Predictive value of aberrant right subclavian artery for fetal chromosomal in women of advanced maternal age

**CURRENT STATUS:** UNDER REVIEW

**BMC Pregnancy and Childbirth**

Jian-Hong You 303912440@qq.com
Zhongshan Hospital Xiamen University
*Corresponding Author*
*ORCiD: 0000-0002-8522-9407*

Li-Ping Chen
Xiamen Maternity and Child Health Hospital

Xiao-Hong Zhong
Xiamen Maternity and Child Health Hospital

Jiang-Hua Chen
Zhongshan Hospital Xiamen University

Jing-Xian Xie
Xiamen Maternity and Child Hospital

Xiao-Kang Chen
Children's Hospital of Fudan University Xiamen Branch

Xiao-Yan Chen
Zhongshan Hospital Xiamen University

Guo-Rong Lyu
Quanzhou medical college

**DOI:**
10.21203/rs.2.15296/v1

**SUBJECT AREAS**
Maternal & Fetal Medicine

**KEYWORDS**
Ultrasonography, Fetus, Aberrant right subclavian artery, Chromosomal abnormalities, Advanced maternal age
Abstract

Background: In entire population, aberrant right subclavian artery (ARSA) was in closely association with chromosomal abnormalities. The risk of fetal chromosomal abnormalities increased with the maternal age exponentially. While, the situation in advanced maternal age (AMA) group is uncertain. This study aimed to establish the incidence of ARSA in Chinese AMA and non-AMA women and to determine the frequency of aneuploidy among AMA and non-AMA women with ARSA.

Methods: The retrospective study included 13,690 singleton pregnancies which were divided into AMA and non-AMA groups. Integrated obstetric ultrasonic screening, biochemical screening, noninvasive prenatal screening and fetal karyotype analysis were analyzed.

Results: 1. The overall incidence of ARSA was 0.69 % with no difference in both groups. 2. The prevalence rate of chromosomal abnormalities in AMA group (37/2,860) was much higher than that in non-AMA group. The risk of chromosomal abnormalities significantly increased with both ARSA detected and additional ultrasound findings. 3. With ARSA detected, the incidence increased to 20.00 % and 10.00 % in AMA and non-AMA cases, respectively. 4. Additionally, a case with chimeric Turner syndrome (45X/46XX) was found with isolated ARSA in AMA pregnancy. Conclusion: There is a high prevalence of chromosomal abnormalities in AMA fetuses. Both isolated and nonisolated ARSA would increase the risk of chromosomal abnormalities. Moreover, when ARSA is found in AMA ones, it confers a sharp increase in the incidence of chromosomal abnormalities.

Introduction

Advanced maternal age (AMA) is defined as a woman who conceiving and delivering babies at the age of 35 years or older [1–4]. According to data from Office for National
Statistics, in 2013, 20% of births in England and Wales were to women aged 35 years or over and the average age of mothers has dramatically increased with years [1]. In China, the proportion of increased gradually from 10.1% in 2011 to 20.5% in 2016, and it would grow to new highs especially after "Two-child Policy" carried out [2].

As we known, maternal age was in closely association with a range of pregnancy complications, such as preeclampsia, stillbirth and fetal anomalies [1-3]. The risk of fetal chromosomal abnormalities increased with the maternal age exponentially. For example, the overall incidence of Down’s syndrome is one in every 800 births while it roughly climbs to 1.44 in every 100 births in AMA women [4].

Even so, according to Chen et al. [3], there is no need for AMA pregnant women to accept invasive prenatal diagnosis directly. But what if there are other associated fetal structural abnormalities in AMA women, like aberrant right subclavian artery (ARSA)? During pregnancy, ARSA may easily be detected by prenatal ultrasonography whatever the trimester of pregnancy [5]. The incidence rate of ARSA as an isolated abnormality in healthy populations is known to be about 1% to 2% [6]. Even so, Chaoui et al. [7] reported the prevalence of ARSA in fetuses with Down’s syndrome for the first time and recommended that an ARSA would act as a new soft marker for trisomy 21 risk assessment. Prevalence of ARSA was 1.02% in euploid fetuses, whereas 23.6% in Down’s syndrome fetuses [8]. Therefore, ARSA appears to be a fairly reliable ultrasound clue for fetal chromosomal abnormalities, especially congenital cardiac defects and aneuploid abnormality [5-8].

