

Hand-held Echo is Not So Handy in Everyone's Hands: Misdiagnosing Congenital Septal Defects in Patients with Heart Murmurs

Biljana Putniković^{1,2}, Ivan Stanković¹, Predrag Miličević¹, Miloje Marjanović¹, Aleksandar N. Nešković^{1,2}

¹Department of Cardiology, Clinical Hospital Center Zemun, Belgrade, Serbia;

²University of Belgrade, School of Medicine, Belgrade, Serbia

SUMMARY

Introduction Echocardiography is a highly operator-dependant technique which requires adequate training and skills that are frequently not present, considering the widespread use of cardiovascular ultrasound. This could particularly be true for hand-held echo devices which made echocardiography more accessible but are frequently used by non-cardiologists and non-experts.

Outline of Cases We present a 45-year-old female and a 37-year-old male with heart murmurs due to atrial and ventricular septal defect, respectively. Congenital septal defects were undiagnosed in both patients during several outpatient examinations due to challenging image acquisition. Careful re-evaluation revealed that, depending on the scanning technique, it was possible to detect or overlook the real cause of the murmur using either hand-held or high-end echo device.

Conclusion Our report underlines the need of adequate knowledge and training of medical professionals performing pocket-size hand-held echocardiography, since potential misdiagnoses may not be related to limited imaging capabilities of pocket-sized echo devices only, but also to inability of insufficiently trained users to obtain good quality images and interpret them adequately.

Keywords: pocket-size hand-held imaging device; congenital septal defect; misdiagnosis

INTRODUCTION

Echocardiography is an indispensable tool for the assessment of cardiac morphology and function in patients with suspected or known heart disease. Continuous improvement in image quality and resolution over the past few decades occurred in parallel with miniaturization of ultrasound systems which are now available not only as large, stationary machines but also as portable and hand-held devices. Being equipped with 2D and color Doppler modalities only, pocket-sized hand-held imaging devices are technically inferior but inexpensive alternative to full-function systems, which may result in their widespread usage in the foreseeable future. There is a growing body of evidence that a quick assessment of cardiac structures and function with hand-held devices may improve diagnostics and patient workflow in different clinical scenarios [1-6], but only if performed by competent users. Whether increasing number of examinations performed with hand-held devices by non-experts would translate into an increasing or decreasing number of medical errors remains unknown.

To underline the importance of adequate level of competence of individuals performing hand-held echocardiography, we present two patients with congenital septal defects who were undiagnosed on several outpatient examinations due to challenging image acquisition and suboptimal scanning technique.

CASE REPORTS

A 45-year-old female and a 37-year-old male with heart murmurs underwent several "quick look" echocardiographic exams before being referred for an expert evaluation in a tertiary care center. Apart from the murmurs detected during routine medical check-ups, and an incomplete right bundle branch block (RBBB) in the female patient, both patients were apparently healthy with unremarkable physical examination. The female patient was asymptomatic and was initially diagnosed with the mitral valve prolapse (MVP) and moderate mitral regurgitation. She was initially examined at a primary care center, at the time of RBBB diagnosis, by a cardiologist not conversant with echocardiography, using a stationary echo system for a "quick look" examination. Approximately one year later, the initial diagnosis of the MVP was confirmed during another examination at a cardiology outpatient clinic performed by an internal medicine specialist using full echo system.

The male patient was initially examined with a pocket-echo device to rule-out a clinical suspicion of endocarditis (a heart murmur during a febrile illness) when an internal medicine specialist did not observe masses consistent with valvular vegetations, and also failed to diagnose the real cause of heart murmur. Later on, the patient presented with mild-to-moderate dyspnea during exercise and was referred

Correspondence to:

Ivan STANKOVIĆ
Department of Cardiology
Clinical Hospital Center Zemun
Vukova 9, 11070 Belgrade
Serbia
future.ivan@gmail.com

