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ORIGINAL ARTICLE

Clinical utility and diagnostic accuracy of palm-held, mini-sized ultrasonocardiographic scanner in congenital heart disease

Mao-Hung Lo, Chien-Fu Huang, I-Chun Lin, Ying-Jui Lin, Hsuan-Chang Kuo, Kai-Sheng Hsieh*

Department of Pediatrics, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Kaohsiung, Taiwan

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Background/purpose: To investigate whether a palm-held ultrasonocardiographic scanner would be useful for screening and follow-up in congenital heart disease (CHD).
Methods: We retrospectively reviewed the echocardiographic images from June 1, 2014 to November 1, 2014. All patients underwent two ultrasonographic examinations including palm-held scanner examination and standard echocardiography. To compare the quality of the two instruments, we developed a diagnostic scoring system ranging from 1 point to 10 points, with 10 points indicating the best quality. Two experienced echocardiographers retrospectively reviewed all recorded images blindedly and gave each examination a score. Comparisons of diagnostic score between two equipments were performed.
Results: A total of 262 patients' images were reviewed. All cardiac lesions could be detected with both instruments. The mean diagnostic score of palm-held scanner and standard echocardiography were 8.20 ± 0.53 versus 9.64 ± 0.37 ($p < 0.05$) in color image and 7.00 ± 1.05 versus 8.56 ± 1.14 ($p < 0.05$) in gray-scale two-dimensional image, respectively. When we compared the score between the two instruments in individual CHDs, we found standard echocardiography had better quality except for detecting muscular ventricular septal defect and pulmonary regurgitation.
Conclusion: The diagnostic sensitivity of palm-held scanner in detecting CHD was very good. Despite both instruments having a high diagnostic score in detecting CHD, standard echocardiography had better quality. Traditional echocardiography is still the standard tool for CHD

Conflicts of interest: All authors have no conflicts of interest to disclose.

* Corresponding author. Department of Pediatrics, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, 123 Ta Pei Road, Niao Sung, Kaohsiung County 833, Taiwan.
E-mail address: kshsieh@adm.cgmh.org.tw (K.-S. Hsieh).

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evaluation. However, the palm-held scanner can support physical examination for initial screening and follow-up, and offer cardiologists an opportunity to visualize and listen to the heart at any time.

Introduction

Technological advancements in ultrasonography have been employed extensively in clinical cardiology for cardiovascular examination including structural and functional evaluation for the past 50 years.[1–4] Congenital heart disease (CHD) has been diagnosed and evaluated by real-time two-dimensional (2D) echocardiography for approximately the past 25 years.[2,5] Initially, the machine used for echocardiography was heavy and large but by the 1990s, the equipment became lighter, and more portable. However, its weight was still >100 kg, and it took time to move the machine to the bedside. The hand-carried device was developed in the early 2000s, but it was still too large and heavy, when compared with a stethoscope.[2,6]

A new palm-held, mini-sized ultrasonoscopic scanner is now available for the diagnosis of CHD. It is palm-held, highly portable, and can be carried inside a laboratory coat pocket. Excellent correlation between palm-held scanner and traditional echocardiography for the measurement of cardiac chamber size and function has been reported in previous studies.[7–13] The palm-held scanner also resulted in cost savings in the diagnosis of cardiac abnormalities.[6,14,15] However, the application for CHD evaluation was seldom reviewed.

The aim of this study is to investigate whether the palm-held scanner would be useful for screening and follow-up in CHD, and offer as good diagnostic accuracy as standard echocardiography.

Materials and methods

We retrospectively reviewed the echocardiographic images of patients who needed cardiovascular evaluation during daily ward rounds, and in the outpatient clinic from June 1, 2014 to November 1, 2014. The main purpose for the patients visiting our outpatient clinic or admitted was for heart murmur survey, chest pain evaluation, and pre- or postsurgical intervention follow up of CHD. All patients underwent two ultrasonographic examinations including palm-held scanner and standard echocardiography by experienced echocardiographers on the same day.

The examination by palm-held scanner was performed with Vscan (GE Vingmed Ultrasound AS, Horten, Norway). The device is palm-held and can be carried in the pocket with a total weight of 390 g. It consists of an 8.89-cm display unit, and a broad-bandwidth phased-array probe (1.7—3.8 MHz). The scanner provides gray-scale 2D imaging for displaying anatomy in real time, and color Doppler imaging for real-time blood flow. The field-of-view for 2D imaging is up to 75° fan-sized image with a maximum depth of 25 cm, whereas the color flow sector represents blood flow within an angle of 30°. It also provides automatic gain adjustment and automatic detection of a full heart cycle for storage without the need for electrocardiography. Basic linear measurements can be performed with the provided caliper tool. Standard echocardiography was performed at the echocardiography laboratory by experienced cardiologists using Philips IE33 (Philips, Bothell, WA, USA).

For the purpose of comparing the quality of the two instruments, we developed a diagnostic scoring system ranging from 1 point to 10 points with 10 points indicating the best quality. Two experienced echocardiographers retrospectively reviewed all recorded palm-held scanner images and standard echocardiograms blindly, and gave each examination a score subjectively.

Comparisons of scores between the two instruments were performed with paired Student t test. Data are expressed as mean ± standard error. A p value < 0.05 was considered statistically significant. Agreement among observers was analyzed using kappa statistics. Our data collections were approved by the Institutional Review Board of Chang Gung Memorial Hospital.

Results

A total of 262 patients' images were reviewed in our study. The age of these patients ranged from 7 days to 87 years, with a median age of 4 years. Among the 262 patients, 11 had subpulmonary type ventricular septal defect (VSD), 24 had perimembranous type VSD, six had muscular type VSD, 20 had secundum type atrial septal defect, 14 had patent ductus arteriosus, three had Tetralogy of Fallot, seven had coarctation of the aorta, seven had aortic stenosis, and 19 had pulmonary stenosis. In addition, aortic regurgitation was detected in 30 patients, mitral regurgitation in 100 patients, pulmonary regurgitation in 36 patients, and tricuspid regurgitation in 44 patients. All cardiac lesions could be detected by both the instruments. The images of patients who had received surgical intervention were not listed in the cardiac structural defect mentioned above because there were no residual defects detected after successful operations. They included endocardial cushion defect in three patients, secundum type atrial septal defect in three patients, patent ductus arteriosus in four patients, Tetralogy of Fallot in four patients, transposition of the great arteries in five patients, and double outlet right ventricle in four patients.

Figure 1 illustrates the key echocardiography images of individual CHDs created by traditional standard echocardiography and palm-held scanners. The diagnostic scores of

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