Most studies indicated that isolated ARSA had no much clinical significance, and there was no need to serve an invasive prenatal chromosomal testing [7-10]. In Italy, an invasive procedure was offered to all patients with intermediate risk and a retrotracheal ARSA [8]. In the study of Fehmi et al. [10], they suggested fetus with ARSA and aneuploid relevant
ultrasonic soft features, AMA and abnormal biochemical screening to undergo amniocentesis. They concluded that in fetuses with ARSA, karyotyping could be offered to detect Down’s syndrome if any high risk factors present. However, in most existing studies, the predictive value of from ARSA in AMA and non-AMA women was not compared. In AMA women, whether ARSA is an effective predictor for fetal chromosomal abnormalities? Is it necessary for those women to take an invasive routinely screened? Hence, the main purposes of this study were to: (1) determine the incidence of both isolated and nonisolated ARSA in Chinese AMA and non-AMA women. (2) assess the correlation between fetal chromosomal abnormalities and ARSA with or without additional ultrasound findings in AMA pregnancy.

Materials And Methods

Study population and device

There were 13,690 singleton pregnancies with complete materials who underwent fetal ultrasonic prenatal screening including grade I, grade II, grade III and fetal echocardiography in our hospital after 16 weeks recruited for this retrospective study, including 10,830 non-AMA women and 2,860 AMA women between September 2015 and January 2018 in Zhongshan hospital of Xiamen university and Maternity and Child Health Care Hospital of Xiamen University. The approval from the Medical Ethics Committee of Xiamen university and written informed consent from the participants were collected. Prenatal ultrasonography screening was performed using a transabdominal high-resolution probe (C4-8-D probe and 9L-D high frequency probe; Voluson E8 / E10; GE Medical Systems, Zipf, Austria).

Study design

The information of all included pregnant women was retrieved from our computerized database. Pregnancies was divided into AMA and non-AMA group based on the age of their
due dates. Upon the discovery of an ARSA, relevant prenatal diagnostic information was classified and summarized including ultrasonography abnormality, soft markers, serum screening, noninvasive and invasive karyotype analysis, chromosomal microarray and so on. All the participants received the ARSA scanning. All ARSA fetuses and suspected cases should be diagnosed by two physicians (with prenatal diagnosis qualification and rich experience) and confirmed by at least one follow-up review. All ARSA cases were followed up until birth by neonatal conventional ultrasonography and echocardiography for postnatal confirmation. ARSA negative fetuses should also be followed up as often as possible to ensure the reliability of the diagnosis, especially to these fetuses at a relatively small gestational age. Prenatal consultation with noninvasive or invasive karyotype analysis was recommended for all fetuses with ARSA. Women who did not undergo invasive karyotype analysis, major aneuploidy abnormalities and karyotype abnormalities were excluded by noninvasive DNA tests, detailed prenatal examinations and neonatal follow-up, and they were considered to have a normal karyotype. All aborted fetuses received autopsies with informed consent on time. The flow chart of this study was shown in Figure 1.

Method of ARSA detection

After routine examination, the fetal heart mode was turned on, and the local amplification function was adjusted to make the section clearly displayed. The angle of ARSA and incident sound wave was ensured less than 30. Axial view (the three vessel and trachea view), longitudinal view and coronal view were conventionally observed to screen ARSA [11]. When ARSA was displayed in two dimension mode, Doppler velocity was adjusted to (15 - 30) cm/s to verify the diagnosis. ARSA departed from the origin of the descending aorta, namely the junction of the aortic arch and ductal arch, walked between the trachea and the vertebra, and extended towards the right shoulder. Anatomical and ultrasonic
Statistical analysis

Statistical analysis was completed using SPSS software, Version 20.0 (IBM Corporation, Somers, NY). A chi-square test and Fisher’s exact test were utilized to compare the incidences of chromosomal abnormalities and ARSA between groups. P < 0.05 was considered statistically significant.