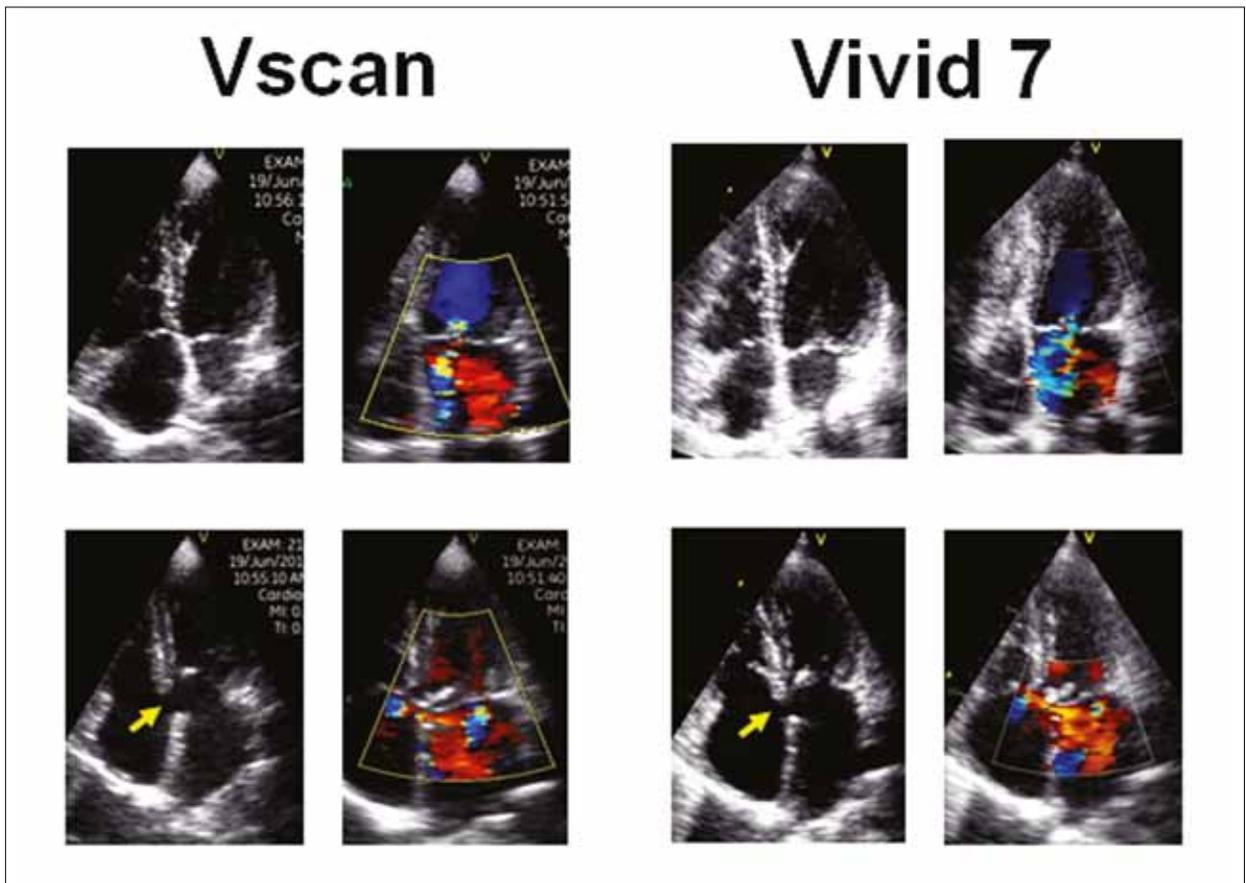


Figure 1. Ostium primum atrial septal defect with cleft mitral valve may (bottom panels, arrow) or may not (upper panels) be clearly visible using hand-held (left panels) and high-end (right panels) echocardiography.

