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Intraoperative three-dimensional echocardiography: comparison of three methods.R. De Simone, S. Mottl-Link, C. Vahl, S. Hagl. *University of Heidelberg, Dpt. of Cardiac Surgery, Heidelberg, Germany*

Objectives: Intraoperative echocardiography requires reliable three-dimensional (3D) imaging of intracardiac anatomy. Up to now all 3D techniques had the major drawbacks of requiring long processing time and of being not directly available during heart surgery. More recently, it became possible intraoperative imaging by "real time" 3D-echocardiography, which allows to get 3D images just by one heart beat. The acquisition and display of pulse echo information from a 3D volume can be obtained without cardiac respiratory gating.

Methods: We assessed the clinical intraoperative application of different 3D techniques based on transthoracic (TEE) and epicardial (E) echocardiography: (1) 3D-TEE, (2) "live" 3D-E and (3) "full volume" 3D-E. Ninety examinations were performed in 30 consecutive patients who underwent cardiac surgery.

Results (see table):

	(1) 3D-TEE	(2) live 3D-E	(3) full volume 3D-E
Acquisition time	158±77 sec	1.2±0.46 sec	8.46±0.46 sec
Reconstruction time	480 ± 94 sec	immediate	1.6 ± 0.74 sec
Additional Information	3/30 (10%)	7/30 (23.4%)	7/30 (23.4%)
ECG-triggering	yes	no	yes
Respiratory triggering	yes	no	no
Advantages	color Doppler, higher resolution	immediate acquisition and reconstruction	quick acquisition and reconstruction
Disadvantages	slow acquisition and reconstruction	small volume data	fusion of four subvolumes

Comparison of three methods.

Conclusions: The newly developed real-time 3D-E overcomes the time limitation of former 3D echo techniques and provides, for the first time, instantaneous imaging of intracardiac anatomy during cardiac surgery.

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3D real time vs transthoracic echocardiography in quick bedside assessment of mitral valve apparatus in patients suspected of acute mitral insufficiency.P. Scislo, J. Kochanowski, S. Stawicki, D. Kosior, G. Opolski. *The Warsaw Medical University, Dept of Cardiology, Warsaw, Poland*

The aim of the study was to compare 3 dimensional real time echocardiography (3DRTE) and 2D transthoracic echocardiography (2DTTE) in quick bedside assessment of mitral valve apparatus morphology in patients suspected of acute mitral insufficiency during acute coronary syndrome (ACS).

Material and methods: We analyzed 10 patients with STT elevation ACS with moderate or severe mitral regurgitation observed in 2 dimensional color Doppler examination using S3 Philips Sonos 7500. For 3DRTE scanning we used X4 probe. All data were digitally recorded for further analysis by 2 independent cardiologists.

Results: PTS were divided in 3 groups using 2D findings:

Group 1 - not unequivocal 2DTTE - 3 pts

Group 2 - no morphology changes - 5 pts

Group 3 - rupture of chordae tendineae - 2 pts

Using 3DRTE we found in:

Group 1 - no morphology changes in 2 pts and rupture of chordae tendineae in 1 pts,

Group 2 - no morphology changes in 4 pts and 1 pts with akinesia of papillary muscle and rupture of chordae tendineae,

Group 3 - 1 pts with rupture of chordae tendineae and 1 pts with chordae tendineae elongation.

Conclusion: 3DRTE echocardiography could be a better diagnostic tool than TTE for quick transthoracic mitral apparatus assessment.

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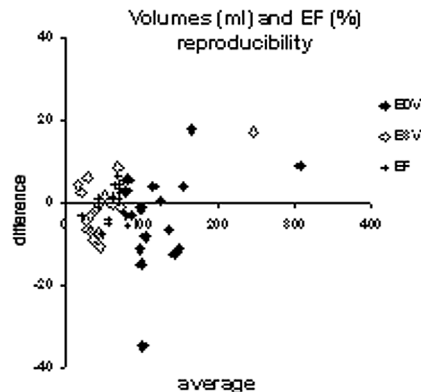
Real-Time 3D echocardiography: reproducibility of left ventricular volumes and ejection fraction.H.F.J. Mannaerts, J.A. Van der Heide, O. Kamp, C.A. Visser. *VU Medical Center, Cardiology, Amsterdam, Netherlands*

Background: a 2nd generation real-time three-dimensional echocardiography (RT-3DE) machine has become available recently, potentially facilitating quick and easy assessment of left ventricular (LV) volumes and ejection fraction (EF).