Results

Demographic data and general characteristics

During this period, a total of 13,690 singleton pregnancies (ranging from 16 weeks + 0 days to 38 weeks + 5 days) were recruited in the study, including 10,830 non-AMA women with the average age of \((27.1 \pm 4.15)\) year old and 2,860 AMA women with the average age of \((38.3 \pm 3.48)\) year old. Among these, ARSA was prenatally detected with the overall incidence of \(0.69\% \ (95 / 13,690)\), including 63 cases \((63 / 95, 66.32\%)\) with isolated ARSA. In non-AMA group, 70 of 10,830 fetuses were prenatally visualized with an ARSA, with the incidence of 0.65 %. And in AMA group, 25 out of 2,860 fetuses were visualized with an ARSA, with the incidence of 0.87 %. In our study, chromosomal abnormalities were detected with a rate of \(0.75\% \ (102 / 13,690)\), including 0.63 \%(65 / 10,380)\) in non-AMA group and \(1.29\% \ (37 / 2,860)\) in AMA group. Demographic data and general characteristics were listed in Table 1.

Of the isolated ARSA babies, 62 \((98.41\%)\) cases were born including 14 \((56.00\%)\) cases in AMA group and 48 \((68.57\%)\) cases in non-AMA group, and no abnormality was found in clinical follow-up observation. Another simple ARSA case in AMA group were detected with sex chromosome aneuploidies \((\text{SNP Array arr (1-22)x2, (X)x1-2})\). The woman had no pregnancy high-risk factors and complications with the critical risk of Down’s syndrome screen. Sex chromosome aneuploidies was firstly implied by Cell-free DNA detecting and
verified by amniocentesis karyotype analysis. Of the 32 cases of ARSA with additional structural malformation, 28 cases had their pregnancies terminated and 11 cases of them had abnormal karyotype. There were 4 patients in AMA group and 7 patients in non-AMA group, including trisomy 13 syndrome, trisomy 18 syndrome and trisomy 21 syndrome. The other four normal karyotype fetuses were delivered smoothly, respectively associated with a choroid plexus cyst, unilateral renal agenesis, persistent left superior vena cava and pulmonary sequestration.

**Prevalence rate of chromosomal abnormalities**

In the ARSA positive crowd, the prevalence rate of chromosomal abnormalities was as high as 20.00 % (5 / 25) in AMA group and 10.00 % (7 / 70) in non-AMA group. Furthermore, follow-up on fetus with nonisolated ARSA and chromosomal abnormalities, we found 58.33 % (7 / 12) cases with trisomy 21 syndrome, 25.00 % (3 / 12) cases with trisomy 18 syndrome, 8.33 % (1 / 12) cases with trisomy 13 syndrome and 8.33 % (1 / 12) cases with chimeric Turner syndrome (45X / 46XX). Among these nonisolated ARSA, the incidence of chromosomal abnormalities was 34.38 % (11 / 32) and the incidence of trisomy 21 syndrome was 21.88 % (7 / 32) including 30.00 % (3 / 10) in AMA group and 18.18 % (4 / 22) in non-AMA group respectively. More information was detailed in Tables 2.