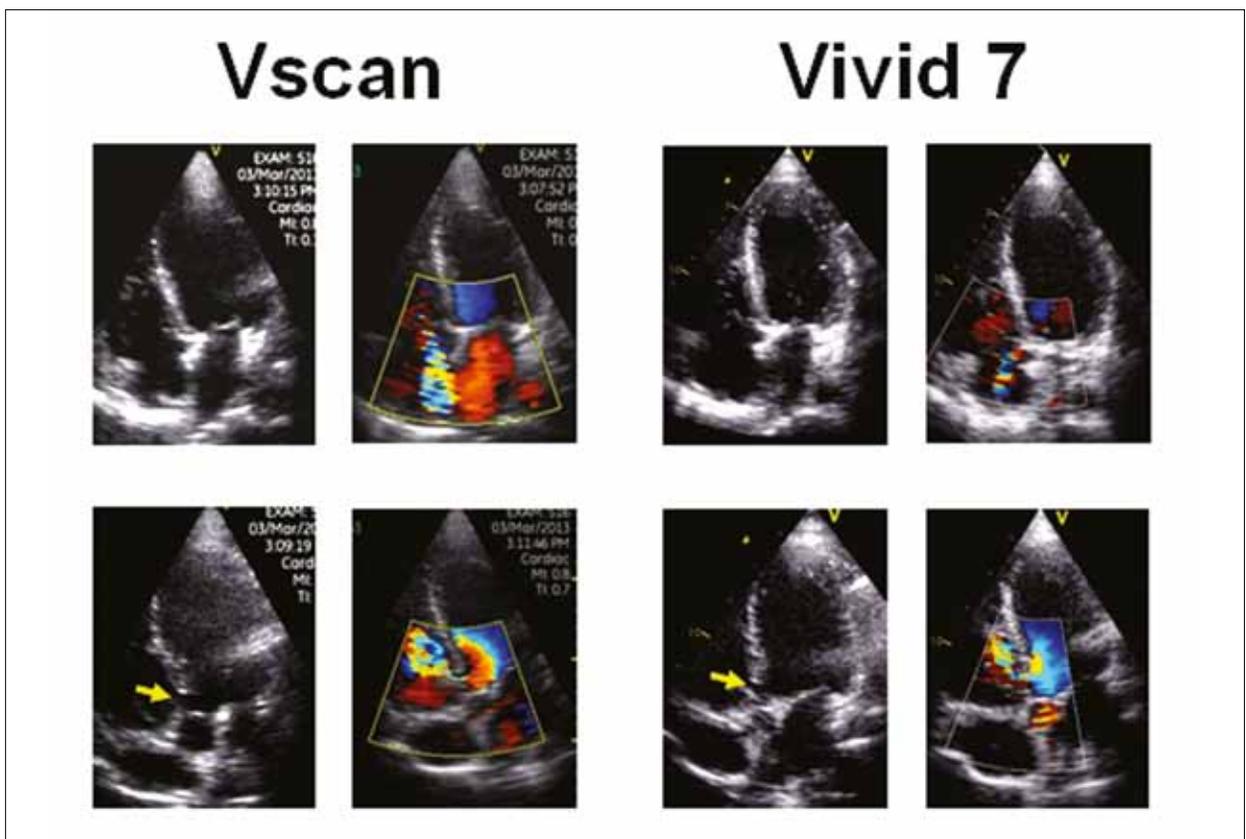


Figure 2. Perimembranous ventricular septal defect could be both detected (bottom panels, arrow) and missed (upper panels) using hand-held (left panels) and high-end (right panels) echocardiography.

for further evaluation of moderate pulmonary hypertension of unknown etiology.

After careful re-evaluation, using both pocket-sized (Vscan, General Electric Vingmed Ultrasound, Horten, Norway) and high-end echo devices (Vivid 7 Pro, General Electric Vingmed Ultrasound, Horten, Norway), we found that ostium primum atrial septal defect with cleft mitral valve was the cause of the murmur in the female patient (Figure 1, bottom panels), while the perimembranous ventricular septal defect was the reason for the pulmonary hypertension in the male patient (Figure 2; bottom panels). Of note, due to their lean body habitus, respiratory maneuvers were required to achieve good image quality in both patients. Both atrial and ventricular septal defects were completely invisible in easily obtainable but suboptimal echo images acquired during normal breathing (Figures 1 and 2, upper panels). However, with appropriate scanning technique, it was possible to detect the real cause of the murmurs using either hand-held or high-end echo device. Once the adequate view had been obtained by either scanner, the diagnosis could be easily reached.

DISCUSSION

Moving a large and heavy echocardiographic machine from a dimly lit diagnostic room to the patient's bedside had been a cumbersome task before the first pocket-sized echo device became commercially available in 2007. Nowadays, these truly pocket-size imaging devices are available from four different vendors and allow initial bedside assessment of ventricular and valvular function, pericardial and pleural effusion or extravascular lung water [7]. Depending on the competence of the performer, the use of hand-held devices could be particularly advantageous or detrimental in prehospital or emergency settings.

