CASE SERIES

Diagnostic application of prenatal ultrasound in foetal heart complex malformation in twin pregnancy

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Abstract

To explore the value of prenatal ultrasound in the diagnosis of twin pregnancy with foetal heart malformation, 30 foetuses with congenital heart disease of twin pregnancy who were 19-37 weeks between July 2016 and January 2018 were selected for prenatal ultrasound examination. The prenatal ultrasound was carried out and the data were collected and analyzed statistically. The results showed that there were 11 cases of ventricular septal defect (VSD), 3 cases of endocardial cushion defect, 3 cases of left cardiac dysplasia, 4 cases of right ventricular double outlet, 5 cases of aortic stenosis, 2 cases of tetralogy of Fallot, and 2 cases of aortic disconnection. It was found that VSD had the highest detection rate amongst foetal congenital heart disease. Therefore, prenatal ultrasound is the most effective method to diagnose foetal congenital heart disease.

Keywords: Prenatal ultrasound, Twin pregnancy, Heart malformation.

Introduction

With the development of assisted reproductive technology, more and more infertile women, especially older women, get pregnant, and the multiple pregnancy increases correspondingly. Multiple pregnancy not only causes maternal complications and adverse pregnancy outcomes, but also significantly increases the risk of foetal malformation in elderly multiple pregnant women.[1] The incidence of foetal abnormalities increases with the number of foetuses in multiple pregnancies. The incidence of foetal abnormality is relatively independent in each twin pregnancy, and the incidence of foetal abnormality is about twice as high as in a single pregnancy.[2] In monozygotic twin pregnancy, the risk of foetal genetic and chromosomal abnormalities is the same as that in single birth, but the incidence of foetal structural abnormalities is significantly increased.[3] Congenital heart disease is the most common congenital malformation, with the highest incidence of birth defects and the highest cause of infant death.[4] Prenatal diagnosis of foetal cardiac malformation has important clinical significance for the selection of pregnancy outcome.[5]

At present, prenatal diagnosis of congenital heart disease mainly depends on foetal echocardiography. Ultrasound is widely used in clinic because it is non-invasive, simple and reproducible. It can advance the diagnosis of congenital heart disease to the foetal stage. Foetal echocardiography can show the anatomical structure of the heart more accurately, which is the gold standard for prenatal diagnosis of congenital heart disease.[6-8] With the development of ultrasound equipment and technology, 3d ultrasound is gradually applied in clinical practice. Studies have shown that three-dimensional ultrasound can more comprehensively and intuitively display the spatial position, internal morphology and adjacent relationship of the foetal heart, and show the deep cardiac structure that can't be displayed by two-dimensional ultrasound, thus providing more information for the diagnosis of complex congenital heart disease.[9-15] The operating skills and diagnostic level of acoustic physicians are constantly improving, and the examination methods are from three-slice method, five-slice method to combined multi-slice method. With the increase of the examination section, the sensitivity and specificity of the examination results also increase.[16-19]

Case Series

We randomly included 30 foetuses who underwent prenatal ultrasonography with twin gestation - foetal congenital heart disease at 19-37 gestation weeks from July 2016 to January 2018. They were diagnosed by prenatal ultrasound examination in China Aerospace Science & Industry Corporation 731 Hospital. All subjects enrolled were managed as per the hospital standards and policy. All the staff received unified training, and the use of ultrasound instruments was strictly in accordance with the "prenatal diagnosis management measures".

Preoperative preparation, foetal system examination, foetal heart examination, follow-up and chromosome examination and quality control were carried out. The

