congenital heart disease; IHD = Ischemic heart disease

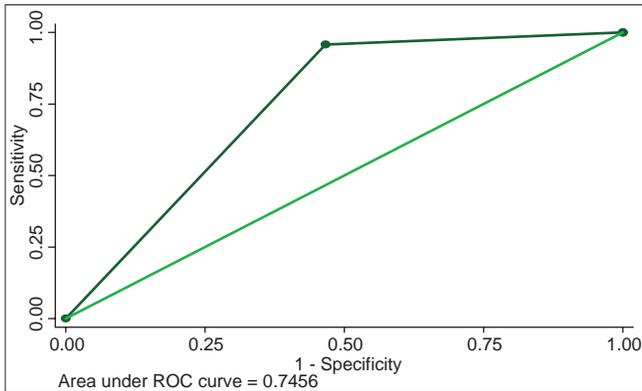


Figure 3: Receiver operating characteristic (ROC) curve for hypertensive heart disease

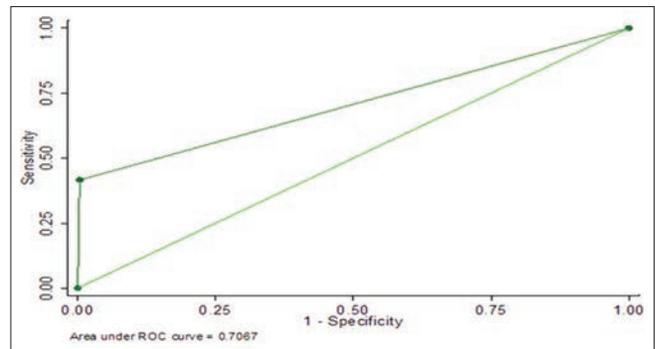


Figure 4: Receiver operating characteristic (ROC) curve for rheumatic heart disease

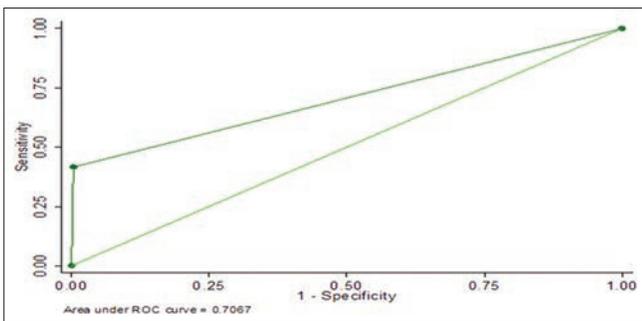


Figure 5: Receiver operating characteristic (ROC) curve for cardiomyopathies

finding to the fact that the center was a National referral hospital for cardiovascular surgery and therefore attracts more of these patients with structural heart disease who are referred for surgery.

In this study, the frequency of IHD was low as reflected by the few requests for echocardiography for this indication.

This corroborates findings from other studies where few cases were also reported.^[4,6-10] The incidence of IHD in Nigeria is thought to be low but rising. This trend has been highlighted by studies done across the country.^[12-15] However, with the epidemiological transition currently taking place in the developing countries, the number of cases is expected to increase especially if adequate preventive measures are not put in place. It is therefore expected that more requests may be made in the near future for this indication.

The sensitivity of clinical diagnosis in the detection of HHD was moderate as evidenced by the fact that most of the clinically diagnosed cases in this study were confirmed on echocardiography. This indicates that echocardiography may be particularly necessary in the detection of cases without clear physical signs and in the objective assessment left ventricular function. The high specificity indicates the ease of clinical diagnosis when signs are florid. Kolo et al.^[8] in their study also reported the confirmation by

echocardiography of the majority of the clinically diagnosed cases of HHD.

In contrast, the sensitivity of clinical examination for RHD was particular low and corroborated the findings by Kolo *et al.*^[8] and Reddy *et al.*^[16] Specificity was, however, high. More cases were detected at echocardiography in this study for which the indication for the study was initially different. This finding confirms the fact that clinical detection and evaluation of murmurs, which is the most important clinical sign in RHD, may be difficult especially for the non-cardiologist. Most of referrals for echocardiography are done by non-cardiologists. Many murmurs may be missed owing to many factors, which include tachycardia, noisy environment, low intensity of the murmur, and most importantly, an untrained ear. Echocardiography is thus indispensable in confirming cases of RHD and detecting subclinical cases since most may be missed or misdiagnosed by clinical examination alone. A study by Marijon *et al.*^[17] had presented a compelling argument for the use of echocardiography as a screening tool for RHD. Their results showed that if clinical diagnosis had been relied on, approximately 90% of the cases detected by echocardiography in their series would have been missed.

For the cardiomyopathies, in this case, dilated cardiomyopathy and EMF, the sensitivity and specificity of clinical diagnosis was high. Almost all the cases diagnosed clinically were confirmed by echocardiography. This can be attributed to the fact that at presentation, most cases tend to have florid clinical signs. Late presentation is almost the norm in the tropical milieu.

Overall, for these three cardiovascular diseases prevalent in the tropics, using echocardiography as a confirmatory tool, clinical diagnostic criteria were found to have high PPV and high NPV.

A significant number of subjects had normal studies in this study. This has also been reported by other workers in Nigeria and elsewhere.^[6-10] Common reasons advanced are the fact that these referrals are done by all cadres of doctors with little knowledge of cardiology and often the patients are also poorly screened for cardiovascular disease before referrals are made.^[10] Competent cardiac auscultation is clearly in decline the world over.^[18] A study of internal medicine residents in the United States, Canada, and United Kingdom showed that correct assessment on auscultation was made in only 22%, 26%, and 20% of patients, respectively.^[19] This clearly highlights that this decline in auscultatory skills is an international problem. Clinical examination skills should be improved especially in the developing countries where other diagnostic tools are expensive and not readily available.

While clinical examination remains a veritable tool in the developing countries for the diagnosis of cardiovascular disease, it is advocated that echocardiography should be made more available at least in secondary and tertiary health care facilities at affordable rates to be used in the verification of clinical diagnosis especially when signs are subtle and may be easily missed.

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