Original **paper**

HEART TUMORS IN 33 FETUSES - REVIEW OF TWENTY-TWO YEARS OF THE SINGLE-CENTRE EXPERIENCE

Authors:
Katarzyna Więckowska[1], Katarzyna Piątek[1], Maria Respondek-Liberska[2,3]

1. Medical University of Lodz, 5th Grade, Scientific Student's Circle of Prenatal Cardiology 2. Department of Diagnoses and Prevention Fetal Malformations, Medical University of Lodz, Poland, 3. Department of Prenatal Cardiology, Polish Mother's Memorial Hospital Research Institute, Lodz, Poland

Prenat Cardio 2016 Jan; 6(1):22-30
DOI: 10.1515/pcard-2016-0003

Abstract

INTRODUCTION: Cardiac tumors (CT) have been diagnosed since the eighties of the last century. The three most commonly diagnosed types of CT are rhabdomyomas, teratomas and fibromas. Severe fetal disturbances, such as arrythmias, fetal hydrops, ventricular obstructions, may be associated with the heart tumor.

AIM OF THE STUDY: To present the key role of the echocardiographic examination in the perinatal care and to present some demographic changes in this population of the youngest patients.

MATERIAL AND METHODS: From the Filemaker database of the Department for Diagnosis and Prevention of Congenital Malformations, Polish Mother's Memorial Hospital & Medical University of Lodz, all cases with prenatal diagnoses of cardiac tumor in singleton pregnancy were compiled over a 22-year period (1993–2015). 33 cases of heart tumors in fetuses had 72 fetal echo examinations. The average number of cases per year was 1,5 (range 1 – 5). The retrospective analysis of the material was performed using the Statistica package. The analysis included the assessment of the cardiovascular condition defined by Cardiovascular Profile Score, location and number of tumors; age, past obstetric history, place of residence of the mother, type of delivery and neonatal follow-up.

RESULTS: The number of fetuses with cardiac tumor cases did not increase during this period. The maternal age was 28,1 years (± 5,2 years) and was decreasing over time. The primigravidae constituted 60% of examined population. The history of past miscarriages was observed in 26% of women. The majority of tumors were detected and diagnosed in the third trimester – at mean 29,6 hbd, but the diagnosis was made earlier in the past decades (regression analysis, p=0,042). The average duration of pregnancy was 36,6 hbd (range: 27-42 hbd). There was no statistical difference between decades in term on pregnancy duration.

The cardiac tumors were more frequent in the female fetuses (71,4% to 28,6%; X2 test; p=0,006). The proportions between the groups of single and multiple tumors changed in last five years – currently the multiple tumors are more frequent (87,5%). The mortality in the group of single tumors was twice as high as in the group of multiple tumors. The percentage of cesarean sections between 1993 and 2005 was 67% and between 2006 and 2015 was 75% (p=0,63). The mortality of neonates with cardiac tumors declined over the period taken into account.

CONCLUSIONS: The perinatal care of the fetuses with cardiac tumors improved over last 20 years. The characteristics of analyzed population had shown that fetal CTs affected healthy, young mothers, more often primigravidae, more often female fetuses. The prevalence of CTs did not increase over time. The gestational age at the time of the diagnosis decreased, thus the period of fetal echo monitoring increased. However, the rate of cesarean sections also increased, which requires further studies and explanations.

Key words: *prenatal cardiology, heart tumors single and multiple , ecology, rate of cesarean sections, CVPS*

DESCRIPTION:

Cardiac tumors, intracardiac masses located in a lumen or walls of the cardiac chambers, in their septa or in the pericardium and have been diagnosed during fetal life since the eighties of the last century. The defects are rare:

How to cite this article:
Więckowska K, Piątek K, Respondek-Liberska M.
Heart tumors in 33 fetuses - Review of twenty-two years of the single-centre experience.
Prenat Cardio 2016 Jan; 6(1):22-30

* the National Polish Registry of Prenatal Cardiac Anomalies reports their prevalence of 1,2% among all fetuses diagnosed with fetal cardiac abnormalities in all prenatal cardiac centers.

The aim of this research was to answer the question: are there any changes in prenatal and

Corresponding author: Maria Respondek-Liberska, majkares@uni.lodz.pl

Submitted: 2015-11-16; accepted: 2015-11-25

perinatal fetal heart tumors prevalence, managements or demographic data in this and previous decade? Do we know any relationship between occurrence of cardiac tumors and hazardous environmental pollutions or other risk factors?

INTRODUCTION

Cardiac tumors, intracardiac masses located in a lumen or walls of the cardiac chambers, in their septa or in the pericardium and have been diagnosed during fetal life since the eighties of the last century[1]. The defects are rare: the National Polish Registry of Prenatal Cardiac Anomalies reports their prevalence of 1,2% among all fetuses diagnosed with fetal cardiac abnormalities in all prenatal cardiac centers.

In general, heart tumors are easy to detect in utero thanks to 2D ultrasound. The real-time three-dimensional echocardiography adds the visualization of continuity, curvature and exact location of tumor, as well as the assessment of dynamic changes of fetal cardiac size and wall motion, although the resolution of this technique is inferior to 2D imaging [2].

The diagnostic procedure may be extended to MRI scan [3].

Fetal cardiac tumors may cause hemodynamic compromise in fetus and later on and still there is lack of information about the cause of the problem[4].

The aim of this research was to answer the question: are there any changes in prenatal and perinatal fetal heart tumors prevalence, managements or demographic data in this and previous decade? Do we know any relationship between occurrence of cardiac tumors and hazardous environmental pollutions or other risk factors?