Methods: 11 healthy volunteers and 6 patients (1 with congestive cardiomyopathy, 1 with moderate aortic regurgitation, 1 with severe mitral regurgitation, 3 with ischemic cardiomyopathy) underwent RT-3DE using a Philips 7500™ RT-3DE machine. A pyramidal dataset, up to 90 by 90 degrees, is acquired by a high-resolution matrix transducer in 8 ECG-triggered heart beats, during one breath-hold. Echo images were stored on harddisk and transferred to a TomTec™ workstation with TomTec 4D Cardio-View RT™ software. LV end-diastolic (EDV) and end-systolic (ESV) volumes and ejection fraction (EF) were measured by manual tracing of the endocardial border. Measurements were repeated to assess reproducibility by a single observer.

Results: RT-3DE acquisition time was approximately 10 seconds. Analysis time was approximately 16 ± 5 minutes (range 10-25).

The percentual bias and limits of agreement were for EDV, SV and EF respectively -0.4 ± 14.4%, -1.0 ± 18.0%, and 0.5 ± 8.7%. In the figure the Bland Altman plot for intraobserver variability is shown.



Bland Altman plot (absolute values)

Conclusion: RT-3DE allows quick and reproducible assessment of LV volumes and EF. This enables its routine clinical use, even without contrast.

HAND-HELD DEVICES

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Hand-carried echocardiography as a screening tool in the emergency department. Comparison between cardiologists with level of training I and III.A. Karavidas¹, E. Matsakas¹, G. Lazaros², F. Panou¹, I. Fotiadis¹, S. Saridakis¹, M. Foukarakis¹, G. Diamantopoulos¹, D. Tsekoura¹, A. Zacharoulis¹. ¹Athens General Hospital, Cardiology Department, Athens, Greece; ²Athens General Hospital 'Elpis', Cardiology Department, Athens, Greece

Purpose: Hand-carried (HC) echocardiography devices provide rapid and readily available information at bedside, overcoming the difficulties imposed by the cumbersome standard equipment. However, the use of these miniaturized devices by cardiologist in training (level I) could potentially lead to misdiagnosis. In this study we have assessed the importance of level of training in echocardiography to the diagnostic yield of HC echocardiography in patients (pts) presenting in the emergency department (ED).

Methods: Our study population consisted of 1048 pts presented in the ED during a 2 months period. For each patient two echocardiographic studies were successively performed with a HC device (SonoHeart II). The first one was performed by a less experienced cardiologist (with level I of training) whereas the second one by a skilled sonographer (with level III of training). The later study served as 'gold standard'. All cardiologists had been trained in the use of the HC device, and imaging was limited to a maximum of 15min.

Results: Among the pts studied 125 (i.e. ~12%) were excluded due to 'poor' acoustic window. From the remainder (i.e. 923 pts), 554 pts (i.e. ~60%) had a normal echo study (agreement for identification of normal studies between level I and level III: 85%, Kappa=0.65). Among the 369 pts with pathologic studies, 221 had wall motion abnormalities (agreement 75%, Kappa= 0.52), 37 had pericardial effusion (agreement 90%, Kappa=0.75), and 29 had severely depressed left ventricular systolic performance (<35%) (agreement 85%, Kappa=0.60).

Conclusions: HC in the ED is a useful screening tool for the rapid identification of cardiovascular pathology in a limited 'goal-oriented' examination. Use of this device by less experienced cardiologists could lead to omissions and misdiagnosis with adverse clinical implications.

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A hand-carried cardiac ultrasound device in the diagnosis of cardiac abnormalities. A comparison to physical examination.

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Aim: To determine the diagnostic potential of a hand-carried cardiac ultrasound (HCU) device (OptiGoTM, Philips Medical Systems) in a cardiology outpatient clinic. A full-featured standard echocardiographic system (SE) was used as a reference.

