

CARDIO3®ECHO EXPERTNÍ SYSTEM PRO HODNOCENÍ KARDIOGRAFICKÝCH NÁLEZŮ

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Introduction

Over the last three decades, a large number of clinical decision support systems have been developed to advise physicians on patient diagnosis and management [1]. There is increasing use of computer systems that provide alerts and reminders to physicians on tasks such as prescription of medication, ordering of investigations, and screening.

Echocardiography is the non-invasive, widely available and basic method to examine the heart. Current devices allow echocardiographic measurements and calculations of large amounts of hemodynamic and morphological parameters. To establish the diagnosis and assessment of severity of heart disease, it is needed to evaluate all available data. The physician must take into account the specificity, sensitivity and possible measurement error of the specific echo parameter.

The goal of this study was to investigate the feasibility of CARDIO3®ECHO expert system for the establishment of diagnosis of heart diseases, using echocardiographic measurement data.

Methodics

We created a tool for the measurement of echocardiographic parameters and implemented basic calculations of hemodynamic parameters (volume, flow, pressure or velocity). This system was tested on a database of findings of the CARDIO3® Comprehensive Atlas of Echocardiography. The measurement results are the basis for the text description, which is compiled from standard clinical keywords (Table 1). The application enables adding other parameters required for the evaluation of echocardiographic findings, such as age, weight and height of the patient. The results and calculations are stored in the database to verify the accuracy of the measurement. The system highlights the possible discrepancy between the measured parameters and calculated values. The application includes stratification of measurement results and the severity of heart disease.

| | |
|--|---|
| Left atrium is dilated | Left atrium is severely dilated |
| Left atrium is mildly dilated | Left atrium is elongated |
| Left atrium is moderately dilated | Left atrium size is within normal limits |

Table 1 – Example of Knowledge Base Findings

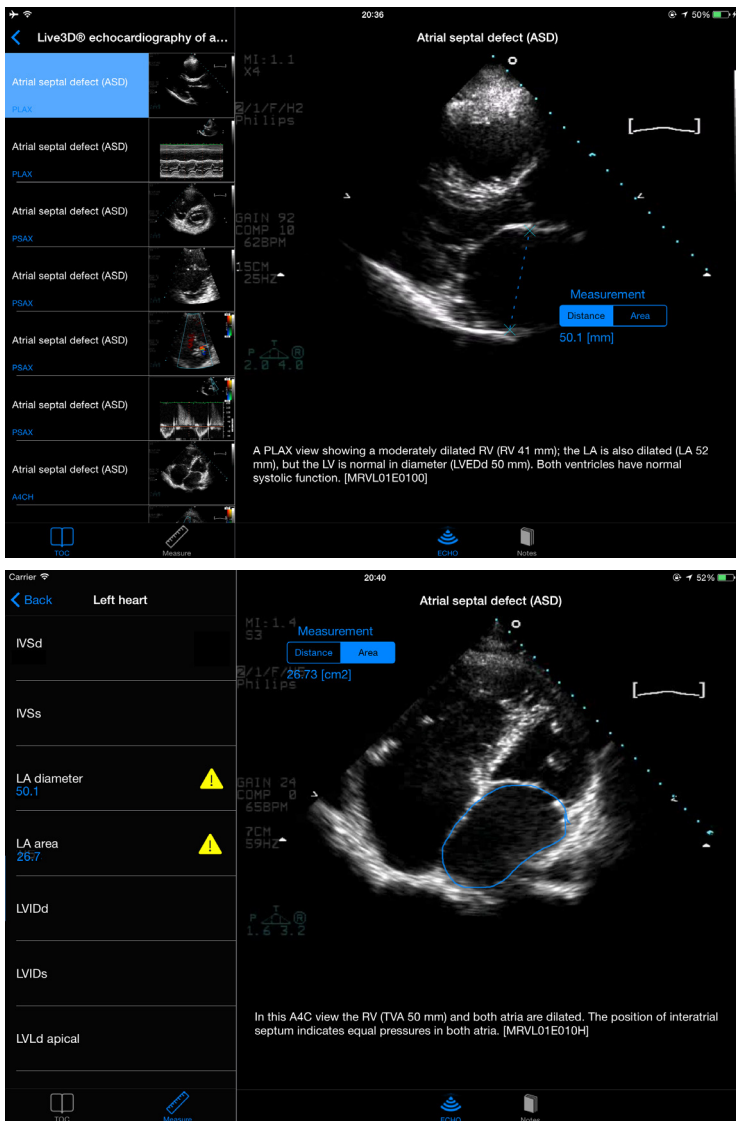


Schéma 1 A - Žluté výstražné značky upozorňují na rozpor v naměřených hodnotách - předozadní velikost levé síně (50.1 mm) měřená z parasternální projekce svědčí pro významnou dilataci levé síně, zatímco parametr plochy levé síně ze 4-dutinové projekce (26.7 cm²) ukazuje pouze mírnou odchylku od normy. Konečné posouzení závisí pak na kontrole obou metod měření a zhodnocení i ostatních klinických parametrů.