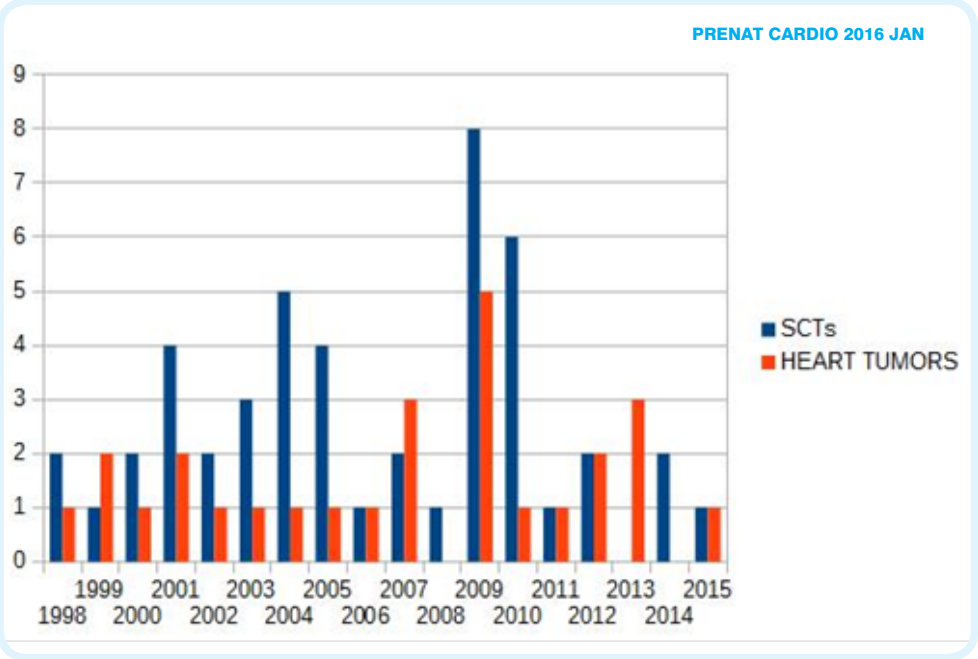

Fig. 1. Number of fetuses with heart tumors between 1993 and 2015 with comparison to the number of fetuses with sacrococcygeal teratoma in our unit.

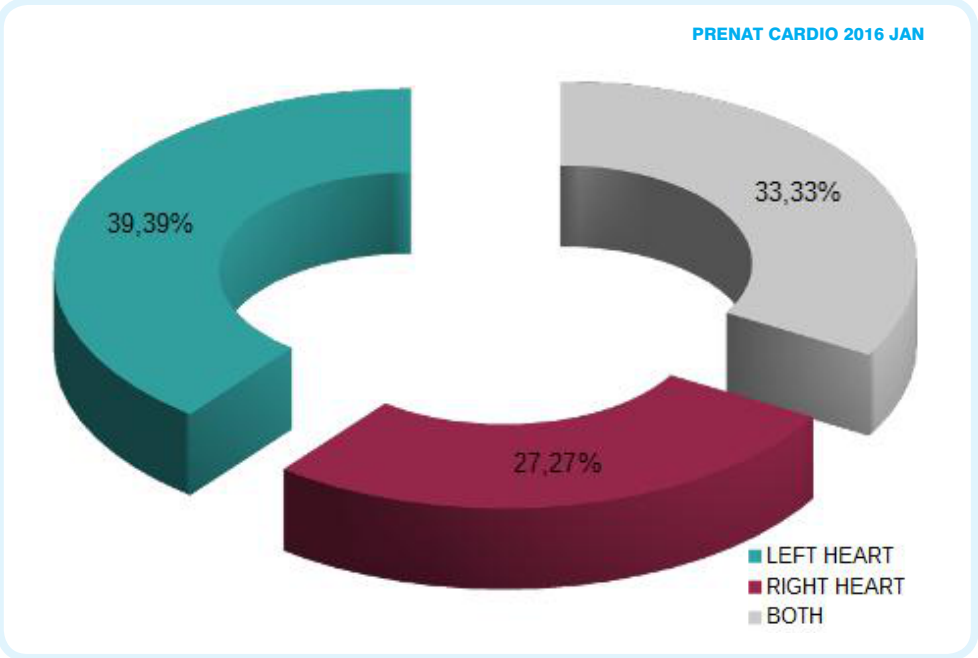

Fig. 2. Location of the tumor.

MATERIAL & METHODS

From the Filemaker and archival databases of the Department for Diagnosis and Prevention of Congenital Malformations of the Medical University and Department of Prenatal Cardiology at Polish Mother's Memorial Hospital (same unit) all cases of prenatal diagnoses of cardiac tumors in singleton pregnancies were compiled over a 22-year period (1993–2015). Thirty three fetuses had a single or multiple heart tumor. Seventy two fetal echo examinations were performed in them.