The prevalence rate of chromosomal abnormalities in AMA group was much higher when comparing to that in non-AMA group ( = 13.79, df = 1; P = 0.00). While there was no difference in ARSA incidence rate between AMA and non-AMA group ( = 1.19, df = 1; P = 0.24), and so was that in isolated and combined ARSA ( = 0.18, df = 1; P = 0.68 and = 1.50, df = 1; P = 0.22). The risk of chromosomal abnormalities significantly increased with ARSA detected ( = 166.90, df = 1; P < 0.00). Among AMA and non-AMA cases, the incidence increased to 20.00 % ( = 55.12, df = 1; P < 0.00) and 10.00 % ( = 89.09, df = 1;
P \leq 0.00) respectively, if ARSA positive. Similarly, with additional ultrasonic findings, chromosomal abnormalities risk sharply increased, especially in non-AMA group (Fisher’s exact test, P \leq 0.00).

The positive and negative likelihood and predictive value of ARSA for chromosomal abnormalities were gathered in Table 3. In entire cohort, the positive and negative likelihood ratios of nonisolated ARSA for chromosomal abnormalities were 69.49 and 0.89, respectively. And those of isolated ARSA for chromosomal abnormalities were 15.47 and 0.90, respectively.

Discussion

In this retrospective study, 13,690 singleton pregnancies were evaluated. We found that the incidence of an ARSA was 0.87% in Chinese AMA and 0.65% in non-AMA women. The incidence of chromosomal abnormalities was much higher in AMA group and with ARSA detected it climbed as high as 20 % in AMA group and 10 % in non-AMA group. Among there, mostly detected was Down syndrome in both groups. Another chimeric Turner syndrome was found in an AMA woman with an isolated ARSA.

In most studies, the prevalence of a prenatal ARSA was studied in the entire population with a prevalence rate ranging from 0.4 % to 1.5 % [12,13]. Concordant with the previous studies, we found the incidence of ARSA in entire cohort was 0.69 %. And as a valuable complementarity, we confirmed there was no difference in the incidence of ARSA during AMA and non-AMA groups. On the timing of prenatal ultrasonic diagnosis of ARSA, Pico et al.[5] presented the mean gestational age for ARSA detecting was 19 weeks + 5 days, ranging from 11 weeks + 5 days to 34 weeks; SD = 4 days). In another study concerning the predictive value of ARSA for Down syndrome, authors successfully checked pregnant women at 16 weeks of gestation [10]. In our experience, ARSA can be detected as early as 12 weeks +4 days gestational age. However, due to the high omission diagnostic rate
during the first trimester and the early mid-trimester, and in order to reduce the bias caused by the difference in technical level between examiners and ensure the accuracy, we set the threshold of 16 weeks of gestation for this study. The correlation between ARSA fetuses and chromosomal abnormalities such as Down syndrome was described by some scholars [10, 14,15]. As we found whether isolated or nonisolated ARSA would increase the risk of chromosomal abnormalities. When it comes to the isolated ARSA, there a controversy should be proposed. Some authors insisted isolated ARSA correlated strongly with trisomy 21 [16]. Reported by Paladini et al. [13], ARSA should be considered among the three most powerful ultrasound indicators of Down syndrome in the second trimester resembling nasal bone abnormality and increased nuchal fold. In their preliminary study, ARSA was found the only sonographic sign in 7.5% (8 / 106) relatively unbiased Down syndrome fetal, which was presented 1.5% in normal fetuses. While a weak association between isolated ARSA and chromosomal abnormalities were reported by other scholars [12]. Recommended by Pico et al. [5], these fetus contained an isolated ARSA required a comprehensive evaluation instead of an invasive karyotype analysis considering isolated ARSA is a condition rarely associated with a chromosomal abnormality.

When concerning the nonisolated ARSA, in virtue of prenatal detected the ARSA with other ultrasound signs, the risk for trisomy 21 increased by factor of 45 described by Fehmi et al. [10]. As in our study, the positive likelihood ratios of nonisolated ARSA for chromosomal abnormalities in the entire population and AMA group were as high as respectively 69.49 and 36.90. The study performed by Svirsky et al.[14] was in support of our results. They claimed ARSA with additional ultrasound findings constitutes a strong predictor for aneuploidy.

