



The value of portable ultrasound for evaluation of cardiomegaly patients presenting at the emergency department[☆]

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Abstract

Objectives: The purpose of this study was to evaluate the value of a hand-carried portable ultrasound device in the emergency department for patients with cardiomegaly and evaluate its impact on diagnosis and treatment. We compared the results of the portable ultrasound with the results of physical examination and with standard echocardiograph (SE) in the cardiomegaly patients in emergency department.

Background: Recently, small portable ultrasound devices have been introduced, and they need more extensive study to evaluate their application.

Methods: We used the OptiGoTM (Agilent Technologies, Andover, MA) portable device to evaluate emergency patients, and compared it with two SE devices available for this study, the Hewlett Packard (Sono 5500; Andover, MA) or the Vingmed (System V; Horten, Norway). Each of 100 patients was studied by physical examination first then examined with the portable ultrasound and standard echocardiography. The yields from physical examination and portable echocardiography were compared and results of the standard and portable were also compared. **Results:** There were a total of 243 cardiovascular findings detected by the standard echocardiographic examination in the 100 patients studied. Cardiac examination failed to detect 40% of the overall findings but the portable device missed only 17% of all findings. The portable device evaluated 201 conditions correctly (83%) and missed relevant clinical findings in 37 (17%) as compared to standard echocardiography, but in only 12 (5%) were these findings of major importance. As an overall measure of diagnostic value, the portable device would have added to clinical judgment, thus boosting diagnostic accuracy from 62% to 83%.

Conclusions: Portable ultrasound technology can provide rapid, readily available and important clinical information for emergency physicians in the management of emergency patients with cardiomegaly.

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1. Introduction

Although cardiovascular physical examination is crucial in the evaluation of patients with suspected heart disease, declining cardiac auscultatory skills and the wide availability of cardiac ultrasound has led physicians to rely on echocardiography to diagnose a variety of cardiovascular conditions [1].

Studies assessing physical examination abilities have shown significant error and omission rates for physicians at all levels of training [2]. However, in the cardiovascular emergency, performance of a standard echocardiography (SE) is inconvenient for the equipment is large and unwieldy. Recently, hand-carried portable echocardiography devices have been introduced [3]. They can be kept to be available for bedside use to improve the availability and timeliness of ultrasound diagnosis in the cardiac emergency patient.

Our study was designed to compare the diagnostic ability of a portable device compared to physical examination and a SE machine when used in emergency patients.

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1.1. Methods

1.1.1. Patients

One hundred consecutive patients with radiographic cardiomegaly (57 men, range 40–95 years) visiting the emergency department (ED) of the National Taiwan University Hospital were enrolled in the study (Table 1). Radiographic cardiomegaly is defined as an increased cardiothoracic ratio over 50% [2].

1.1.2. Study design

All patients had a baseline chest X-ray and received a cardiovascular physical examination by a physician in the emergency department. The examination protocol were performed according to each physician's usual practice and their findings were recorded immediately afterwards. The initial assessment included a complete history, review of pertinent available medical records, laboratory tests and electrocardiogram. Transthoracic echocardiography using a portable device was subsequently performed by one of two emergency physicians who had received full cardiology training. All subjects also had a complete standard echocardiographic study within 1 h, which serve as a standard for comparison. Cardiovascular findings were recorded and divided into major and minor diagnoses depending on their clinical importance. Major findings were considered those that would result in altering the patient's prognosis, require emergency operation, cardiac intervention or indicate the need for endocarditis prophylaxis. Specifically, that included moderate or severe valvular regurgitation or stenosis, moderate or severe ventricular dysfunction, regional wall motion abnormality, hypertrophic cardiomyopathy, pulmonary hypertension, mitral valve prolapse or cardiac tamponade. No special manoeuvres or agents were used to enhance the ability to detect abnormalities. An emergency cardiologist not involved in the patient evaluation interpreted the results.

Table 1
Baseline characteristics of studied patients ($N=100$)

| Characteristic | (%) |
|--------------------------|-----------|
| Age (year) | 67 ± 26.7 |
| Men | 57 |
| Medical history | |
| Hypertension | 89 |
| COPD | 17 |
| Diabetes mellitus | 43 |
| Stable angina | 13 |
| Prior CABG | 7 |
| Prior CHF | 56 |
| Chronic medications | |
| ACE inhibitors | 36 |
| β-Blockers | 25 |
| Calcium channel blockers | 17 |
| Diuretics | 34 |
| Antiarrhythmics | 6 |
| Digoxin | 26 |

1.1.3. The ultrasound stethoscopes

The OptiGo™ (Agilent Technologies, Andover, MA) portable device consists of a base unit (33 cm × 23 cm × 9 cm), phased array 2.5 MHz transducer, battery weighing 3.3 kg. The two-dimensional control settings are comparable to a SE device and a caliper is integrated for linear measurements. Color Doppler echocardiographic images are provided. Images can be frozen and scrolled for review or stored in a removable CompactFlash card. The OptiGo™ can be connected to a personal computer or a printer.

Two SE devices were available for this study, Hewlett Packard (Sono 5500; Andover, MA) or Vingmed (System V; Horten, Norway).

1.1.4. Statistical analysis

The results from physical examination and portable echocardiography were compared with a Kappa chi-square test. The results of the SE and portable studies were compared for each patient to determine the ability of portable device to answer clinical questions.

Linear regression was performed to find the agreement between SE and the portable device for measurement of the left ventricular end-diastolic dimension (LVEDd). A P -value of <0.05 was considered significant.

2. Results

There was a total of 243 cardiovascular findings detected by standard echocardiographic examination in the 100 patients studied. These included left ventricular dysfunction in 92 patients (92%), valve dysfunction in 67 patients (67%), pericardial effusion or tamponade in 10 patients (10%), possible thrombus in 7 patients (7%), possible endocarditis in 13 patients (13%). Of these 243 findings, 206 were considered to be of major clinical importance. Representative images are shown in Fig. 1.

Physical examination failed to detect 40% of the overall findings and the portable device missed only 17% of all findings without any difference among the three cardiologists. This 60% reduction in missed cardiovascular abnormalities was statistically significant. The portable device was superior to physical examination for the identification of significant ventricular systolic dysfunction and the systolic murmurs. Aortic regurgitation, mitral regurgitation, tricuspid regurgitation and regional wall motion abnormality were correctly detected more often with the portable device compared with physical examination (Table 1).

Of the 243 SE findings the portable device correctly evaluated 201 (83%) and missed relevant clinical findings in 37 (17%) compared with SE, but only 12 (5%) of these were the major findings. The missed clinical findings included pulmonary hypertension (6), LV function (3) and moderate mitral regurgitation (3). The portable device was able to evaluate 88 of 100 patients with cardiomegaly or heart failure (Table 2). The unanswered questions included one case of

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