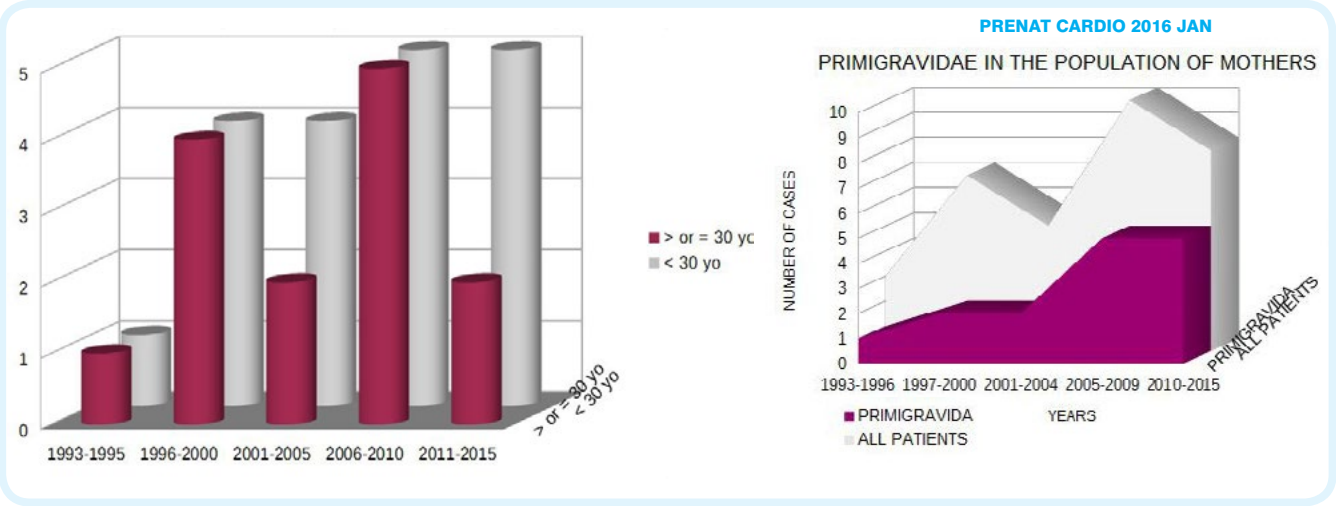

Fig. 3. Maternal characteristics – age and past obsteric history.

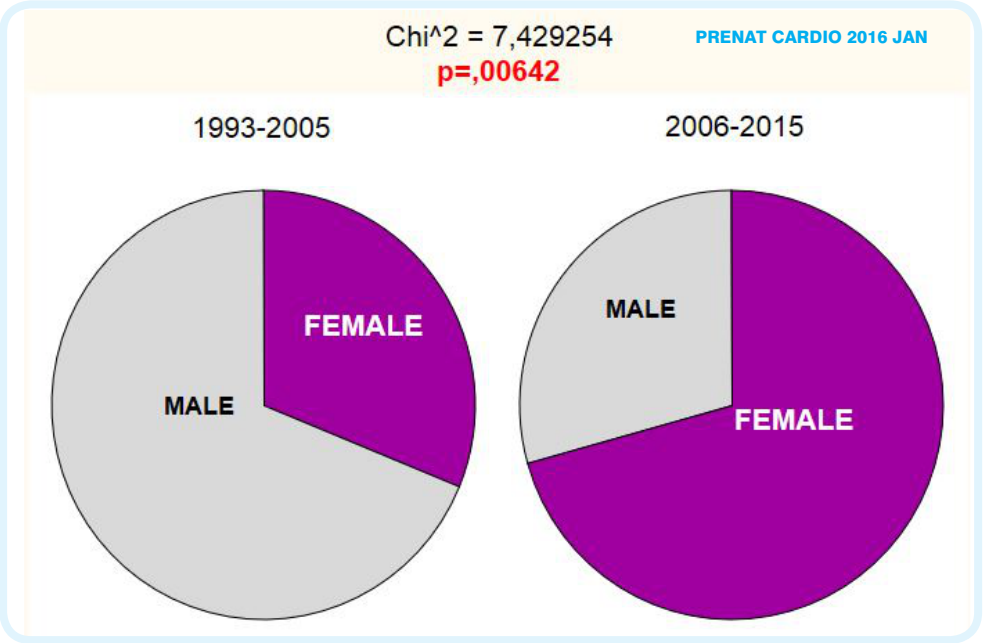

Fig. 4. Sex of the fetuses.

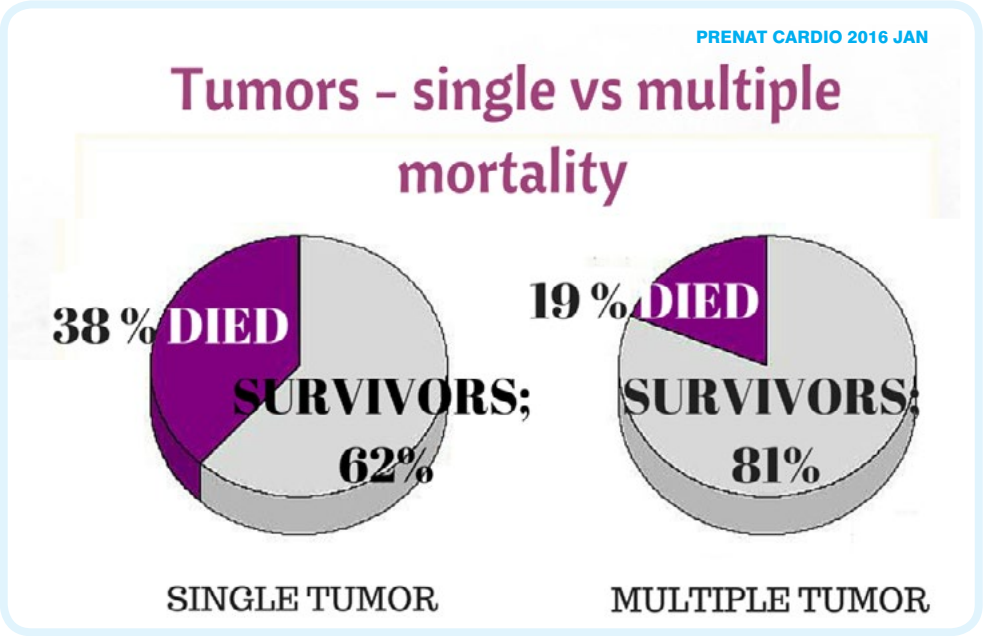

Fig. 5. Mortality in the groups of single and multiple tumors.

The analysis included the assessment of the cardiovascular condition defined by Cardiovascular Profile Score, location and number of tumors; age, past obstetric history, place of residence of the mother, type of delivery and neonatal follow-up. The retrospective analysis of the material was performed using the Statistica 12 package.