Methods: 300 consecutive patients referred for the first time to the cardiology outpatient clinic were studied with the HCU device by an experienced investigator prior to their visit to the cardiologist. The echocardiographer noted whether the HCU was able to confirm or reject the referral diagnosis, which pathology was detected and whether SE investigation was necessary. Physical examination by a cardiologist followed and thereafter, an echocardiographer performed a complete study with a SE whenever the cardiologist required it. Both were blinded to the results of the HCU. HCU and SE data were independently evaluated for major and minor cardiovascular abnormalities. The HCU data were compared to the clinical diagnosis by the cardiologist and the SE diagnosis.

Results: The cardiologist referred 203 patients for a SE study, 13 patients for transesophageal echocardiography, and in 84 patients no further examination was considered necessary. The most frequently question the SE was asked for, was the assessment of left ventricular function (60%), followed by the evaluation of valvular abnormalities (30%), congenital abnormalities (7%) left ventricular hypertrophy (11%), and endocarditis (3%). HCU echocardiography was able to confirm or reject the suspected clinical diagnosis in 159 of 203 patients (78%) whereas in 44/203 patients (22%) a hemodynamic assessment with SE Doppler was needed after the HCU. Of the 84 patients that were not referred for a SE study by the cardiologist, in 83% of the patients there was an excellent agreement with the clinical diagnosis (100%) and in 17% of the patients, unsuspected major findings were detected by the HCU and missed with the physical examination. Those findings were verified with the SE after request of the HCU echocardiographer. The agreement between the HCU and SE for the detection of major abnormalities was 98%, $k=0.95$. The HCU device missed 25% of minor and 4% of major abnormalities.

Conclusion: Integration of HCU in the physical examination of new patients at the outpatient cardiology clinic often allows an instant diagnosis, the detection of unexpected cardiovascular abnormalities and may avoid referral to the expensive diagnostic ultrasound facilities in a considerable number.

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A hand-held echocardiographic device for screening for early left ventricular dysfunction. A comparison to brain natriuretic peptide and standard echo.

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Background: A hand-carried cardiac ultrasound (HCU) device is a recently introduced imaging device which may be potential useful in the primary care setting for screening for left ventricular (LV) dysfunction. Brain natriuretic peptide (BNP) is a cardiac neurohormone that is secreted in the ventricles as a response to volume and pressure overload and is elevated in patients with impaired LV function.

Aim: To test the screening potential of a HCU for the detection of LV dysfunction by evaluating LV ejection fraction (LVEF) compared to BNP measurements. A standard echocardiographic system (SE) was used as a reference.

Methods: Eighty-eight (88) consecutive patients (56 male, age 59 ± 12 years) with suspected LV dysfunction were enrolled in the study. The HCU-LVEF was visually estimated and the SE-LVEF derived by the Simpson's biplane method. Both studies were performed on the same day by two independent cardiologists blinded to each other's results and to medical history or clinical status of the patient. A LVEF $<40\%$ represented LV dysfunction. BNP levels $>$ or $=$ than 15 pmol/L were considered abnormal. The correlation of the HCU-LVEF and the BNP to the SE-LVEF were analysed independently using twotwo tables. An investigator blinded to the results of the echocardiographic examinations performed the functional classification of the patients according to the New York Heart Association (NYHA).

Results: Six patients were excluded because of poor echo images. Sixty-four/82 patients were NYHA class I or II, 14 were class III and 4 patients were class IV. Nineteen/82 (23%) patients had LV dysfunction diagnosed with the SE. The HCU and BNP could identify 17 and 18 out of these 19 patients respectively. The agreement for LVEF between SE and HCU was 96% ($k=0.89$). The sensitivity of the HCU-LVEF versus the BNP in identifying patients with LV dysfunction were respectively: 89% vs 94%; specificity: 98% vs 90%; positive predictive value: 94% vs 75%; negative predictive value: 97% vs 98%.

Conclusion: A HCU device is a reliable screening tool for the identification of LV dysfunction and compare to SE and to BNP measurements.

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Preliminary experience with hand-held echocardiography in pediatric cardiology.

