Brief Group Training of Medical Students in Focused Cardiac Ultrasound May Improve Diagnostic Accuracy of Physical Examination

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Background: Physical examination and auscultation can be challenging for medical students. The aim of this study was to investigate whether a brief session of group training in focused cardiac ultrasound (FCU) with a pocket-sized device would allow medical students to improve their ability to detect clinically relevant cardiac lesions at the bedside.

Methods: Twenty-one medical students in their clinical curriculum completed 4 hours of FCU training in groups. The students examined patients referred for echocardiography with emphasis on auscultation, followed by FCU. Findings from physical examination and FCU were compared with those from standard echocardiography performed and analyzed by cardiologists.

Results: In total, 72 patients were included in the study, and 110 examinations were performed. With a stethoscope, sensitivity to detect clinically relevant (moderate or greater) valvular disease was 29% for mitral regurgitation, 33% for aortic regurgitation, and 67% for aortic stenosis. FCU improved sensitivity to detect mitral regurgitation (69%, $P < .001$). However, sensitivity to detect aortic regurgitation (43%) and aortic stenosis (70%) did not improve significantly. Specificity was ≥89% for all valvular diagnoses by both methods. For nonvalvular diagnoses, FCU's sensitivity to detect moderate or greater left ventricular dysfunction (90%) was excellent, detection of right ventricular dysfunction (79%) was good, while detection of dilated left atrium (53%), dilated right atrium (49%), pericardial effusion (40%), and dilated aortic root (25%) was less accurate. Specificity varied from 57% to 94%.

Conclusions: After brief group training in FCU, medical students could detect mitral regurgitation significantly better compared with physical examination, whereas detection of aortic regurgitation and aortic stenosis did not improve. Left ventricular dysfunction was detected with high sensitivity. More extensive training is advised. (J Am Soc Echocardiogr 2014;27:1238-46.)

Keywords: Focused cardiac ultrasound, Pocket sized, Physical examination, Diagnostic accuracy, Medical students

Although patient history and physical examination, including auscultation, remain the basis of the initial assessment of a cardiac patient, the limited diagnostic accuracy of the stethoscope is well known.[1]

In recent decades, the emerging field of portable ultrasound has challenged the use of the stethoscope. The recent arrival of pocket-sized devices facilitates true bedside routine use and has created a new paradigm for the use of ultrasound. The concept of focused cardiac ultrasound (FCU) has been introduced. Despite their small size and limited features, pocket-sized scanners have proven diagnostic value when used as an adjunct to physical examination by experienced echocardiographers.[2-8] Low cost and simplified operation have opened their potential use to nontraditional cardiac ultrasound users, and a growing body of evidence suggests that inexperienced operators also improve bedside diagnosis with such scanners.[9-17] However, the amount of training required to reach a given and standardized level of accomplishment is still a matter of debate. The prospect of educating and training all physicians represents an enormous challenge, and the demand for cost-effective training programs may gain in importance.

Few studies have thus far evaluated the use of the pocket-sized FCU devices in a large group of medical students. Our aim with the present study was to investigate whether a brief, group-based FCU

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The study was supported by Centre for Cardiological Innovation, funded by the Research Council of Norway. T.M.S. received a grant from the Medical Student Research Program at the Faculty of Medicine, University of Oslo.

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0894-7317/$36.00

http://dx.doi.org/10.1016/j.echo.2014.08.001

Abbreviations
AR = Aortic regurgitation
AS = Aortic stenosis
FCU = Focused cardiac ultrasound
LV = Left ventricular
MR = Mitral regurgitation

training course would allow medical students to improve their ability to detect clinically relevant cardiac lesions at the bedside.

METHODS

Study Population

In this prospective study, 21 medical students from the University of Oslo, all in their second half of medical school and without prior echocardiographic experience, were randomly recruited from 104 applicants to complete a standardized 4-hour FCU training program. A total of 72 elective patients already referred for routine echocardiographic examinations were included in the study, which was conducted in the Department of Cardiology, Oslo University Hospital, Rikshospitalet (Oslo, Norway), between February and May 2012. All patients who were available during the days of inclusion were asked to participate. Exclusion criteria included practical and medical considerations, such as lack of consent, shortage of time between scheduled procedures, and postprocedural or hemodynamically unstable patients. Written informed consent was obtained from all participants, including patients and students. The study was approved by the Regional Committee for Medical Research Ethics and conducted according to the second Declaration of Helsinki.