At the same time the National Polish Registry of Prenatal Cardiac Anomalies was searched for the reports on characteristics and outcome in the overall population of fetal cardiac tumors in Poland between 2004 (the year of establishing of the Registry) and 2015.

RESULTS:

The average number of fetuses with heart tumors was 1,5 per year (range 0 – 5). The number of cases per year is presented in Figure 1. There was one startling peak of diagnosed fetuses in 2009 and it coincided with peak of sacrococcygeal teratomas diagnosed in our institution.

There was a large variability in tumors size. The average size of the tumors was 18,4x16,1x12 mm. The maximal diameters range

	N	Mean	Min	Max
Maternal age [years]	33	28,1	19	37
GA at the time of diagnosis [hbd]	33	29,9	20	40
GA at the time of diagnosis at the Department of Prenatal Cardiology, Lodz [hbd]	33	33,1	22	41
Size 1. of largest the tumors, first exam [mm]	31	18,4	3,5	47
Size 2. of largest the tumors, first exam[mm]	27	16,1	4	46
Size 3. of largest the tumors, first exam [mm]	8	12	4	20
Fetal weight [g]	33	2011	301	4090
HA/CA	32	0,408	0,3	0,8
CVPS	31	8,39	5	10
Time of the labour [hbd]	27	36,8	27	42
Apgar	27	7,3	0	10
Birth weight [g]	27	2883,7	770	4000
Days of hospitalization	22	23,5	1	71

Table 1. Maternal and fetal characteristics.

Type of congenital heart's defect	Outcome
Aortic Stenosis	Surgical management, good outcome
Tetralogy of Fallot	Surgical management, good outcome
Atrioventricular Septal Defect	Neonatal death (third day of life)
Aortic Stenosis	Neonatal death (tenth day of life)
Hypoplastic Left Heart Syndrome	Neonatal death
Aortic Stenosis	Surgical management, good outcome

Table 2. Types of congenital heart tumors coexisting with fetal heart tumor.

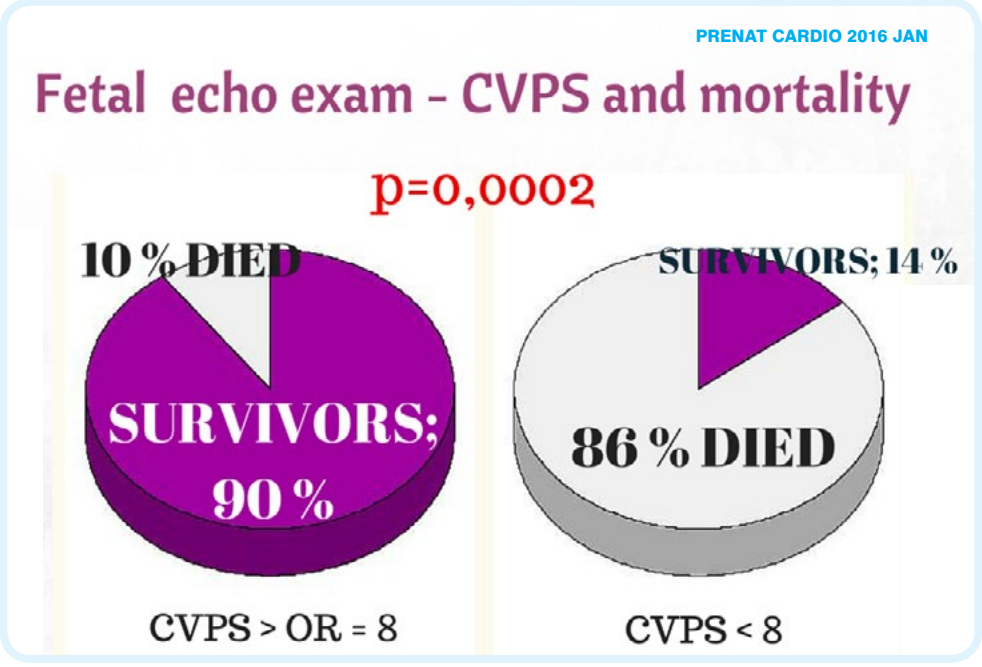

Fig. 6. The prognostic factor in fetal cardiac tumors – CVPS.

between 4 and 47 mm. One third of fetuses have a tumor placed in the right heart, one third in the left, remaining in both sides (Figure 2). The location of tumor did not play a key role in prognosing the neonatal survival. The maternal and fetal characteristics are presented in Table 1.

Pregnant women were most frequently referred for echocardiographic examination because of abnormal four-chamber views observed during obstetric ultrasonographic scans. If a cardiac tumor was suspected, fetal echocardiographic examination was performed to assess cardiac anatomy, number of tumors, their localization, and the hemodynamic status. The first observation of the tumor was made at 20 week of gestation (the latest at 40th week of gestation!).

The average age of the gravida was 28,1 years (± 5,2 years). Examined mothers of fetuses with cardiac tumors were healthy women < 30 years of age. Primigravidae accounted for a large part of the population: they constituted 60% of patients in the last six years (Fig. 3). 26% of patients had a bad obstetric history, but this percentage diminishes in years.

Regarding fetuses population, the majority of affected patients were female. These proportions changed from the past decade, when the boys were more often touched by cardiac tumors (X^2 test, p=0,006; Fig 4).

In six out of 33 cases fetal heart tumor coexisted with congenital heart disease. They are listed in Table 2.

Multiple cardiac tumors were more frequent than the single ones which stems from the theory that the multiple rhabdomyomas are the most common type of CT. The mortality in the group of single tumors (rather more malignant fibromas or teratomas) was twice as high as in the group of multiple tumors (implicilty rhabdomyomas) – 38% to 19% (Fig. 5.)