What is more, when ARSA is found in AMA ones, we got a sharp increase in the incidence of chromosomal abnormalities. The prevalence rate of chromosomal abnormalities with
ARSA in AMA group was 20 % ( 5 / 25) which is much higher when comparing to that in non-AMA group 10 % ( 7 / 70). And the positive likelihood ratios of nonisolated ARSA for chromosomal abnormalities were 36.90 in AMA group and 14.51 in non-AMA group. These findings may contribute to prenatal counseling especially for advanced maternal age pregnant women.

Last but not least, a chimeric ( 45X / 46XX) case with isolated ARSA was found in AMA group in our study. Turner syndrome is well known to be closely associated with cardiovascular malformations with the frequency of 23% to 45%. As reported by Lee et al. [17], an aberrant right subclavian artery was one of the most common major vessel abnormalities in the Turner syndrome patients ( 3 / 20 patients, 15 %). The obstruction of lymphococinesia during embryogenesis may be the possible mechanism of cardiovascular defects in Turner syndrome. In our case of Turner syndrome, we found the unique structural defect by prenatal ultrasound. The suspicious diagnosis clue of sex chromosome aneuploidies was presented by noninvasive prenatal screening with cell-free DNA. And it was eventually confirmed by chromosomal karyotype analysis with amniocentesis and SNP- Array chip inspection. The clinical effect of noninvasive prenatal screening in AMA pregnancy was discussed in a multicenter retrospective study [18]. Authors found the detection efficiency was satisfactory with almost 100% accurate results. Even for sex chromosome aneuploidy in AMA pregnancy, the positive predictive value was approximately 41.30%. Considering the high prevalence of chromosome abnormality including sex chromosome, scholars strongly suggested noninvasive prenatal screening for AMA pregnancy, especially over 40. Therefore, we believe that although only isolated ARSA was found in advanced ones, vigilance will still be needed and the noninvasive prenatal screening might benefit. It would be very conducive to further managing and genetic counseling for advanced maternal women.
In a word, for AMA pregnancy, we suggest that ARSA should be used as a soft indicator of chromosomal abnormalities in genetic ultrasound. Once ARSA is found, a comprehensive assessment is essential. Although only isolated ARSA was found in AMA ones, the noninvasive prenatal screening would help to some degrees.

There were also some limitations in our study. Firstly, a small percentage of fetuses in non-AMA group did not undergo invasive karyotype analysis. The major aneuploidy abnormalities and karyotype abnormalities were excluded by the negative results of noninvasive DNA tests, detailed prenatal examinations and neonatal follow-up. In clinical practice, many people are reluctant to accept invasive karyotype analysis considering the possible risks of invasive operations. In theory, an isolated ARSA was not a sufficient indication for karyotype analysis [5]. Reported by Ranzini et al. [12], all fetuses with ARSA and genetic anomalies totally had additional ultrasound findings. Thus, in similar studies (respectively published in Fetal Diagn Ther and J Ultrasound Med) [5,6], the authors typically included fetuses have consistently classified fetuses with negative prenatal screening and postpartum follow-up as normal karyotypes. Therefore, we believe that the method adopted in this study is acceptable. Secondly, chromosomal microarray analysis was not analyzed in our current study. While it worth noting, quite a part of deformity might be neglected without chromosomal microarray analysis according to Maya et al. [15]. What’s more, the incidence of ARSA in super-aged women (≥40) and its’ predictive value for chromosome abnormality were not evaluated individually in our current study. That may probably have profound guiding significance in this group. We look forward to further discussion of these issues in future studies.

Conclusions

In conclusion, the incidence of an ARSA in Chinese AMA women resembled that in non-AMA women. We have described a high prevalence of chromosomal abnormalities in AMA
fetuses. Either isolated or nonisolated ARSA would increase the risk of chromosomal abnormalities. Moreover, when ARSA is found in AMA ones, it confers a sharp increase in the incidence of chromosomal abnormalities and the noninvasive prenatal screening may sever the purpose. In addition, it was worth further exploration in the incidence of ARSA in super-aged women (≥40) and its’ predictive value for chromosome abnormality.