The European Association of Cardiovascular Imaging (EACVI) has addressed the importance of adequate training and competence for performing both emergency and pocket echocardiography in two recent recommendation documents [7, 8]. In contrast to the emergency echocardiography recommendations which specified the requirements for reaching competence in this field, the position statement on hand-held devices just roughly outlined requirements for medical professionals using this type of scanners. According to the EACVI position statement [8], accredited echocardiographers are allowed to use hand-held imaging devices without any additional training, while for cardiologists not fully familiar with echocardiography, specific training was recommended although training syllabus was not specified. For non-cardiologists or non-experts, the EACVI has recently launched an online learning platform and a certification process.

On top of cardiac application, all available devices also have possibility for non-cardiac imaging, which gives them potential to make exciting changes in the patients' care, through the concept of point-of-care ultrasonography. It is defined as "ultrasonography brought to the patient and performed by the provider in real time, allowing findings

to be directly correlated with the patient's presenting signs and symptoms" [9]. The key feature of this type of examination, also known as focus cardiac ultrasound (FoCUS), is that the performer is also responsible for immediate decision making and/or treatment [10]. Usually completed in less than 5 minutes, FoCUS is intended to provide clear (yes/no) answers regarding the presence of depressed ventricular function, hypovolemia, cardiac tamponade, pleural effusion, free intraperitoneal fluid and pneumothorax [11, 12, 13]. In addition, hand-held imaging devices are useful for guiding invasive procedures (central and peripheral vascular access, thoracentesis, paracentesis, etc.) and screening purposes, while in resource-limited settings they may be the only ultrasound machines available. It should be noted here that FoCUS examination may provide essential information for urgent decision-making only if it is performed by properly trained clinician. There is, however, a whole spectrum of medical specialists who may find themselves in a position of performing FoCUS, and therefore specialty-specific training programs for FoCUS imaging should be developed by respective societies [10]. In the case of focused cardiovascular ultrasound exams performed by non-cardiologists, the training requirements should minimally include a combination of basic knowledge on cardiac pathophysiology and recognition of echocardiographic pattern of various cardiac conditions that may be found in critically ill patients. Finally, not only non-cardiologists with a basic knowledge of cardiac ultrasound, but also cardiologists not fully conversant with comprehensive echocardiography should be discouraged from performing suboptimal echo examination in non-emergent clinical scenarios.

In conclusion, echocardiography is a highly operator-dependent technique and adequate level of training and knowledge is a prerequisite for establishing an accurate diagnosis. Expert level echocardiography is generally performed in well-equipped hospitals by properly trained echocardiographers, while "quick look" echo examinations are increasingly used on the spot by non-experts (general practitioners, anesthesiologists, internal and emergency medicine specialists), due to widespread availability of hand-held devices. This practice, as shown in our report, may lead to inaccurate diagnoses not only related to limited imaging capabilities of pocket-sized echo devices, but also to inability of insufficiently trained users to obtain good quality images, and interpret them adequately.

ACKNOWLEDGEMENT

The authors would like to thank GE Healthcare for generous and unrestricted software support.

NOTE

B. P. and A. N. N. are partially supported by the grant No. 175099 of the Ministry of Education, Science and Technological Development of the Republic of Serbia.