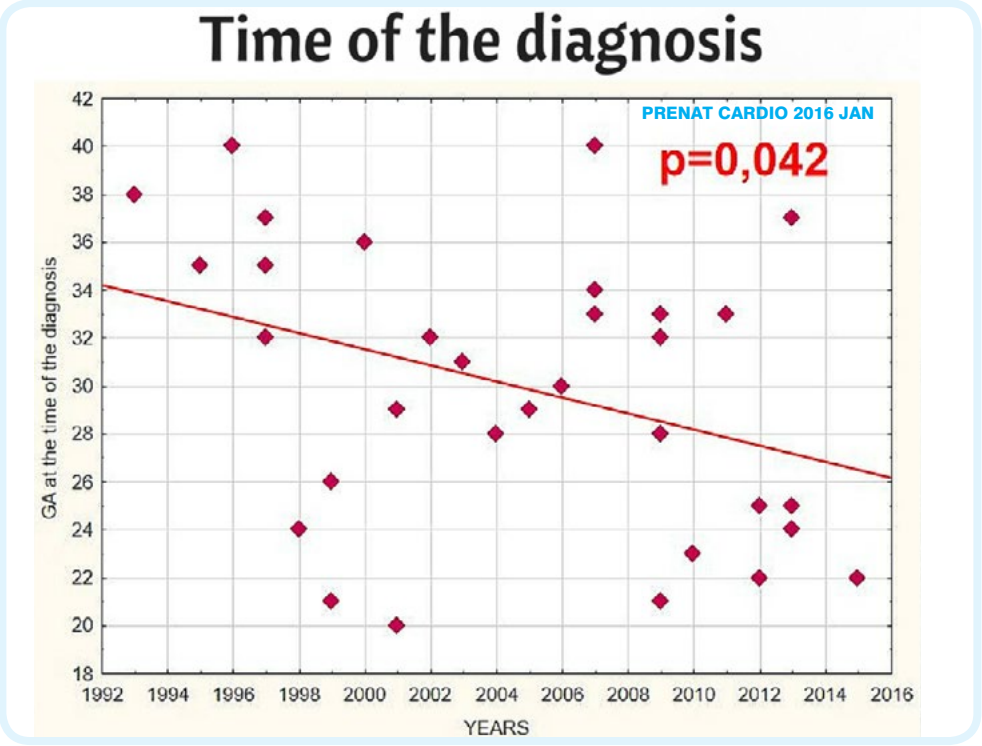

Fig. 7. Regression analysis of the gestational age at the time of he first visualisation of the tumors.

The overall mortality in the analyzed population has dropped down to about 20% in late nineties of the twentieth century. We should therefore ask if this outcome may be better in future years. The mortality of fetus in the group of a bad cardiovastular condition (CVPS < 8) was more than eight times higher than in the group of good cardiovascular profile (CVPS > or = 8), which was statistically proven with p=0,0002 (X^2 test, Fig. 6).

The prenatal diagnosis of fetal heart tumor in the last decade was made earlier during gestational age than it was being done in the past years and it was statistically proven (Fig. 7)

When the mothers' place of residence was taken into account, the occurrence of cardiac tumors in certain parts of Poland, especially around the Kuiavian-Pomeranian voivodeship, was observable.

Therefore, the ecological situation of this region was checked, based on the data of the Inspection of Environmental Protection. According to the data from years 2007 and 2008 cardiac tumors were recorded in regions of high concentration of benzapirene and other polycyclic aromatic hydrocarbons (red on the map). Benzene can also be a suspect factor (Fig. 8).

The data below were obtained from the National Polish Registry of Prenatal Cardiac Anomalies data from years 2004-2015.

In the group of multiple tumors the average birth weight of a neonate was 3277 g (2050 g – 4080 g). 66,7% of children died within 10 minutes after the labor. The majority (53%) of alive neonates was discharged home, 33% were referred to the tertiary cardiac care center, 7% to the Intensive Care Units of these centers, there were no neonatal deaths recorded in this group. One third (33%) of neonates underwent a cardiosurgical procedure.

In the group of single tumors the average birth weight of a neonate was 2930 g (1000 g – 3950 g). The questionnaire concerning the labor was filled in 37,9% of cases. 54,5% of children died within 10 minutes after the labor. The follow-up of 27% of alive children is not known, 27% of neonates were discharged home, 18% were referred to the tertiary cardiac care center, 9% to the Intensive Care Units of these centers. 18% died in the neonatal period. Three neonates underwent a cardiosurgical procedure, one out of them died after the surgery.

DISCUSSION:

Fetal cardiac tumors are rare anomalies. Based on the National Polish Registry of Prenatal Cardiac Anomalies between 2004 ans 2015, 76 cases out of 7097 (1,07%) between 2004 and 2015 presented at different fetal cardiac centers with cardiac tumors of all types. 47 cases (61%) were multiple lesions. Average number of US examinations before the tumor was detected was 3,6, and the diagnosis was made at 28,6 weeks of gestation on average.

In National Polish Registry of Prenatal Cardiac Anomalies database only 34,2 % of parents sent a follow-up letter, so the final outcome is relative difficult to follow. In our unit and tertiary teaching hospital we had more data for analysis.

Types of fetal cardiac tumors

Rhabdomyomas

It is the most comon type of tumor (76% - 83%)[5,6,7,8]. They usually are multiple (less often single), homogenous, well-circumscribed masses, variable in size and location[5]. Normally, they do not cause cardiac compromise, but cases of obstructive or arrhythmogenic tumors are known.