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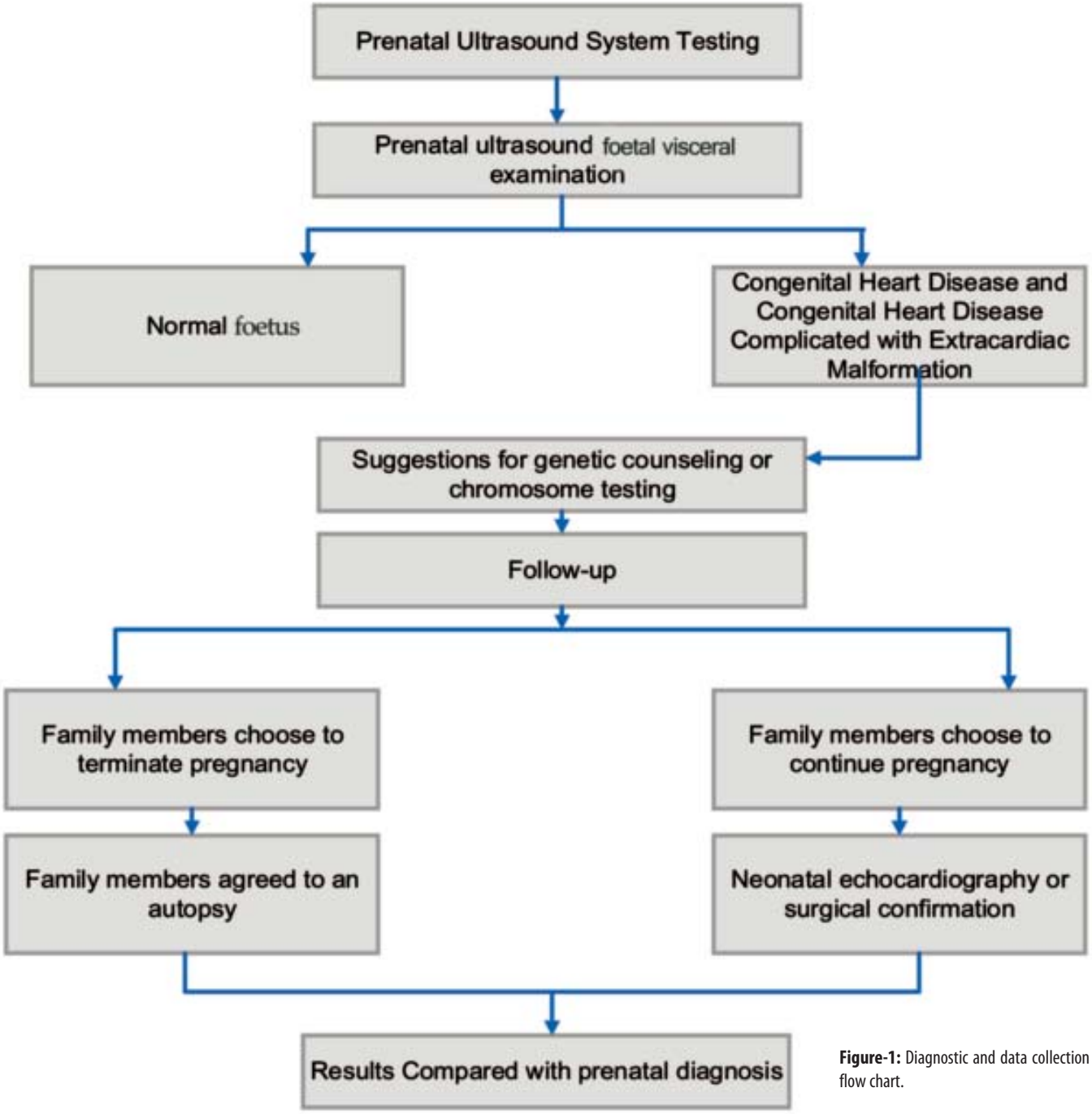

Figure-1: Diagnostic and data collection flow chart.

foetus with chromosomal abnormality and the foetus with normal chromosome but fatal congenital heart disease (CHD) chromosome were recommended to terminate the pregnancy. Data was entered and analysed by using SPSS 16.0 statistical software, chi-square test was applied for counting data, and p-value < 0.05 was taken as significant. Thus, the purpose of this research was to study the application of prenatal ultrasound in the diagnosis of foetal heart complex malformations in twin pregnancies.

Preoperative Preparation

Preoperative examination included blood routine, coagulation function, liver function biochemistry, C-reactive protein and leucorrhoea routine, etc., and contraindications such as vaginal bleeding, vaginal inflammation, abnormal coagulation function and abnormal liver function were excluded. The patients and their families were explained that abortion, preterm birth,

chorionic amnionitis and other complications may be caused by the reduction of pregnancy and the pregnant women and their families carefully read the informed consent and signed it. All foetal structural abnormalities were confirmed by ultrasonography. For prenatal diagnosis of chromosomal disease or haemophilia, the foetus was determined according to placental location. Before the prenatal diagnosis cycle of chromosomal disease, fluorescence in situ hybridization of foetal heart blood or chromosome gene chip analysis was performed to confirm the target foetus.

