

'Just-flow' visualization of the aortic arch in fetuses \leq 16 weeks

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Introduction

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Fetal echocardiography in first and early second trimester of pregnancy (≤ 16 weeks) is now considered an integral part of fetal cardiology in centres with expertise in this area ^{1,2}. Early echocardiography was complete in 71% of fetuses at 12-16 weeks ³ and the aortic arch seen in axial views in $>90\%$ fetuses at 12-13 weeks ⁴. Although the aortic arch has also been imaged on sagittal plane^{1,3}, there is no systematic evaluation on feasibility, impact of maternal body mass index (BMI) or fetal position. Recently, we described B-mode subtracted colour Doppler angiography ('just-flow') ⁵, a technique to improve visualization of the fetal heart in mid-gestation and routinely use this across all gestational ages. 'Just-flow' images can be obtained by total reduction of B-mode gain during color flow mapping, so that the background B-mode information is not shown. In some systems (e.g. Hitachi) reducing overall B-mode gain is sufficient whilst in others (e.g. Canon) TGC gain also needs to be reduced. This gives greater priority to color information, so its gain may need adjustment to avoid color saturation. This simple and practical technique can be applied to any commercially available ultrasound system with high-definition flow-imaging modalities. In this report we evaluated the feasibility of imaging the entire aortic arch in sagittal view using "just-flow" modality in early pregnancy.

Methods and Results

We retrospectively reviewed cardiac scans performed between October 2016 and May 2018 in all pregnant women who underwent transabdominal echocardiography performed by a single operator at ≤ 16 weeks (n=94). We noted if the entire aortic arch was visible in sagittal plane and number of branches seen.

Images were recorded and available for review in 91/94 women (97%). Patients' median age (range) was 33 (16.9-60) years and median BMI (range) was 23.9 (18.6-41.2). Scans were performed with Aloka alpha-10 (Aloka/ Hitachi, Japan) or Toshiba Aplio i800 (Toshiba/ Canon, Japan), using high frequency curvilinear transducer whenever possible, at a mean gestational age of 15⁺³ weeks (range 13⁺¹-16⁺⁶ weeks).

Eighty women had a singleton pregnancy, nine had a dichorionic-diamniotic twin pregnancy (n= 18 fetuses), one monochorionic-diamniotic pregnancy complicated with previous demise of one co-twin (n= 1 fetus) and one had a monochorionic-triamniotic triplet pregnancy complicated by TRAP of one twin (n = 2 fetuses) for a total of 101 fetuses. Indications for the scans are presented in table 1. The entire aortic arch and at least one branch were visible in all 101 fetuses (Figure 1). The spine was anterior in almost one third of cases (29%). In the majority, it was possible to see two branches (n=55, 55%) and in 22 fetuses (22%) all three branches were imaged.

The early cardiac scan was normal in 87 of 101 fetuses (86%). Fourteen (14%) were diagnosed with a heart abnormality, nine of whom also had an extra-cardiac defect. An aortic arch abnormality involving transverse arch and/or isthmal hypoplasia/suspected coarctation was identified in six cases of 14 cases, five had additional cardiac abnormalities. All six had increased NT, three of whom were hydropic at 16 weeks. A genetic syndrome was suspected in two and one had Turner syndrome. Two of the six were born alive, coarctation was confirmed postnatally in one (Figure 2). Post-mortem examination was not available in 3/4 cases of termination. In the remaining, there was a bicuspid aortic valve but no coarctation.

Conclusion

“just-flow’ visualisation of the aortic arch in sagittal plane, including at least one aortic branch was always possible in early gestation, in singleton and multiple pregnancies, irrespective of spine position and within a wide range of maternal BMI.

Accepted Article

References

- 1) Carvalho JS, Moscoso G, Ville Y. First-trimester transabdominal fetal echocardiography. *Lancet*. 1998 Apr 4;351(9108):1023-7.
- 2) Clur SA, Bilardo CM. Early detection of fetal cardiac abnormalities: how effective is it and how should we manage these patients? *Prenat Diagn* 2014;34:1235e45.
- 3) Moon-Grady A, Shahanavaz S, Brook M, Rodriguez H, Hornberger LK. Can a complete fetal echocardiogram be performed at 12 to 16 weeks' gestation? *J Am Soc Echocardiogr*. 2012 Dec;25(12):1342-52.
- 4) Hutchinson D, McBrien A, Howley L, Yamamoto Y, Sekar P, Motan T, Jain V, Savard W, Hornberger LK. First-Trimester Fetal Echocardiography: Identification of Cardiac Structures for Screening from 6 to 13 Weeks' Gestational Age. *J Am Soc Echocardiogr*. 2017 Aug;30(8):763-772.
- 5) Gonçalves ES, Carvalho JS. 'Just-flow' images of the fetal heart: insights into interventricular shunting across a small ventricular septal defect and enhanced visualization of the fetal heart. *Ultrasound Obstet Gynecol*. 2013 Feb;41(2):226-7.