These tumors are likely to appear at 20 weeks of gestational age and predominatingly disappear completely in infancy [9-11]. According to Yinon et al.[6] about 80% patients with rhabdomyosarcoma are alive and well at follow-up appointment in infancy. In about 12% of pregnancies the intrauterine or neonatal death was observed. They were associated with:

- fetal hydrops,

- large size of the tumor (≥20-40 mm),
- delivery before 31 weeks of gestation,
- fetal dysrhythmia, especially treatment-resistant SVT.[6,7]

Association with tuberous sclerosis

These tumors are commonly associated with Bourneville-Pringle disease, known also as tuberous sclerosis. This genetical disorder is inherited autosomally dominantly with high penetrance. It is caused by mutations in Hamartin

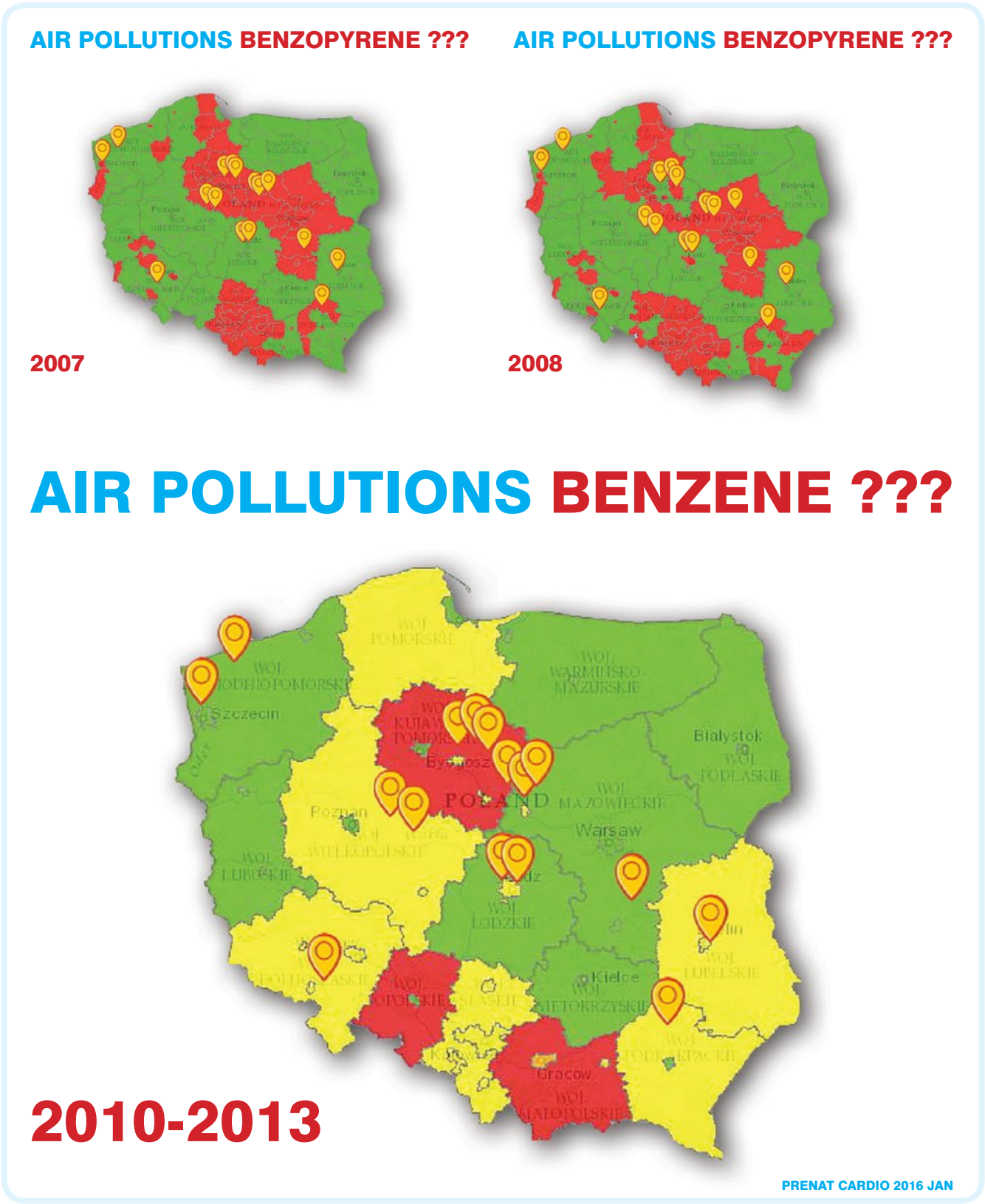

Fig. 8. Analysis of the mother's place of residence superimposed on the Poland's map with benzene and benzopyren increased level according to official goverment report (data from: powietrze.gios.gov.pl).

	HA/CA	CVPS	FO	PE	TR	Single/ Multiple	APGAR SCORE	BIRTH WEIGHT	NEONATAL DEATH
1	0,4	9				S	9	2000	NND
2	0,3	8		PE	trace	S	7	2800	NND
3	0,43	8				M	7	3500	
4				PE		S	9	3200	
5	0,8	5		PE	TR	S			NND
6	0,3	9		PE		S	9	2900	
7	0,63	6		PE	TR	M	0	2450	NND
8	0,3	10				M	8	2200	
9	0,43	8			TR	S	6	3700	
10	0,42	9				M	9	3650	
11	0,38	9				M	9	3200	
12	0,35	10				S	8	2000	
13	0,38	10				M	3	2600	
14	0,45				TR	S	9	2950	
15	0,54	7		PE	TR	M	9	2320	NND
16	0,37	9			trace	M			
17	0,36	8			trace	M	9	3250	
18	0,4	9				S	9	3950	
19	0,51	6		PE		M	6	2850	
20	0,41	9				M			
21	0,51	5	Restriction	PE	TR	S	7	2220	NND
22	0,52	8		PE		S	9	3250	
23	0,45	5	Restriction	PE	TR	M			NND
24	0,35	10				S	8	4000	
25	0,34	10				M	9	2400	
26	0,38	8			trace	S			
27	0,3	8		PE	TR	M	6	2200	
28	0,39	7		PE		S	2	770	NND
29	0,36	10				M	10	3600	
30	0,34	10				M	10	3900	
31	0,3	10				M	10	3300	
32	0,35	10				M	9	2700	
33	0,3	10				M			

Table 3. Echocardiographic findings and neonatal outcome in analysed population.