Echocardiographic Training

Before attending the training course, the students were encouraged to study a selection of echocardiographic loops provided online, demonstrating normal cardiac anatomy and common pathologies. The precourse material also featured a compendium describing the cardiac views in ultrasound and instructions on how to position the transducer to obtain the different views. The course for six trainees at a time (pilot group of three) consisted of a 45-minute introduction to cardiac ultrasound with a review of the same echocardiographic loops that were provided online. The loops demonstrated (which were recorded with an FCU device) are summarized in Table 1 and included both normal cardiac anatomy and common pathologies. In addition, the FCU examination protocol was demonstrated in practice, with emphasis on scanning technique to obtain the cardiac views and the evaluation criteria for each parameter (Table 2). After the initial session, the students were given 60 minutes to practice on one another, to familiarize themselves with the device and to practice obtaining all images according to the protocol. Each student examined two other students. Furthermore, the students had 75 minutes of practice on patients in the cardiology ward. These patients were selected for cardiac pathology. Two students examined each patient together, and each student pair examined two different patients. This was followed by 60 minutes of case reviews, in which the recorded images from the ward patients were discussed and compared with a standard echocardiogram. The students thus were challenged in image interpretation. Training in electrocardiographic interpretation and auscultation was not involved, as these skills had been taught in the clinical curriculum.

Study Protocol

The students were blinded to medical and drug history, prior echocardiograms, and other interventions. They completed a sequential assessment of each patient, consisting of a brief medical history, a physical examination, and finally an FCU examination. History was limited to exploring the presenting symptoms and New York Heart Association class. Physical examination included inspection (detection of peripheral pitting edema and jugular venous distension), cardiac and lung auscultation, and interpretation of the provided electrocardiogram. Cardiac murmurs were reported in terms of location (parasternal or apical), intensity (I–VI), and timing (systolic or diastolic). Furthermore, the students were asked to suggest if their auscultatory findings represented mitral regurgitation (MR), aortic regurgitation (AR), or aortic stenosis (AS) and to classify the lesion as either mild, moderate, or severe. The cardiac landmarks assessed by FCU are shown in Table 2. The report sheets for physical examination are in Appendix 1 and 2 (available at www.onlinejase.com) and FCU examination in Appendix 3 (available at www.onlinejase.com). Findings from the students' examinations were compared with a standard echocardiogram as the reference method.

Echocardiographic Equipment and Methods

The FCU examination was performed with the Vscan (GE Vingmed Ultrasound AS, Horten, Norway). The device is handheld, fits in the pocket, and consists of a display unit (135 × 73 × 28 mm) and a broad-bandwidth phased-array probe (120 × 33 × 26 mm; frequency, 1.7–3.8 MHz). Other specifications include a 3.5-inch flip-up display (resolution, 240 × 320 pixels), a total weight of 390 g, and approximately 60 minutes of scanning time. The scanner provides grayscale two-dimensional imaging and color Doppler imaging, automatic gain adjustment, and automatic detection of a full heart cycle for storage without the need for electrocardiography. Basic measurements can be performed using the provided caliper tool.

Standard echocardiography was performed in the hospital's echocardiography laboratory by experienced cardiologists, with the high-end Vivid E9 or Vivid 7 scanner (GE Vingmed Ultrasound AS). The investigators were blinded to the result of the FCU examinations. Data were digitally stored for offline analysis using dedicated software (EchoPAC; GE Vingmed Ultrasound AS). The evaluation criteria for the two echocardiographic methods are shown in Table 2.

Data Analysis

As suggested by the Standards for Reporting of Diagnostic Accuracy statement, diagnostic accuracy was calculated in terms of sensitivity, specificity, positive and negative predictive value, and κ values.[18]

A cardiac lesion was defined as clinically relevant when it was moderate or greater in severity, which routinely leads to an additional evaluation by standard echocardiography. In addition to presenting accuracy data with the cutoff for clinically relevant lesions at moderate or greater, results from valvular diagnoses are also presented with the cutoff at mild or greater pathology to show the total number of detected lesions.

To compare accuracy among the students, we developed a diagnostic scoring system modified from Decara *et al.*[11] and Panoulas *et al.*[17] For each true-positive finding of a significant cardiac lesion, two points were given. For each true-positive finding of a mild lesion, one point was given. For each true-negative or normal finding, 0.5 points were given. For each false-negative finding, zero points were given. For each false-positive finding, 0.5 points were deducted. In cases of underestimation of a lesion (student reports mild when truly moderate or severe), 0.5 points were still given. In cases of overestimation (student reports moderate or severe when truly mild), 0.5 points were still given. To calculate the diagnostic score, the total score obtained by the student was divided by the maximum score possible.