REFERENCES

1. Kitada R, Fukuda S, Watanabe H, Oe H, Abe Y, Yoshiyama M, et al. Diagnostic accuracy and cost-effectiveness of a pocket-sized transthoracic echocardiographic imaging device. *Clin Cardiol*. 2013; 36(10):603-10.
2. Michalski B, Kasprzak JD, Szymczyk E, Lipiec P. Diagnostic utility and clinical usefulness of the pocket echocardiographic device. *Echocardiography*. 2012; 29(1):1-6.
3. Andersen GN, Haugen BO, Graven T, Salvesen O, Mjølstad OC, Dalen H. Feasibility and reliability of point-of-care pocket-sized echocardiography. *Eur J Echocardiogr*. 2011; 12(9):665-70.
4. Prinz C, Dohrmann J, van Buuren F, Bitter T, Bogunovic N, Horstkotte D, et al. The importance of training in echocardiography: a validation study using pocket echocardiography. *J Cardiovasc Med (Hagerstown)*. 2012; 13(11):700-7.
5. Dalen H, Haugen BO, Graven T. Feasibility and clinical implementation of hand-held echocardiography. *Expert Rev Cardiovasc Ther*. 2013; 11(1):49-54.
6. Prinz C, Dohrmann J, van Buuren F, Bitter T, Bogunovic N, Horstkotte D, et al. Diagnostic performance of handheld echocardiography for the assessment of basic cardiac morphology and function: a validation study in routine cardiac patients. *Echocardiography*. 2012; 29(8):887-94.
7. Sicari R, Galderisi M, Voigt JU, Habib G, Zamorano JL, Lancellotti P, et al. The use of pocket-size imaging devices: a position statement of the European Association of Echocardiography. *Eur J Echocardiogr*. 2011; 12(2):85-7.
8. Neskovic AN, Hagendorff A, Lancellotti P, Guarracino F, Varga A, Cosyns B, et al. Emergency echocardiography: the European Association of Cardiovascular Imaging recommendations. *Eur Heart J Cardiovasc Imaging*. 2013; 14(1):1-11.
9. Moore CL, Copel JA. Point-of-care ultrasonography. *N Engl J Med*. 2011; 364(8):749-57.
10. Neskovic AN, Edvardsen T, Galderisi M, Garbi M, Gullace G, Jurcut R, et al. Focus cardiac ultrasound: the European Association of Cardiovascular Imaging viewpoint. *Eur Heart J Cardiovasc Imaging*. 2014; 15(9):956-60.
11. Via G, Hussain A, Wells M, Reardon R, El Barbary M, Noble VE, et al; International Liaison Committee on Focused Cardiac UltraSound (ILC-FoCUS); International Conference on Focused Cardiac UltraSound (IC-FoCUS). International evidence-based recommendations for focused cardiac ultrasound. *J Am Soc Echocardiogr*. 2014; 27(7):683.e1-683.e33.
12. Alpert JS, Mladenovic J, Hellmann DB. Should a hand-carried ultrasound machine become standard equipment for every internist? *Am J Med*. 2009; 122:1-3.
13. Via G, Breikreutz R, Price S, Daniel T; WINFOCUS ECHO-ICU Group. Detailed echocardiography (echo) protocols for the critical patient. *J Trauma*. 2009; 66(2):589-90.

Ручни ехокардиографски апарат није поуздан у свачијим рукама: погрешне дијагнозе урођених септалних дефеката код болесника са шумовима на срцу

Биљана Путниковић^{1,2}, Иван Станковић¹, Предраг Миличевић¹, Милоје Марјановић¹, Александар Н. Нешковић^{1,2}

¹Служба кардиологије, Клиничко-болнички центар „Земун“, Београд, Србија;

²Универзитет у Београду, Медицински факултет, Београд, Србија

КРАТАК САДРЖАЈ

Увод Ехокардиографија је метода чија тачност зависи од одговарајуће обуке и вештина лекара који је изводе, а које повремено нису заступљене имајући у виду велику распрострањеност примене ултразвука у кардиоваскуларној медицини. Ово се посебно односи на примену ручних ултразвучних апарата који су ехокардиографију учинили доступнијом, али их често користе лекари који нису кардиолози, као и лекари без довољно искуства.

Прикази болесника Приказали смо случај 45-годишње болеснице и 37-годишњег болесника са срчаним шумовима услед атријалног и вентрикуларног септалног дефекта. Урођени септални дефекти нису били препознати током неколико амбулантних прегледа услед потешкоћа у добијању ехокардиографских слика одговарајућег квалитета. Пажљивом поновном проценом смо показали да је, у зависности од технике прегледа, било могуће и открити и пропустити прави узрок шума на срцу, користећи било ручни, било стандардни ехокардиографски апарат.

Закључак Приказ ова два болесника наглашава потребу одговарајућег знања и обуке лекара који користе ручне (цепне) ехокардиографске апарате с обзиром на то да могуће грешке не морају бити последица само ограничених техничких могућности цепних ехо-апарата, већ и немогућности недовољно обучених корисника да добију ехокардиографске слике задовољавајућег квалитета и на правилан начин их протумаче.

Кључне речи: ручни (цепни) ехо-апарат; конгенитални септални дефект; погрешна дијагноза

Примљен • Received: 17/06/2014

Прихваћен • Accepted: 11/09/2014