(TSC-1) and Tuberin (TSC-2) genes. Located on 9q34 and 16p13 chromosomes. Hamartin and tuberin are responsible for tumors supression. In Bourneville-Pringle disease nodules, especially hamartomas, are present in the skin, brain, kidneys and visceral organs. Cardiac tumors are usually rhabdomyomas. The spectrum of the disease is very wide. Some signs may be absent[4].

In case series reported by Sciacca et al. [12] about 30% of rhabdomyomas associated with TS were observed in fetal echocardiographic examination. In case of postnatal diagnosis, 50 to 80 percent of cases are associated with rhabdomyomas. The intracranial lesions are found in 40% of cases in the MRI examinations, what means that absence of brain tumors does not rule out tuberous sclerosis.

Recently, the tuberous sclerosis is achieved by molecular testing. The material is obtained during cordocentesis, chorionic villus sampling or amniocentesis. The early diagnosis should be conducted when the family history of epilepsy[13], chronic headaches or subtle skin lesions, such as nodules or cafe-au-lait spots, is positive. Genetic counselling is needed in all cases of fetal rhabdomyomas[4,14,15].

Teratomas

Teratoma is a cystic pericardial tumor[5]. It may be attached to the aortic root or to the pulmonary artery. In the largest number of cases a teratoma is single, it consists multiple cysts. Moreover, pericardial effusion is associated with this kind of heart tumor. Although it is histologically benign, it may be life-threatening because it leads to heart's compression and in consequence to fetal hydrops and intrauterine death.

Outcome of pregnancies known from literature differ. Yinon et al.[6] recall three cases, none of them ends favourably. On the other hand, a multidisciplinary approach to this rare tumor may have superb effects[16,17]. Tollens et al.[17] present a management algorithm for cases diagnosed with teratoma in antenatal period. It bases on the presence of fetal hydrops and size of the tumor's mass.

Fibromas

These rare tumors are usually single and they are difficult to distinguish from rhabdomyoma[5]. Sometimes they degenerate centrally and form cysts. There is an

association between fibromas and pericardial effusion. There are few articles reporting fetal diagnosis of cardiac fibroma[18,19].

CONCLUSIONS:

This report shows that fetal cardiac tumors occur in the population of healthy young mothers, expecting their first child. The risk factors are not easily detectable.

We have found that clinical condition and neonatal outcome is not different between neonates with single and multiple tumors, which is consistent with the analysis performed by Niewiadomska-Jarosik et al. (2010)[20]. The tumors were located mostly in the left ventricle, but these observations were made on a small populations[21]. When they are placed in the LVOT, they may induce a cardiovascular compromise in fetus.

Due to the fact that the prognosis of the outcome cannot be made only on the basis of the size[22], location or number of the tumors the cardiovascular condition of the fetus (CVPS) should be monitored subsequently to the time of labor.

The perinatal care has done a milestone – the diagnosis is made earlier which enables longer monitoring of the fetus in future years. The role of fetal echocardiography must be stressed. There is no monitoring of cardiac tumors without the prenatal cardiologist. The multidisciplinary approach including 2-D echocardiography, histology, genetics, and cardiac surgery is recommended[23,24].

In case of single tumor surgical procedures is likely to be performed in neonate. The multiple tumors have chance to dissapear in infancy, therefore the observation and early neurological care is recommended. Children with confirmed tuberous sclerosis may benefit the antiepileptic treatment introduced before the onset of clinical seizures, continued to the second year of age[25].

ACKNOWLEDGEMENTS

The authors would like to thank all obstetricians who referred pregnant women directly to our unit for an out-patient clinic evaluation whose cases were analyzed in this article: Jerzy Węgrzynowski, Elżbieta Kukawczyńska, Jacek Paluszyński, Katarzyna Niewiadomska-Jarosik, Sławomir Świderski, Ryszard Jęczeń, Mariusz Dubiel, Bartłomiej Mroziński, Piotr Kaczmarek and Wiktor Świercz among others. We thank as well as also our colleagues from obstetrical departments of our institute for whom we made a fetal heart evaluation on hospital basis.

This article could not be written without the data obtained during examinations performed at the Department of the Prenatal Cardiology by Katarzyna Janiak, Alicja Żarkowska, Sebastian Foryś, Hanna Moczulska, Jakub Malinowski and Beata Radzymińska-Chruściel.

This paper was presented at the 54th Polish and 12th International Juvenes Pro Medicina Conference, 22nd and 23rd April 2016.

References

1. DeVore GR, Hakim S, Kleinman CS, Hobbins JC. The in utero diagnosis of an interventricular septal cardiac rhabdomyoma by means of real-time-directed, M-mode echocardiography. American Journal of Obstetrics & Gynecology. 1982 Aug 15;143(8):967-9.

2. Hata T, Yan F, Dai S, Kanenishi K, Yanagihara T. Real-Time 3-Dimensional Echocardiographic Features of Fetal Cardiac Tumor. Journal of Clinical Ultrasound 2007, 35(6):338-340.