Foetal System Examination

GE Voluson color doppler ultrasound was used for diagnosis, and pregnant women were in supine position. The ultrasound diagnostic instrument was set as the condition for systematic screening and examination of the foetus, and the probe was placed on the abdominal wall of the pregnant woman. Routine obstetric ultrasound measurement was conducted for the foetus according to the "prenatal ultrasound examination guide" P01, including foetal double top diameter, head circumference, femur length, bone length and other growth parameters. Then the foetal head, labial face, spine, chest cavity, abdominal cavity, limbs and other systems were examined successively, and the amniotic fluid, placenta and umbilical cord were evaluated. If any abnormality was found in the inspection process, multi-section scanning would be carried out for the abnormal structure. During the inspection, the instrument was adjusted to the best display according to individual differences, and the image was collected in the computer work station.

Foetal Heart Examination

After the systematic examination, the ultrasonic diagnostic instrument was set as the condition of foetal heart examination, the enlarged image was used to occupy 1/3 to 1/2 of the display screen, and the instrument was adjusted to the best display according to individual differences.

Follow-up and Chromosome Examination

For the foetus with cardiac malformation examined by ultrasound above, it was suggested to conduct clinical genetic counselling after chromosome examination. The foetus with chromosomal abnormality and the foetus with normal chromosome but fatal congenital heart disease (CHD) chromosome were recommended to terminate the pregnancy. For those who chose to terminate the pregnancy with the consent of the family members and had signed the consent of autopsy and pathological examination, autopsy could be conducted. For those who chose to continue pregnancy, the neonatal echocardiography or telephone follow-up was performed until the child was 1 year old, and the follow-up results were recorded. Some of the patients examined in other hospitals were followed up by telephone.

Quality Control

The criteria were strictly enforced, patients who met the criteria were included. The participants included two chief physicians, two deputy chief physicians, and one attending physician. Patients were required to carefully read and sign the informed consent, and fill in the prenatal examination questionnaire. All cases were registered and followed up regularly to ensure the integrity of ultrasonogram and clinical data. Finally, the accuracy of ultrasound diagnosis was determined by calculating the coincidence rate on the basis of postnatal autopsy results or neonatal EKG examination and postnatal surgery. The loss of follow-up rate (cases where autopsy or neonatal echocardiography was performed or surgery was performed and was consistent with prenatal examination results / cases where autopsy or neonatal echocardiography was performed or surgery was performed) should be controlled within 10%. SPSS 16.0 statistical software was used for statistical analysis in this data, chi-square test was used for counting data, and $P < 0.05$ was

Table-1: Prenatal ultrasound examination of 8 cases of fetal CHD with extracardiac malformation.

No.	Gestational weeks	Congenital heart disease	Extracardiac malformation
1	32	AVSD, double outlet of ventricle	Talipes equinovarus
2	29	DORV, VSD, HLHS	Widened clear septum, single umbilical artery
3	34	Aortic coarctation	Hydrops abdominis
4	25	TOF	Left kidney loss, left horseshoe varus, single umbilical artery
5	26	Left atrial isomerism, AVSD	Partial visceral inversion
6	19	HLHS	Whole forebrain, chest and peritoneal effusion, foetal skin oedema
7	38	TOF	Short limbs, missing thumbs in both hands
8	23	AVSD	Left radius and ulna lost, deformity of both hands

AVSD: Aortoventricular Septal defect. DORV: Double Outlet Right Ventricle. VSD: Ventricular Septal Defect. HLHS: Hypoplastic left heart syndrome. TOF: Tetralogy of Fallot.

considered statistically significant.

Comparison of the Types of Foetal Malformations Between the two Groups

There were 30 cases of foetal congenital heart disease in twin pregnancy, including 28 cases of twin chorionic twins and 2 cases of single chorionic twins. In cardiac abnormality types, there were 11 cases (36.7%) of ventricular septal defect, 3 cases (10%) of Atrioventricular septal defects (AVSD), 3 cases (10%) of Hypoplastic left heart syndrome (HLHS), 4 cases (13.3%) of Double Outlet Right Ventricle (DORV), 5 cases (16.7%) of aortic stenosis, 2 cases (6.7%) of TOF (tetralogy of Fallot), and 2 cases (6.7%) of interrupted aortic arch (IAA). For multiple co-existing complex CHD (congenital heart disease), as shown in Figure-2.

