Original **paper**

ECHOCARDIOGRAPHIC METHODS OF FETAL HEART SIZE ASSESSMENT- HEART TO CHEST AREA RATIO AND TRANSVERSAL HEART DIAMETER

Authors:
Oskar Sylwestrzak[1], Maria Respondek-Liberska[2,3]

1. Medical University of Lodz, 3th Grade, Student Science Club "Prenatal Cardiology" 2. Department of Diagnosis and Prophylaxis of Congenital Malformations of Medical University of Lodz 3. Department of Prenatal Cardiology of Polish Mother's Memorial Hospital Research Institute in Lodz

Prenat Cardio 2018 Jan; 8(1):20-23
DOI: 10.1515/pcard-2018-0003

Abstract

Introduction: Ultrasound assessment of fetal heart size (FHS) is widely used and recommended in many guidelines of fetal echocardiography due to its clinical value. The aim of this study was an analysis of some fetal heart measurements: ratio of heart area to chest area (HA/CA) and transversal diameter of heart (AP) and their correlation to gestational age.

Material and methods: This retrospective study was based on database of records of ultrasound and echocardiographic examinations performed in our unit and included fetuses between 15th and 39th week of gestation with no evidence of heart defect or any abnormality.

Results: 609 ultrasound examinations were analyzed. The mean HA/CA was 0,30 ± 0,015, with no statistical difference between female and male (p>0,05), and seemed to be relatively constant with slight increase with advancing gestational age. The AP diameter in whole group correlated with gestational age (r=0,94) and there was no difference related to the fetuses gender.

Conclusion: The correlation of AP diameter and relative constancy of HA/CA ratio with gestational age presented in our normograms could be used for monitoring fetal development, but also for fetal cardiomegaly assessment..

Key words: *heart measurement, cardiomegaly, fetal development, fetal echocardiography*

INTRODUCTION

Ultrasound assessment of fetal heart size (FHS) is widely used and recommended in many guidelines of fetal echocardiography.[1,2,3,4] Echocardiographic FHS assessment can be achieved by many ways[5,6] and seems to be relatively easy and helpful both for screening of fetal congenital heart defects as well as for diagnosing some additional functional abnormalities e.g. in Ebstein's anomaly, tricuspid dysplasia, atrioventricular septal defect or in normal heart anatomy and beginning of congestive heart failure[7-10]. Many forms of congenital heart disease do not show cardiac enlargement but individual chambers abnormal measurement6, so not only FHS should be measured, but also many other parameters and not only in normal heart anatomy but also in extracardiac anomalies[11,12].

FHS during longitudinal echocardiographic monitoring might reflect fetal heart adaptation to actual conditions. Using this method we can evaluate some heart defects progression or well-being in properly growing fetuses.

How to cite this article:
Sylwestrzak O, Respondek-Liberska M. Echocardiographic methods of fetal heart size assessment- heart to chest area ratio and transversal heart diameter. Prenat Cardio 2018 Jan; 8(1):20-23

This simple measure, sometimes indicating severe heart defect with necessity of organizing the delivery of the child in reference center, can support providing better care of patients.[13]

The importance of FHS assessment also arises from the high chance of demise and complicated postnatal period when the cardiomegaly occurs, independently of the reason.[14]

In this study we wanted to point some fetal heart measurements out and their correlation to gestational age.

MATERIAL & METHODS

This retrospective study was based on database of records of ultrasound and echocardiographic examinations, performed in our unit. The included group comprised fetuses between 15th and 39th week of gestation with no evidence of heart defect or any abnormality. Analyzed parameters consisted of the transversal diameter of heart ("AP") measured in short axis of fetal chest taken at the level of the 4 chamber view (Fig.1), the ratio of heart area to chest area (HA/ CA)(Fig. 1), sex and gestational age at examination.