3. Shukla AK, Reddy AK, Latha A, Jayamohan AE. Cardiac rhabdomyoma: an antenatal illustration. British Medical Jornal Case Reports 2015 Published online. doi:10.1136/bcr-2014-209256

4. Abuhamad A, Chaoui R. A Practical guide to Fetal Echocardiography. Wolters Kluwer PA, US, 2010.

5. Sharland G. Fetal Cardiology Simplified. A Practical Manual. tfm Publishing Ltd. 2013, pp. 275-281.

6. Yinon Y, Chitayat D, Blaser S, Seed M, Amsalem H, Yoo S, Jaeggi ET. Fetal cardiac tumors: a single-center experience of 40 cases. Prenatal Diagnosis 2010; 30: 941-949.Chao AS, Chao A, Wang TH, Chang YC, Chang YL, Hsieh CC, Lien R, Su WJ. Outcome of antenatally diagnosed cardiac rhabdomyoma: case series and a meta-analysis. Ultrasound in Obstetrics & Gynecology 2008; 31:289-295.

7. Chao AS, Chao A, Wang TH, Chang YC, Chang YL, Hsieh CC, Lien R, Su WJ. Outcome of antenatally diagnosed cardiac rhabdomyoma: case series and a meta-analysis. Ultrasound Obstet Gynecol 2008; 31:289-295.

8. Atalay S, Aypar E, Uçar T, Altu N, Deda G, Teber S, Tutar E. Fetal and neonatal cardiac rhabdomyomas: clinical presentation, outcome and association with tuberous sclerosis complex. The Turkish Journal of Pediatrics 2010; 52:481-487.

9. Paladini D, Palmieri S, Russo GM, Pacileo G. Cardiac multiple rhabdomyomatosis: prenatal diagnosis and natural history. Ultrasound in Obstetrics & Gynecol. 1996; 7:84-5

10. Colosi E, Russo C, Macaluso G, Musone R, Catalano C. Sonographic diagnosis of fetal cardiac rhabdomyomas and cerebral tubers: a case report of prenatal Tuberous Sclerosis. Journal of Prenatal Medicine 2013; 7(4):51-55.

11. Milano EG, Prioli MA, Vassanelli C. Spontaneous regression of a large rhabdomyoma of the interventricular septum. Cardiology in the Young 2014;24:379-381.

12. Sciacca P, Giacchi V, Mattia C, Greco F, Smilari P, Betta P, Distefano G. Rhabdomyomas and Tuberous sclerosis complex. Our experience in 33 cases. BioMed Central Cardiovascular Disorders 2014;14:66.

13. Chen C, Chang T, Guo W, Su Y, Chen Y, Chern S, Su J, Wang W. Detection of maternal transmission of a splicing mutation in the TSC2 gene following prenatal diagnosis of fetal cardiac rhabdomyomas mimicking congenital cystic adenomatoid malformation of the lung and cerebral tubers and awareness of a family history of maternal epilepsy. Taiwanese Journal of Obstetrics&Gynecology 2013;52:415-419.

14. Gupta N, Singh N, Sarangi S, Dalmia S, Mittal S. Fetal cardiac rhabdomyoma with maternal tuberous sclerosis complicating pregnancy. Arch Gynecol Obstet 2008; 278:169-170.

15. Karadeniz C, Çiftçi Ö, Demir F, Atalay S, Uçar T, Tutar E. Reflection of paternal tuberous sclerosis in the fetus: Cardiac rhabdomyoma. Journal of Obstetrics and Gynaecology, 2013;Vol.33 (6):627-628

16. Iacona GM, Barber MA, Medina M, Abella R. Intrapericardial teratoma in a low birth weight preterm infant: a successful multidisciplinary approach. Interactive Cardiovascular and Thoracic Surgery 2011; 12:287-289.

17. Tollens M, Grab D, Lang D, Hess J, Oberhoffer R. Pericardial Teratoma: Prenatal Diagnosis and Course. Fetal Diagnosis & Therapy 2003;18:432–436

18. Malisch TW, Jeanty P. Cardiac fibroma. Fetus:1991;1:1.

19. Munoz H, Sherer DM, Romero R, Sanchez J, Hernandez I, Diaz C. Prenatal sonographic findings of a large fetal cardiac fibroma. Journal of Ultrasound in Medicine 1995;14:479-481.

20. Niewiadomska-Jarosik K, Stańczyk J, Janiak K, Jarosik P, Moll JJ, Zamojska J, Respondek-Liberska M. Prenatal diagnosis and follow-up of 23 cases of cardiac tumors. Prenatal Diagnosis 2010;30:882-887.

21. Geipel A, Krapp M, Germer U, Becker R, Gembruch U. Perinatal diagnosis of cardiac tumors. Ultrasound in Obstetrics & Gynecology 2011; 17: 17-21.

22. Lacey SR, Donofrio MT. Fetal cardiac tumors: prenatal diagnosis and outcome. Pediatric Cardiology 2007;28:61-67.

23. Pucci A, Botta G, Sina N, Tibaldi M, Valori A, Grosso E, Zonta A, Giudici M, Agnoletii G, Bergamasco L, Abbruzzese PA, Bartoloni G. Life-threatening tumors of the heart in fetal and postnatal age. The Journal of Pediatrics;vol. 162;5:964-969.

24. Padalino MA, Reffo E, Cerutti A, Favero V, Biffanti R, Vida V, Stellin G, Milanesi O. Medical and surgical management of primary cardiac tumours in infants and children. Cardiology in the Young 2014;24:268-274.

25. Jóźwiak S, Kotulska K, Doma ńska-Pakieła D, Łojszczyk B, Syczewska M, Chmielewski D, Dunin-Wąsowicz D, Kmie ć T, Szymkiewicz-Dangel J, Kornacka M, Kawalec W, Kuczy ński D, Borkowska J, Tomaszek K, Jurkiewicz E, Respondek-Liberska M. Antiepileptic treatment before the onset of seizures reduces epilepsy severity and risk of mental retardation in infants with tuberous sclerosis complex. European Journal of Pediatric Neurology 2011(15):424-431.

Division of work:

Katarzyna Więckowska: first draft, literature search, statistical analysis

Katarzyna Piątek: data base analysis, literature search, work with manuscript

Maria Respondek-Liberska: concept of the research, 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