Among the 30 cases, 8 cases were foetal congenital heart disease complicated with extracardial malformation (one case could be complicated with multiple extracardial malformations), and the characteristics were shown in Table-1. A total of 24 of the 30 cases underwent chromosome examination, and the specific results were shown in Figure-3. The incidence of chromosomal abnormalities in foetuses with CHD was significantly higher than that in foetuses with only CHD.

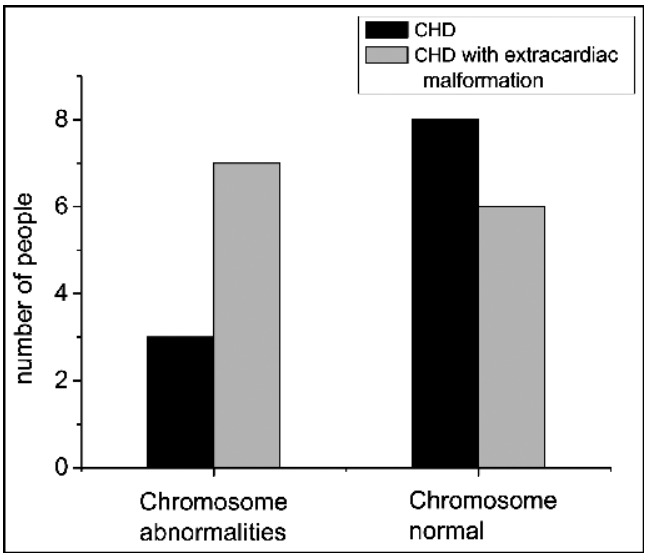

Figure-3: Chromosome examination results of CHD and CHD combined with extracardiac malformation.

Discussion

Clinically, about 40% of infants die of heart defects. Congenital heart defects are also one of the high-risk factors leading to infant death. During pregnancy, 20 weeks after pregnancy is the period of complete foetal heart development. If the heart has irreversible lesions, prenatal screening should be carried out in time to determine whether there is heart abnormality, so as to terminate the pregnancy in time Improve the birth quality of the population. After 20 weeks of pregnancy, the foetal heart gradually develops completely. Prenatal ultrasound can effectively diagnose foetal heart malformation.[20] However, due to the small size and complex structure of foetal heart, the accuracy of screening is affected by foetal development, maternal factors, instrument conditions and other factors in the process of ultrasound examination.[21]

Due to the limitation of medical technology, most of the heart malformation foetuses are difficult to cure, so prenatal diagnosis and screening is particularly important.