Declarations

Abbreviations

ARSA: Aberrant right subclavian artery; AMA: Advanced maternal age

Acknowledgements

We thank all department members for their support and cooperation.

Funding

This study was supported by grants from the Natural Science Foundation of Fujian Province (No. 2015D015 & No. 2015J01363) and Collaborative Innovation Center for Maternal and Infant Health Service Application Technology.

Natural Science Foundation of Fujian Province (No. 2015D015 & No. 2015J01363): design of the study, collection, analysis. Collaborative Innovation Center for Maternal and Infant Health Service Application Technology: interpretation of data, and in writing the manuscript.

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Authors’ contributions

Guo-Rong Lyu: Manuscript editing, Presentation. Jiang-Hua Chen: Project development, Supervision. Jing-Xian Xie: Data management and analysis, Follow-up, Funding acquisition. Jian-Hong You: Experimental design, Project administration, Writing - review & editing. Li-
Ping Chen: Writing - original draft, Perform experiment, Data curation. Xiao-Kang Chen: Analysis and interpretation of data. Xiao-Yan Chen: Data collection, Figure editing. Xiao-Hong Zhong: Conceptualization, Conception and design of the study, Formal analysis. All authors approved the final version of the manuscript.

Ethics approval and consent to participate

Written informed consent was obtained from all participants in this study, and the study was approved by the Ethics Committee of the School of Medicine, Xiamen University.

Consent for publication

Not applicable.

Conflict of interest

The authors have no conflicts of interest.

Disclosure Summary

The authors have nothing to disclose.

References

1. Lean SC, Derricott H, Jones RL, Heazell AEP. Advanced maternal age and adverse pregnancy outcomes: A systematic review and meta-analysis. PLoS One. 2017;12(10):e0186287.

2. Zeng Y, Hesketh T. The effects of China's universal two-child policy. Lancet. 2016;388(10054):1930–8.

3. Laopaiboon M, Lumbiganon P, Intarut N, Mori R, Ganchimeg T, Vogel JP, Souza JP, Gülmezoglu AM; WHO Multicountry Survey on Maternal Newborn Health Research Network. Advanced maternal age and pregnancy outcomes: a multicountry assessment. BJOG. 2014;121 Suppl 1:49–56.

4. Zhu Y, Lu S, Bian X, Wang H, Zhu B, Wang H, Xu Z, Xu L, Yan W, Zeng Y, Chen Z, Tang S, Shen G, Miao Z. A multicenter study of fetal chromosomal abnormalities in
Chinese women of advanced maternal age. Taiwan J Obstet Gynecol. 2016;55(3):379-84.

5. Pico H, Mancini J, Lafouge A, Bault JP, Gorincour G, Quarello E. Prenatal Associated Features in Fetuses Diagnosed with an Aberrant Right Subclavian Artery. Fetal Diagn Ther. 2016;40(3):187-94.

6. Gursoy Erzincan S, Karamustafaoglu Balci B, Tokgoz C, Kalelioglu IH. Incidence of an Aberrant Right Subclavian Artery on Second-Trimester Sonography in an Unselected Population. J Ultrasound Med. 2017;36(5):1015-9.

7. Willruth AM, Dwinger N, Ritgen J, Stressig R, Geipel A, Gembruch U, Berg C. Fetal aberrant right subclavian artery (ARSA) - a potential new soft marker in the genetic scan? Ultraschall Med. 2012;33(7):E114–8.

8. Scala C, Leone Roberti Maggiore U, Candiani M, Venturini PL, Ferrero S, Greco T, Cavoretto P. Aberrant right subclavian artery in fetuses with Down syndrome: a systematic review and meta-analysis. Ultrasound Obstet Gynecol. 2015;46(3):266–76.