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Introduction: In clinical practice several questions can be answered without extensive echocardiography. Recently, hand-carried (HC) echocardiography devices have been introduced. These devices are attractive because of their size, portability and cost. The use of these devices has not been evaluated in pediatric cardiology.

Methods: In the present study we compared a HC device (Optigo; Philips Medical Systems) with a standard echo (SE) machine. (Sonos 5500, Andover, Massachusetts; Philips Medical Systems). Thirty-one consecutive patients were examined with both the HC device and the SE machine.

Results: Median age of the patients was 2.5 years (range 1 month to 17 years), median body weight was 16 kg (range 4 to 62 kg). Among the 31 patients 69 questions (1-4 per patient) had to be answered. The HC machine gave a correct result in 56/69 questions, while 13 were false (19%). We subdivided the questions into six categories: the presence or absence of valvular stenosis or valvular insufficiency, the presence and location of a ventricular septal defect, ventricular function, the presence or absence of pericardial effusion and a rest-group. The rate of missed diagnosis ranged from 0% in diagnosing ventricular septal defect (VSD) or pericardial effusion to 24% in diagnosing valvular insufficiency (Table 1).

Table 1

	Correct diagnosis	Incorrect diagnosis
Valvular insufficiency	16	5
Valvular stenosis	9	1
Ventricular function	10	2
Ventricular septal defect	7	0
Pericardial effusion	7	0
Otherwise	7	5
Total	56	13

Accuracy of the hand-held device according to underlying defects

Conclusions: Although there are at the moment restrictions about the use of HC machines in pediatric cardiology our study showed that about 80% of clinical questions could be answered. This is even better for certain categories as pericardial effusion and the presence of a VSD. Furthermore, because of its low weight and compactness the present HC machine was very easy to handle. Therefore, this machine certainly merits a place in pediatric cardiology.

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High diagnostic accuracy of hand-held echocardiography with cw/pw Doppler and tissue harmonic imaging.

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Background Previously developed hand-held echocardiography was evaluated with divergent results due to inherent technical limitations. New hand-held devices with CW/PW Doppler as well as tissue harmonic imaging were introduced in identical clinical settings. Comparisons were drawn between standard echocardiography (the gold standard) and these new devices.

Methods In 315 patients, two consecutive echocardiographic examinations were performed by experienced and independent examiners using hand-held echocardiography and standard echocardiography. The hand-held device used was a SonoSite 180plus (SonoSite Inc. Washington, USA) with a C15/4-2 (15 mm broadband, 4-2 MHz) transducer. Standard devices employed included Vingmed Vivid 5 & 7 (GE, Horten, Norway).

The diagnostic accuracy of hand-held echocardiography was assessed by 2 x 2 tables with kappa statistics. Kappa values of 0.81 or greater were considered as an almost perfect strength of concordance between the two modes of echocardiography. The agreement was measured as the sum of true positive and true negative results divided by the total number of patients.

Results Of the 315 patients, 171 (54.3%) were male, 144 (45.7%) were female, with a mean age of 55.6 years (SD 16.8). Ten patients were excluded due to a reduced acoustic window. 177 (56.2%) patients had normal cardiac function; 138 (43.8%) had underlying cardiologic pathology. The overall diagnostic accuracy of hand-held echocardiography is defined as the ability to detect the clinically relevant finding for which the echocardiographic examination was ordered. In this regard, hand-held echocardiography has an agreement of 94.8% and a kappa of 0.89. Hand-held echocardiography detected valve disease with an agreement of 96.7% and a kappa of 0.93. With this new technology, global left ventricular function was assessed correctly in 85.6% of cases (compared to standard echocardiography). A pericardial effusion was diagnosed with an agreement of 91.2%. Dyskinesia was confirmed by hand-held echocardiography with an agreement of 95.4% and a kappa value of 0.88.

Conclusion The previously published studies showed that hand-held echocardiography without harmonic imaging and PW-Doppler failed to quantify valve disease and left ventricular kinetics. This study demonstrates: (a) the high diagnostic accuracy of new hand-held devices with CW/PW Doppler and harmonic imaging; and (b) that these devices broaden the diagnostic spectrum, while allowing for enhanced mobility in everyday clinical applications.