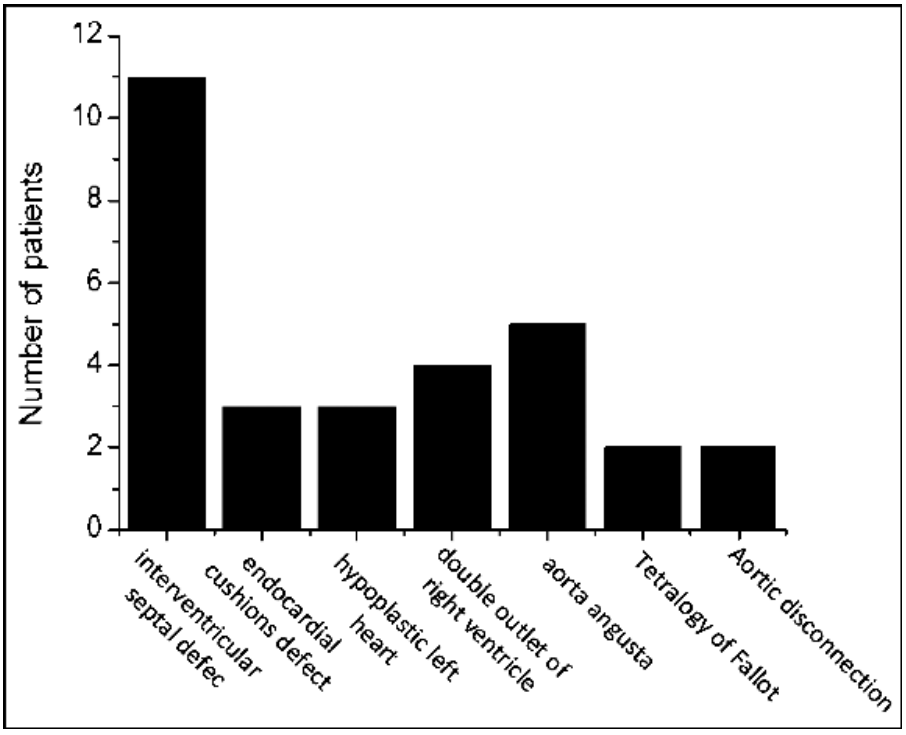

Figure-2: Incidence of congenital heart disease in 30 foetuses.

At present, the main screening method is ultrasonic examination, which has the advantages of non-invasive and economic.[22] It can detect foetal heart malformation in early stage, timely implement treatment, reduce the birth rate of foetal heart malformation, and improve the survival rate of foetal heart malformation.[23]

This study analysed and summarized the cases of foetal heart malformation under ultrasound, which provided the basis for clinical diagnosis and classification. It was found that 11 cases of VSD, 3 cases of endocardial cushion defect, 3 cases of left cardiac dysplasia, 4 cases of right ventricular double outlet, 5 cases of aortic stenosis, 2 cases of tetralogy of Fallot and 2 cases of aortic disconnection were diagnosed by ultrasound. The most common is ventricular septal defect (VSD), which is congenital heart disease of the foetus, with the highest prenatal detection rate.

Ventricular septal defect (VSD) is an opening in the ventricular septum that results in blood flow between the left and right ventricles.[24] The interventricular septal anatomical structure is composed of four parts: the inflow tract septum, the outflow tract septum (including cone part and funnel part), the membrane septum and the muscle septum. According to the anatomical structure, VSD can be divided into four types, among which the peri membranous part is the most common, accounting for about 80%, the muscular part accounts for about 5%-20 %, the inflow tract accounts for about 5% - 8%, and the outflow tract accounts for about 5%. Two-dimensional ultrasound can be detected in the middle and late pregnancy. The commonly used sections include four-chamber section and five-chamber section. Because foetal ventricular pressures on the left and right are almost equal, all VSD colour doppler shows no obvious shunt or bidirectional shunt.

Endocardial pad defect, also known as complete atrioventricular septal defect, is the abnormal heart development of atrial septal primary septal defect combined with ventricular septal defect and abnormal common atrioventricular valve connecting left and right ventricles.[25] It is caused by the failure of endocardial cushion fusion during embryonic development and can be divided into equilibrium and non-equilibrium. AVSD is most easily detected in the four-chamber cardiac tangential plane, common atrioventricular valve can be seen in diastole, and the cross structure disappears. Left ventricular dysplasia is a complex cardiac dysplasia, including severe dysplasia of the left ventricle and left ventricular outflow tract.[21]

Interruption of aortic arch is a developmental abnormality in which the ascending aorta is completely dissociated from the descending aorta. IAA can be divided into three types according to different interrupt sites: type A, the distal end of the left subclavian artery; type B, the interruption is located between the left common carotid artery and the left subclavian artery; type C, the interruption is between the brachiocephalic trunk and the left common carotid artery. Among them, type B is the most common and type C is rare. The main section of the two-dimensional ultrasound diagnosis is the long axis section of the aortic arch, and the continuity of the ascending aorta and the descending aorta is interrupted.

The main reason for misdiagnosis in clinical examination is that the current medical technology level cannot detect the patent ductus arteriosus. At the same time, the reason why the simple malformation of the heart cannot be detected before delivery may be related to the operation ability of the operator, the performance of the instrument and the fetal movement.[26] In order to further improve the detection rate of foetal congenital heart malformation, it is necessary to strengthen the training of relevant personnel, in order to improve the accuracy of the examination, and provide a technical basis for the realization of eugenics and the protection of mother and infant health and safety.[27] In addition, with the continuous development and progress of medical technology, prenatal ultrasound can be combined with cytogenetic examination to improve the detection rate of foetal heart malformation.[28]

In summary, ultrasound screening has the advantages of low price, high accuracy and low risk. It can detect foetal heart malformation early, provide clinical basis for further pregnancy and intervention, so as to improve the prognosis and survival rate of infants with heart malformation, which is worth further promotion in clinical.