Corresponding author: sylwestrzakoskarpatryk@gmail.com

Submitted: 2017-07-05, accepted: 2017-07-07

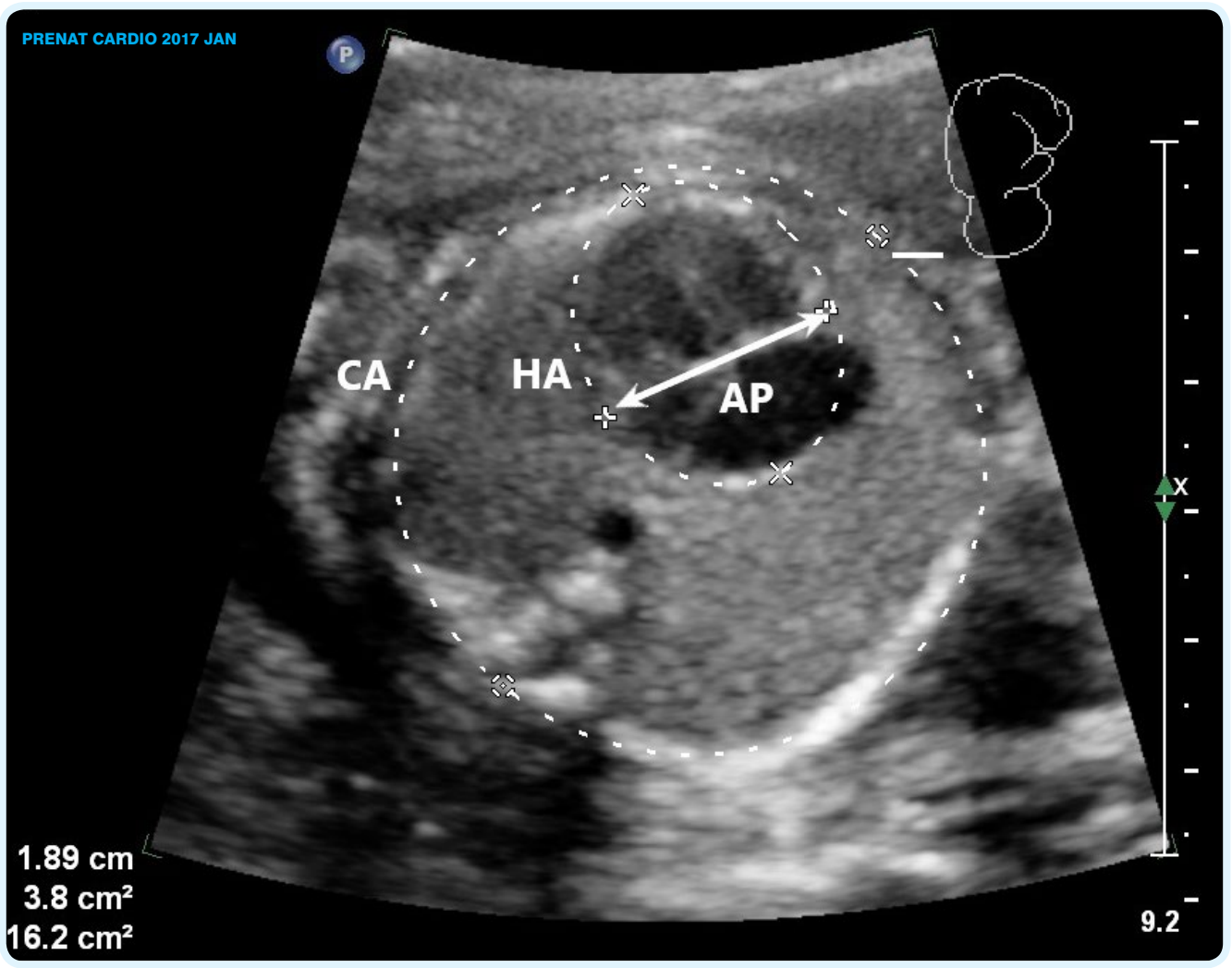

Fig.1. HACA-and-AP-measurement-technique

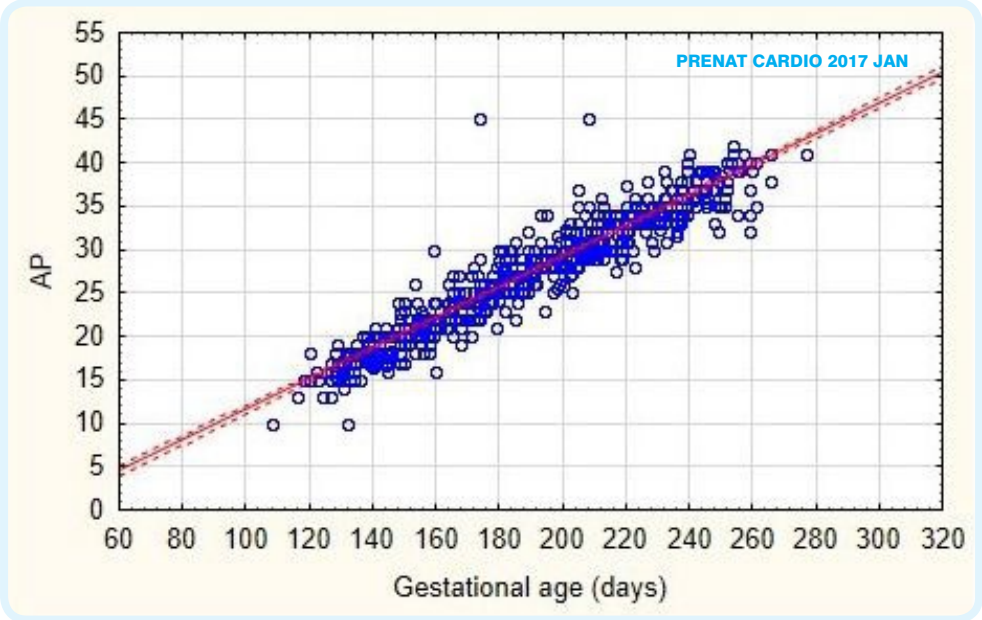

Fig. 2. HACA relative to gestational-age

Analysis of material was achieved using Statistica 13.1 programme.

Interobserver and intraobserver variations were not analyzed. The first author (O.S) did not take measurements, but performed an analysis of collected data.

RESULTS

609 ultrasound examinations were analyzed. In 179 cases sex was identified as female, in 267 as male and in 163 cases sex was not stated in medical records. The mean HA/CA was 0,30 ± 0,015 and seemed to be relatively constant with slight increase with advancing