Left Atrial Dimensions / Volumes

| Reference limits and partition values for left atrial dimensions/volumes ^[2] | | | | | | |
|---|-----------------|-----------------|---------------------|-------------------|-----------------|--|
| | Women | | | | Reference range | |
| | Reference range | Mildly abnormal | Moderately abnormal | Severely abnormal | | |
| Atrial dimensions | | | | | | |
| LA diameter, cm | 2.7–3.8 | 3.9–4.2 | 4.3–4.6 | ≥4.7 | 3.0–4.0 | |
| LA diameter/BSA, cm/m ² | 1.5–2.3 | 2.4–2.6 | 2.7–2.9 | ≥3.0 | 1.5–2.3 | |
| RA minor-axis dimension, cm | 2.9–4.5 | 4.6–4.9 | 5.0–5.4 | ≥5.5 | 2.9–4.5 | |
| RA minor-axis dimension/BSA, cm/m ² | 1.7–2.5 | 2.6–2.8 | 2.9–3.1 | ≥3.2 | 1.7–2.5 | |
| Atrial area | | | | | | |
| LA area, cm ² | ≤20 | 20–30 | 30–40 | >40 | ≤20 | |
| Atrial volumes | | | | | | |
| LA volume, mL | 22–52 | 53–62 | 63–72 | ≥73 | 18–58 | |
| LA volume/BSA, mL/m ² | 22 ± 6 | 29–33 | 34–39 | ≥40 | 22 ± 6 | |
| <ul style="list-style-type: none">• BSA, Body surface area; LA, left atrial; RA, right atrial.• Green values: Recommended and best validated. | | | | | | |

Schéma 1 B - Žluté výstražné značky upozorňují na rozpor v naměřených hodnotách - předozadní velikost levé síně (50.1 mm) měřená z parasternální projekce svědčí pro významnou dilataci levé síně, zatímco parametr plochy levé síně ze 4-dutinové projekce (26.7 cm²) ukazuje pouze mírnou odchylku od normy. Konečné posouzení závisí pak na kontrole obou method měření a zhodnocení i ostatních klinických parametrů.

Mitral stenosis - severity

| Recommendations for classification of mitral stenosis severity ^[6] | | | |
|---|------|----------|--------|
| | Mild | Moderate | Severe |
| Specific findings | | | |
| Valve area (cm ²) | >1.5 | 1.0-1.5 | <1.0 |
| Supportive findings | | | |
| Mean gradient (mmHg) ^a | <5 | 5-10 | >10 |
| Pulmonary artery pressure (mmHg) | <30 | 30-50 | >50 |
| <ul style="list-style-type: none"> • ^aAt heart rates between 60 and 80 bpm and in sinus rhythm. | | | |

Schéma 2 A - Vlevo je viditelný střední tlakový gradient otevřenou mitrální chlopní (mean gradient 7.9 mmHg), vpravo planimetrické měření plochy mitrální chlopně (valve are 1.14 cm²). Oba parametry svědčí souhlasně pro středně závažnou mitrální stenózu.