Conclusion

We concluded that 11 cases of ventricular septal defect, 3 cases of endocardial pad defect, 3 cases of left cardiac dysplasia, 4 cases of right ventricular double outlet, 5 cases of aortic stenosis, 2 cases of tetralogy of Fallot and 2 cases of aortic disconnection were detected. The most common occurrence was ventricular septal defect, which was the congenital heart disease of the foetus with the highest prenatal detection rate.

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Conflict of Interest: We declare that all contributing

authors of this paper have no conflict of interest and all have contributed equally for this research work.

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References

1. Chelli D, Achour A, Mraihi F, Abdallah M, Boudaya F. EP08. 04: Contribution of ultrasound in the diagnosis and management of twin pregnancies with single fetal malformation. Ultrasound Obstet Gynecol 2017;50(Suppl 1):293.
2. Neves AR, Nunes F, Branco M, Almeida MDC, Santos Silva I. The role of ultrasound in the prediction of birth weight discordance in twin pregnancies: are we there yet? J Perinat Med 2018;46:163-8. doi: 10.1515/jpm-2016-0371.
3. Kadji C, Bevilacqua E, Hurtado I, Carlin A, Cannie MM, Jani JC. Comparison of conventional 2D ultrasound to magnetic resonance imaging for prenatal estimation of birthweight in twin pregnancy. Am J Obstet Gynecol 2018;218:128.e1-11. doi: 10.1016/j.ajog.2017.10.009.
4. Liu J, Ashraf MA. Face recognition method based on GA-BP neural network algorithm. Open Physics 2018;16:1056-65. DOI: 10.1515/phys-2018-0126
5. Nasreen S, Rafique U, Ehrman S, Ashraf MA. Synthesis and Characterization of Mesoporous Silica Nanoparticles for Environmental Remediation of Metals, PAHs and Phenols. Ekoloji 2018;27:1625-37.
6. Barkat MQ, Mahmood HK. Phytochemical and antioxidant screening of Zingiber officinale, Piper nigrum, Rutag raveolanes and Carum carvi and their effect on gastrointestinal tract activity. Matrix Sci Med 2018;2:9-13. DOI: 10.26480/msm.01.2018.09.13
7. Chen S, Meng X, Wang Y, Sun X. Antioxidant activity and optimisation of ultra sonic-assisted extraction by response surface methodology of aronia melanocarpa anthocyanins. Matrix Sci Pharma 2018;2:6-9. DOI: 10.26480/msp.01.2018.06.09
8. Khan F, Khan MI, Khan S, Zaman MA, Rasheed H, Khan AR. Evaluation of agronomic traits for yield and yield components in wheat genotypes with respect to planting dates. Malays J Sustain Agric 2018;2:7-11.
9. Ying HS, Anuar MS, Nor MZM. Drying, Colour and Sensory Characteristics of 'Berangan'Banana (Musa Accuminata) Flesh Dried Using a Microwave Oven. Malays J Halal Res 2018;1:10-4. DOI: 10.26480/mjhr.01.2018.10.14
10. Lu Z, Daxing X, Hailun W. Two-Stage Cubature Kalman Filterand Its Application in Water Pollution Model. Acta sci Malays 2018;2:9-13. DOI: 10.26480/asm.01.2018.09.13
11. Nordin NFH, binti Ibrahim NHS, Chowdhury AJK. Physicochemical parameters and bacterial composition in sungau pusu gombak. Sci Herit J 2018;2:10-2. DOI: 10.26480/gws.01.2018.10.12
12. Mukhtar S, Khan H, Kiani Z, Nawaz S, Zulfiqar S, Tabassum N. Hospital waste management: execution in Pakistan and environmental concerns-a review. Environ Contam Rev 2018;1:13-7. DOI: 10.26480/ecr.01.2018.18.23
13. Nwankwoala HO, Tariah DI, Udom GJ. Aspects of Shallow Groundwater Quality in Calabar South, Cross River State, Nigeria. Acta Chemica Malaysia 2018;2:20-5. DOI: 10.26480/acmy.01.2018.20.25