gestational age. (Fig.2) In group of female the mean HA/ CA was 0,30 ± 0,01 and in group of male 0,30 ± 0,02, and the U Mann- Whitney test showed no statistical difference between groups ($p > 0,05$). The "AP" diameter in whole group correlated with gestational age ($r=0,94$) (Fig. 3), and there was no difference related to the fetuses gender: in female group ($r=0,92$) and in male group ($r=0,95$).

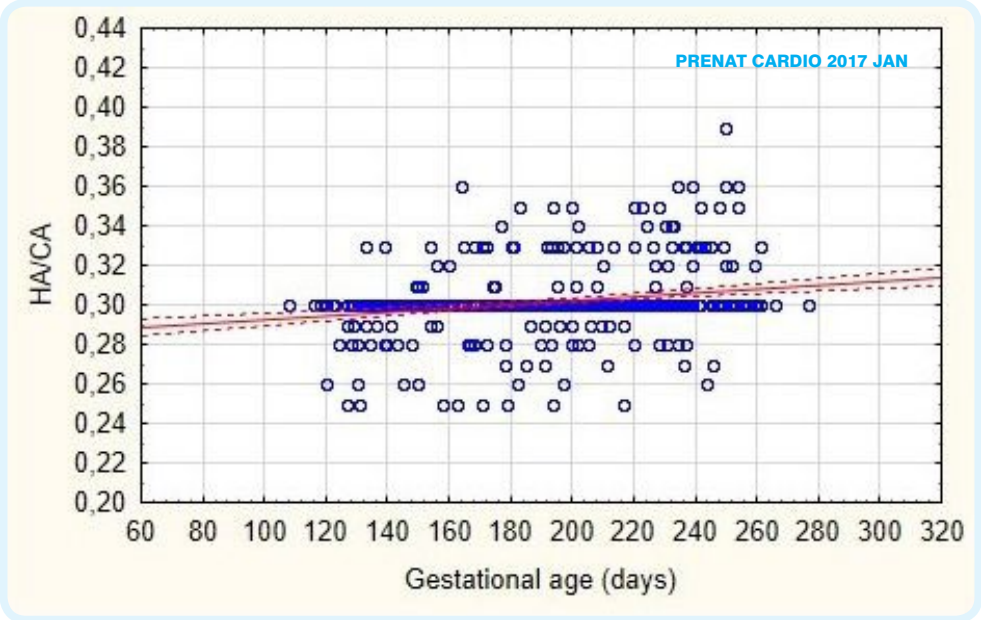

Fig 2. AP relative to gestational-age

DISCUSSION

For the first time in literature FHS was described by Garrett and Robinson in 1970.[15] In the early 1980s fetal echocardiography was introduced to clinical medicine and the logical approach to detection of some congenital heart defects was enabled by concept of using four-chamber view as initial screening tool.[16] This intersection also turned out to be suitable for normalized assessment of FHS.