9. Sagi-Dain L, Singer A, Josefsberg S, Peleg A, Lev D, Samra NN, Bar-Shira A, Zeligson S, Maya I, Ben-Shachar S. Microarray analysis has no additional value in fetal aberrant right subclavian artery: description of 268 pregnancies and systematic literature review. Ultrasound Obstet Gynecol. 2019;53(6):810–5.

10. Fehmi Yazıcıoğlu H, Sevket O, Akin H, Aygün M, Özyurt ON, Karahasanoğlu A. Aberrant right subclavian artery in Down syndrome fetuses. Prenat Diagn. 2013;33(3):209-13.

11. De León-Luis J, Gámez F, Bravo C, Tenías JM, Arias Á, Pérez R, Maroto E, Aguarón Á, Ortiz-Quintana L. Second-trimester fetal aberrant right subclavian artery: original study, systematic review and meta-analysis of performance in detection of Down syndrome. Ultrasound Obstet Gynecol. 2014;44(2):147-53.
12. Ranzini AC, Hyman F, Jamaer E, van Mieghem T. Aberrant Right Subclavian Artery: Correlation Between Fetal and Neonatal Abnormalities and Abnormal Genetic Screening or Testing. J Ultrasound Med. 2017;36(4):785–90.

13. Paladini D, Sglavo G, Pastore G, Masucci A, D’Armiento MR, Nappi C. Aberrant right subclavian artery: incidence and correlation with other markers of Down syndrome in second-trimester fetuses. Ultrasound Obstet Gynecol. 2012;39(2):191–5.

14. Svirsky R, Reches A, Brabbing-Goldstein D, Bar-Shira A, Yaron Y. Association of aberrant right subclavian artery with abnormal karyotype and microarray results. Prenat Diagn. 2017;37(8):808–11.

15. Maya I, Kahana S, Yeshaya J, Tenne T, Yacobson S, Agmon-Fishman I, Cohen-Vig L, Levi A, Reinstein E, Basel-Vanagaite L, Sharony R. Chromosomal microarray analysis in fetuses with aberrant right subclavian artery. Ultrasound Obstet Gynecol. 2017;49(3):337–41.

16. Borenstein M, Minekawa R, Zidere V, Nicolaides KH, Allan LD. Aberrant right subclavian artery at 16 to 23 + 6 weeks of gestation: a marker for chromosomal abnormality. Ultrasound Obstet Gynecol. 2010;36(5):548–52.

17. Lee SH, Jung JM, Song MS, Choi Sj, Chung WY. Evaluation of cardiovascular anomalies in patients with asymptomatic turner syndrome using multidetector computed tomography. J Korean Med Sci. 2013;28(8):1169–73.

18. Yu B, Li H, Chen YP, Zhang B, Xue Y, He Q, Zhou Q, Cai Z, Wang T. Clinical evaluation of NIPS for women at advanced maternal age: a multicenter retrospective study. J Matern Fetal Neonatal Med. 2018;21:1–6.

Tables

Due to technical limitations, tables are only available as a download in the supplemental files section.
The flowchart of our study. AMA, advanced maternal age; non-AMA, appropriate maternal age; ARSA; aberrant right subclavian artery; In-, Intracardiac malformation; Ex-, Extracardiac malformation; Both, Intracardiac and extracardiac malformation.
Inspection of fetal aberrant right subclavian artery (ARSA). a: Anatomical diagram of fetal ARSA. b: The three vessels and trachea view of normal fetuses. c: Fetal ARSA in the three vessels and trachea view. d: Fetal ARSA in the coronal view.

ARCH, aorta; DA, descending aorta; LCA, left carotid artery; LSA, left subclavian artery; MPA, main pulmonary artery; RCA, right carotid artery; RSA, right subclavian artery; SVC, superior vena cava; T, trachea.

Supplementary Files

This is a list of supplementary files associated with the primary manuscript. Click to download.

Table 2.docx
Table 3.docx