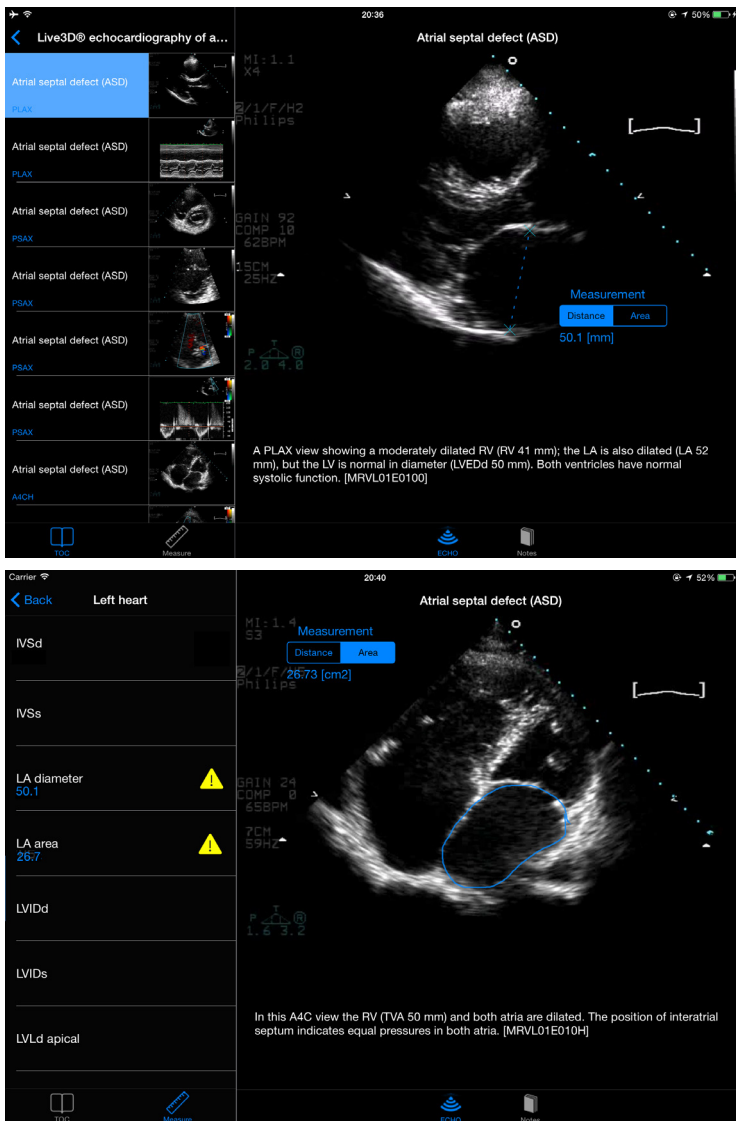


Schéma 2 B - Vlevo je viditelný střední tlakový gradient otevřenou mitrální chlopní (mean gradient 7.9 mmHg), vpravo planimetrické měření plochy mitrální chlopně (valve are 1.14 cm2). Oba parametry svědčí souhlasně pro středně závažnou mitrální stenózu.

Results

During testing on the CARDIO3® database consisting nowadays of 644 echocardiographic samples (112 various case reports), we revealed several inaccuracies in calculated clinical findings. The authors of the cases and charts are comprised of clinical cardiologists and internal fellows. For instance the left atrium dimension measured from parasternal view (LA PSAX) indicated a severely dilated left atrium (LA) whereas measurement of the left atrium area from apical view resulted in moderate LA dilatation (Scheme 1). Scheme 2 shows assessment of mitral valve where both parameters suggested moderately significant valve disease.

Another example was the evaluation of severity of aortic valve stenosis. Aortic valve area (AVA) measured directly from the parasternal short-axis view (PSAX) mismatched the calculation of AVA using a continuity equation. The system is a rule-based expert system making alerts if significant difference occurs in the assessment of valvular heart diseases using various methods. Current version measures dimensions, areas, pressure gradients and velocities in evaluation of pulmonary hypertension or hemodynamics in wide range of cardiac disorders. The app is available on iPad devices.

Conclusion

Our study showed that simulator-based training in echocardiography could be very effective and if implemented in the echocardiography device may be helpful in clinical practice. In a routine clinical setting it enables quicker processing of the examination protocol and a prompt final recommendation for the management of the patient.

Reference

- [1.] Hunt DL, Haynes RB, Hanna SE, Smith K. Effects of computer based clinical decision support systems on physician performance and patient outcomes: a systematic review. *JAMA*. 1998;280:1339–46.
- [2.] Lang RM, Bierig M, Devereux RB, Flachskampf FA, Foster E, Pellikka PA, Picard MH, Roman MJ, Seward J, Shanewise J, Solomon S, Spencer KT, St John Sutton M, and Stewart W. Recommendations for chamber quantification. *Eur J Echocardiogr* 2006 Mar; 7(2) 79-108. doi:10.1016/j.euje.2005.12.014 pmid:16458610
- [3.] Baumgartner H, Hung J, Bermejo J, Chambers JB, Evangelista A, Griffin BP, Jung B, Otto CM, Pellikka PA, and Quiñones M. Echocardiographic assessment of valve stenosis: EAE/ASE recommendations for clinical practice. *J Am Soc Echocardiogr* 2009 Jan; 22(1) 1-23; quiz 101-2. doi:10.1016/j.echo.2008.11.029 pmid:19130998.

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