Total prevalence of congenital heart defects (CHD) varies among studies[17,18] and birth prevalence of CHD is generally accepted as 8 per 1,000 live births,[19] but prevalence of prenatal cardiac defects is much bigger according to Norwegian and Chinese data from the last decade.[20,21] Ultrasound prenatal examination, especially in tertiary referral centers, where well- trained specialists demonstrate high performance of scans[22], allows for favourable postnatal outcome, even if some selected critical CHD.[23]

The CHD usually have normal heart size, , even during progression of the malformation in fetal period[24]. Enlargement of cardiac chambers is a universal sign of heart failure, so fetal heart size ratio belongs to cardiovascular profile score (CVPS) elements, where $<0,35$ and $> 0,2$ means normal and implies adequate tissue perfusion. When the heart failure occurs, the long-term prognosis depends on the underlying cause, but is always connected with poorer outcome. When growth- restricted fetuses, cardiomegaly was one of the strongest predictors for adverse neonatal outcome. A CVPS <7 is associated with mortality.[8,25] Moreover in severe second-trimester twin-twin transfusion syndrome cardiomegaly is one of the frequently observed features, most often in recipient twins, that may lead to death, when not treated.[26] The cardiothoracic ratios are also very useful in the prenatal evaluation of pulmonary hypoplasia and skeletal dysplasia.[5] Therefore detection of fetal heart cardiomegaly may have significant impact on neonatal follow-up and parents counselling.

FHS should be included in every written report from echocardiography examination due to its clinical value. Simplicity of methods performed in our unit strongly suggest that could also be used by obstetricians performing routine ultrasound screening at different gestational age.[6]

Comparing with the previous publications (Table 1) our results are similar. There are some differences between HA/CA, which may result from different techniques of measurements or different gestational age of fetuses [4]

Name of the 1st author	Year of publication	Gestational age (weeks)	Area of heart/ thorax
Garrett et al.	1970	32-40	0,21 ± 0,05
Respondek et al.	1992	22-38	0,30 ± 0,05
Chaoui et al.	1994	20-40	0,25 (20 weeks) 0,30 (40 weeks)
Gembruch et al.	2000	1.10.2017	0,19-0,23
Sylwestrzak & Respondek- Liberska	2018	15-39	0,30 ± 0,015

Table 1. Area of heart/ thorax by different studies[4]

Our normograms could be used for monitoring fetal development, but also for fetal cardiomegaly assessment.

CONCLUSION:

Heart transversal diameter correlates with gestational age

Ha/Ca ratio is relatively constant with slight increase with gestational age.

ACKNOWLEDGEMENTS

The authors would like to thank Maciej Słodki, Katarzyna Zych-Krekora, Joanna Płużańska, Aneta Krasoń, Julia Murlewska, Małgorzata Wlazłowicz, Piotr Surmacki, Agnieszka Żalińska, Bogna Sobkiewicz, Jakub Staniczek, Łukasz Sokołowski, and Monika Wójtowicz- Marzec. This article could not be written without the data obtained during examinations performed at Department of Prenatal Cardiology by them.

References

1. Respondek-Liberska M, Sklansky M, Wood D, Słodki M, Weiner S, Cuneo B, Huhta C.J, Gembruch U, Rizzo G, Sharland G, Achiron R, Pruetz J.D.: Recommendations for fetal echocardiography in singleton pregnancy in 2015. Prenat Cardio. 2015; 5(2): 28-34

2. Satomi G. Guidelines for fetal echocardiography. Pediatr Int. 2015; 57(1): 1-21.

3. American Institute of Ultrasound in Medicine. AIUM practice guideline for the performance of fetal echocardiography. J Ultrasound Med. 2013; 32(6): 1067-82.

4. Strzelecka I, Słodki M, Płużańska J, Moszura T, Węgrzynowski J, Respondek-Liberska M. Routine third trimester fetal cardiac evaluation: time for consideration. Prenat Cardio. 2015; 5(3): 18-23.

5. Gembruch U, Shi C, Smrcek JM. Biometry of the fetal heart between 10 and 17 weeks of gestation. Fetal Diagn Ther. 2000; 15(1): 20-31.

6. Respondek M, Respondek A, Huhta J.C., Wilczynski J. 2D echocardiographic assessment of fetal heart size in the 2nd and 3rd trimester of uncomplicated pregnancy. Eur J Obstet Gynecol Reprod Biol. 1992; 44(3): 185-8.

7. Paladini D, Chita SK, Allan LD. Prenatal measurement of cardiothoracic ratioin evaluation of heart disease. Arch Dis Child. 1990; 65: 20-3.

8. Huhta JC, Diagnosis and treatment of foetal heartfailure: foetalechocardiography and foetal hydrops. Cardiol Young. 2015 Aug;25 Suppl 2:100-6.

9. Davey B, Szwast A, Rychlik J. Diagnosis and management of heart failurein the fetus. Minerva pediatrica. 2012; 64(5): 471-492

10. Thakur V, Fouron JC, Mertens L, Jaeggi ET. Diagnosis and management of fetal heart failure. Can J Cardiol. 2013; 29(7): 759-67.