Figure legends:

Figure 1 - 'Just-flow' images of normal aortic arch on sagittal plane obtained from three fetuses at 14+4 (A), 15+0 (B) and 16+0 (C) weeks with maternal BMI of 23 (A), 33.9 (B) and 41.2 (C) respectively. Images obtained by completely reducing B-mode gain and optimising color gain whilst imaging with high-definition color Doppler modality. Standard curvilinear probes of high (A) or low (B, C) frequency were used.

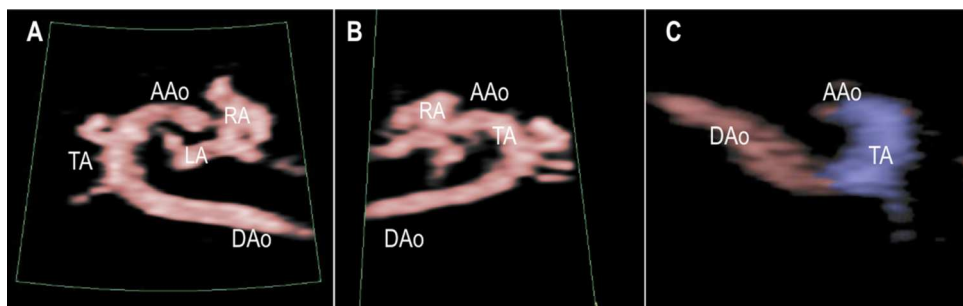
AAo = ascending aorta, Dao = descending aorta, LA = left atrium, RA = right atrium, TA = transverse aortic arch

Figure 2 - 'Just-flow' images obtained from two fetuses with arch hypoplasia/ suspected coarctation. Images A-C were taken from a fetus at 15+4 weeks of gestation with maternal BMI of 23, using a high frequency probe. Coarctation was confirmed after birth. Images D-F were obtained from another fetus at 15+6 weeks of gestation with maternal BMI of 31.8 (D, E, F), using a low frequency probe . Coarctation was not present at birth.

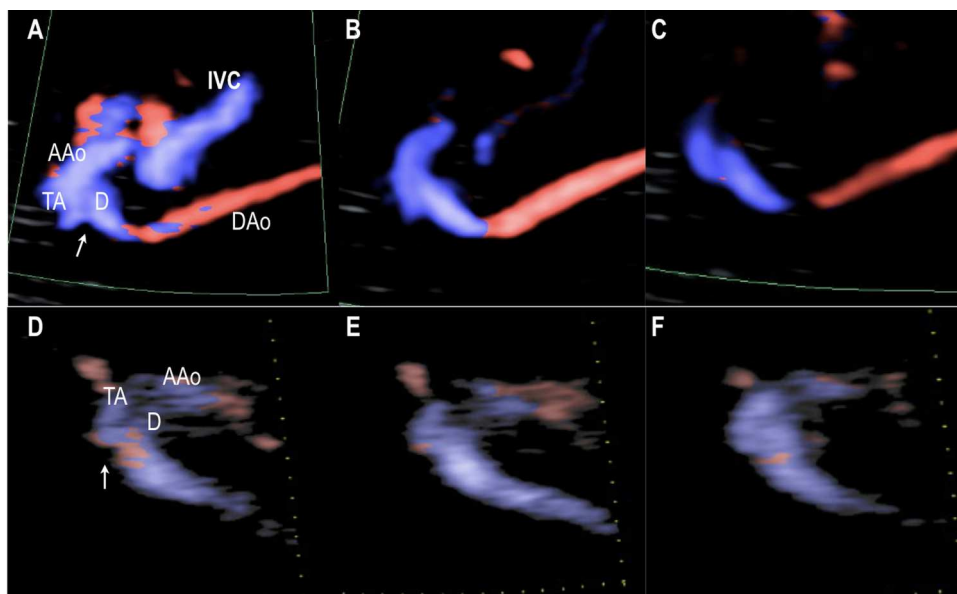
Table 1 - Indications for early cardiac scans.

Parameters	Singleton Pregnancies	Multiple Pregnancies
	N (%)	N (%)
Increased NT	40 (50)	7 (63.6)
Family history of CHD	33 (41.3)	0
Known chromosomal abnormalities/suspected CHD	7 (8.8)	0
Extra-cardiac abnormality	0	2 (18.2)
Others	0	2 (18.2)
Total	80	11

CHD = congenital heart disease; NT = Nuchal translucency; N = number



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UOG_20235_Figure 2_Sileo & Carvalho.tif