14. Jasim SN, Salih NM, Kadim RJ, AL-Bayar AH, Abd-Abdlatif SA. Quantitative Assessment Of Chemical Composition, Antimicrobial Efficacy And Some Active Compounds Of Merremia Dissecta. Acta Chemica Malaysia 2018;2:1-5. DOI: 10.26480/acmy.02.2018.01.05
15. Morin L, Lim K. No. 260-Ultrasound in Twin Pregnancies. J Obstet Gynaecol Can 2017;39:e398-411. doi: 10.1016/j.jogc.2017.08.014.
16. Fosler L, Winters P, Jones KW, Curnow KJ, Sehnert AJ, Bhatt S, et al. Aneuploidy screening by non-invasive prenatal testing in twin pregnancy. Ultrasound Obstet Gynecol 2017;49:470-7. doi: 10.1002/uog.15964.
17. Wang HL, Sun L, Zhou S, Wang F. Association between 5,10-methylenetetrahydrofolate, gene polymorphism and congenital heart disease. J Biol Regul Homeost Agents 2018;32:1255-60.
18. Moreau A, Bolze P, Joly H, Atallah A, Massardier J, Massoud M. P29. 03: Assessment of fetal myocardial performance index in routine follow?up of twin pregnancy: feasibility study. Ultrasound Obstet Gynecol 2017;50(Suppl 1):250.
19. Farsetti D, Pisani I, Tiralongo G, Lo Presti D, Gagliardi G, Manicuti C, et al. P29. 02: Maternal hemodynamic in monochorionic twin pregnancy: hypodynamic circulation and reduced cardiac power. Ultrasound Obstet Gynecol 2017;50(Suppl 1):249-250.
20. Malutan AM, Dudea M, Albu C, Ciortea R, Diculescu D, Mocan-Hognogi R, et al. Monochorionic-diamniotic twin pregnancy complicated by twin reversed arterial perfusion sequence and retroplacental hematoma - a case report. Med Ultrason 2018;20:396-8. doi: 10.11152/mu-1486.
21. Zosmer N, Jauniaux E, Bunce C, Panaiotova J, Shaikh H, Nicholaides KH. Interobserver agreement on standardized ultrasound and histopathologic signs for the prenatal diagnosis of placenta accreta spectrum disorders. Int J Gynaecol Obstet 2018;140:326-31. doi: 10.1002/ijgo.12389.
22. Jauniaux E, Collins S, Burton GJ. Placenta accreta spectrum: pathophysiology and evidence-based anatomy for prenatal ultrasound imaging. Am J Obstet Gynecol 2018;218:75-87. doi: 10.1016/j.ajog.2017.05.067.
23. Li JL, Hai-Ying W, Liu JR, He QM, Chen KS, Yang J, et al. Fetal Lymphangioma: Prenatal diagnosis on ultrasound, treatment, and prognosis. Eur J Obstet Gynecol Reprod Biol 2018;231:268-73. doi: 10.1016/j.ejogrb.2018.10.018.
24. Revels JW, Wang SS, Itani M, Nasrullah A, Katz D, Dubinsky TJ, et al. Radiologist's Guide to Diagnosis of Fetal Cardiac Anomalies on Prenatal Ultrasound Imaging. Ultrasound Q 2019;35:3-15. doi: 10.1097/RUQ.0000000000000412.
25. Li L, Bahtiyar MO, Buhimschi CS, Zou L, Zhou QC, Copel JA. Assessment of the fetal thymus by two- and three-dimensional ultrasound during normal human gestation and in fetuses with congenital heart defects. Ultrasound Obstet Gynecol 2011;37:404-9. doi: 10.1002/uog.8853.
26. Moon NR, Min JY, Kim YH, Choi SK, Shin JC, Park IY. Prenatal diagnosis of epignathus with multiple malformations in one fetus of a twin pregnancy using three-dimensional ultrasonography and magnetic resonance imaging. Obstet Gynecol Sci 2015;58:65-8. doi: 10.5468/ogs.2015.58.1.65.
27. McFadden P, Smithson S, Massaro R, Huang J, Prado GT, Shertz W. Monozygotic Twins Discordant for Trisomy 13: A Case of Trisomic Rescue Supporting the Continued Need for First-Trimester Ultrasound. Pediatr Dev Pathol 2017;20:340-7. doi: 10.1177/1093526616686471.
28. Xu T, Wang X, Luo H, Yu H. Sirenomelia in twin pregnancy: A case report and literature review. Medicine (Baltimore) 2018;97:e13672. doi: 10.1097/MD.0000000000013672.