11. Firpo C, Hoffman JI, Silverman NH. Evaluation of fetal heart dimensions from 12 weeks to term. Am J Cardiol. 2001; 87(5): 594-600.

12. Słodki M, Janiak K, Szaflik K, Wilczyński J, Oszukowski P, Chilarski A, Respondek-Liberska M. [Fetal echocardiography in fetal ovarian cysts]. Ginekol Pol. 2008; 79(5): 347-51.

13. Słodki M, Respondek-Liberska M. New classifications of prenatally diagnosed congenital heart defects and their influence of neonatal survivability. Prenat Cardio. 2015; 5(3): 6-8.

14. Słodki, M, Janiak, K, Zarkowska A, Forys S, Respondek-Liberska M. P04.06: Cardiomegaly in fetus: a powerful indicator of fetal and neonatal demise. Ultrasound Obstet Gynecol. 2009; 34:192.

15. Garrett WJ, Robinson DE. Fetal heart size measured in vivo by ultrasound. Pediatrics. 1970; 46(1): 25-7.

16. Devore GR. Three-dimensional and four-dimensional fetal echocardiography: a new frontier. Curr Opin Pediatr. 2005;17(5): 592-604.

17. Dolk H, Loane M, Garne E; European Surveillance of Congenital Anomalies (EUROCAT) Working Group. Congenital heart defects in Europe: prevalence and perinatal mortality, 2000 to 2005. Circulation. 2011; 123(8): 841-9.

18. Leirgul E, Fomina T, Brodwall K, Greve G, Holmstrøm H, Vollset SE, Tell GS, Øyen N. Birth prevalence of congenital heart defects in Norway 1994-2009-a nationwide study. Am Heart J. 2014; 168(6): 956-64.

19. van der Linde D, Konings EE, Slager MA, Witsenburg M, Helbing WA, Takkenberg JJ, Roos-Hesselink JW. Birth prevalence of congenital heart disease worldwide: a systematic review and meta-analysis. J Am Coll Cardiol. 2011; 58(21): 2241-7.

20. Zhang Y, Riehle-Colarusso T, Correa A, Li S, Feng X, Gindler J, Lin H, WebbC, Li W, Trines J, Berry RJ, Yeung L, Luo Y, Jiang M, Chen H, Sun X, Li Z Observed prevalence of congenital heart defects from a surveillance study in China. JUltrasound Med. 2011; 30(7): 989-95.

21. Tegnander E, Williams W, Johansen OJ, Blaas HG, Eik-Nes SH. Prenatal detection of heart defects in a non-selected population of 30,149 fetuses--detection rates and outcome. Ultrasound Obstet Gynecol. 2006; 27(3): 252-65.

22. Persico N, Moratalla J, Lombardi CM, Zidere V, Allan L, Nicolaides KH. Fetal echocardiography at 11-13 weeks by transabdominal high-frequency ultrasound. Ultrasound Obstet Gynecol. 2011; 37(3): 296-301.

23. Respondek-Liberska M, Sokołowski Ł, Słodki M, Zych-Krekora K, Strzelecka I, Krekora M, Maroszyńska I, Moll J, Moll J. Prenatal diagnosis of TAPVC on Monday, delivery of Tuesday and cardiac surgery at Wensday – a model of perinatal care in 3rd trimester in case of fetal/neonatal critical heart defect in tertiary center. Prenat Cardio. 2016; 6(1):37-42

24. Słodki M, Respondek Liberska M. Hypoplastic left heart syndrome at the tertiary fetal cardiac center: as planned, urgent or severest congenital heart disease? Prenatal classification for obstetricians and neonatologists. Prenat Cardio. 2013; 3(4): 23-27.

25. Mäkikallio K, Räsänen J, Mäkikallio T, Vuolteenaho O, Huhta JC. Human fetal cardiovascular profile score and neonatal outcome in intrauterine growth restriction. Ultrasound Obstet Gynecol. 2008; 31(1): 48-54.

26. Sueters M, Middeldorp JM, Vandenbussche FP, Teunissen KA, Lopriore E, Kanhai HH, Le Cessie S, Oepkes D. The effect of fetoscopic laser therapy on fetal cardiac size in twin-twin transfusion syndrome. Ultrasound Obstet Gynecol. 2008; 31(2): 158-63.

Division of work:

Oskar Sylwestrzak:first draft of manuscript, literature search, statistical analysis

Maria Respondek- Liberska: idea of the article, final version

Conflict of interest: The authors declare no conflict of interest

Authors do not report any financial or personal links with other persons or organizations, which might affect negatively the content of this publication and/or claim authorship rights to this publication