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Original Article

Ductus venosus Doppler velocimetry in normal pregnancies from 11 to 13 + 6 weeks' gestation—A Taiwanese study

Chien-Chih Tseng [a], Hsing-I Wang [b,c], Peng-Hui Wang [a,d], Ming-Jie Yang [a,d], Chi-Mou Juang [a,d], Huann-Cheng Horng [a,d], Yi-Cheng Wu [a], Chia-Chien Chen [a], Huei-Ling Shiu [a], Mei-Mei Chiang [a], Huei-Jie Lin [a], Chih-Yao Chen [a,b,d,*], Kuan-Chong Chao [a,d]

[a] *Department of Obstetrics and Gynecology, Taipei Veterans General Hospital, Taipei, Taiwan, ROC*
[b] *Institute of Clinical Medicine, National Yang-Ming University, Taipei, Taiwan, ROC*
[c] *Taipei Mackay Memorial Hospital, Taipei, Taiwan, ROC*
[d] *National Yang-Ming University School of Medicine, Taipei, Taiwan, ROC*

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Abstract

Background: To investigate flow in the ductus venosus at 11–13 + 6 weeks of gestation in women with normal pregnancies in the Taiwanese population.
Methods: Two hundred and fifty-two normal singleton pregnancies with gestational ages ranging from 11 to 13 + 6 weeks were examined in this study. The pulsatility index for veins (PIV), resistance index (RI), peak velocity during ventricular systole (S-wave), and peak velocity during ventricular diastole (D-wave) were recorded from the ductus venosus.
Results: We analyzed 252 participants who all fulfilled the inclusion and exclusion criteria of our study. The mean maternal age was 31 (range 19–45 years), with a corresponding gestational age of 12 + 4 weeks (range 11–13 + 6). No significant change was found in the vascular indices as gestational age increased for the S-wave (S-wave = 1.4214 (GA) + 17.448, r = 0.09, $P = 0.154$), PIV (PIV = −0.0358 (GA) + 1.4143, r = −0.05, $P = 0.378$) and RI (RI = −0.035 (GA) + 1.1478, r = −0.064, $P = 0.468$). In contrast, the D-wave behaved differently from the other variables. There was a significant increase ($r = 0.155$, $P = 0.013$) in the D-wave with gestational age (D-wave = 1.4896 (GA) − 7.1547).
Conclusion: D-wave velocity in the ductus venosus increased with gestational age. S-wave peak velocity showed an increasing trend and PIV showed a decreasing trend with gestational age, but they did not reach statistical significance.

Keywords: D-wave; diastolic wave velocity; ductus venosus; fetal color Doppler ultrasound; NT; nuchal translucency; PIV; pulsatility index for veins; RI; resistance index; S-wave; systolic wave velocity

1. Introduction

The sphincter-like ductus venosus (DV) is an important regulator of fetal circulation. It carries the oxygenated blood from the umbilical vein to the inferior vena cava and foramen ovale, thus bypassing the hepatic circulation. Highly oxygenated blood passes through the right atrium and goes to the left atrium to perfuse the fetal brain and trunk.[1–3]

Doppler measurements of the DV have become important in monitoring the fetus in cases of intrauterine growth restriction[4–6] and cardiac defects.[7–9] The analysis of the DV has also been used to identify fetuses at risk of acidemia and perinatal death.[4,6] An abnormal DV blood flow velocity waveform is also associated with fetal anemia and twin-to-twin transfusion syndrome.[10] Recent studies on the A-wave of the DV have also demonstrated the importance of the ductus venosus in first-trimester screening for fetal chromosomal abnormalities.[11,12]

* Corresponding author. Dr. Chih-Yao Chen, Department of Obstetrics and Gynecology, Taipei Veterans General Hospital, 201, Section 2, Shih-Pai Road, Taipei 112, Taiwan, ROC.
E-mail address: zachary.joyce@gmail.com (C.-Y. Chen).

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Combined with nuchal translucency and fetal nasal bone, DV further augments the power of Down's syndrome screening. However, some studies have shown the influence of ethnicity and the need for correction of biochemical and ultrasound markers of chromosomal anomalies in the first trimester for different ethnic groups.[13–16] Those studies focused on nuchal translucency and fetal nasal bone as ultrasound markers, but did not include DV. Hence, it is important to establish a database for a Chinese population in Taiwan. The aim of our study was to investigate ductus venosus flow indices at 11 to 13 + 6 weeks of gestation in a normal pregnancy in the Taiwanese population and to compare our results with previously published reports.

2. Methods

2.1. Patient population

A total of Two hundred and fifty-two women with normal singleton pregnancy between 11 and 13 + 6 weeks' gestation were examined in this study. Fetal age was estimated from the last menstrual period, and it was confirmed by ultrasonographic measurement of the crown-rump length. The following women were excluded from our study: (1) women with gestational diabetes, preterm labor, antepartum congenital abnormalities, and maternal systemic disease;, (2) women on a regimen of tocolytic and antihypertensive agents;, and (3) women who were absent during the patient follow-up process. Hospital medical records were reviewed to confirm pregnancy outcomes, and newborns with abnormal karyotypes or major structural abnormalities were also excluded. The study was approved by the Institutional Review Board at Taipei Veterans General Hospital in Taipei, Taiwan, and each patient participating in the study provided a signed and approved informed consent form.

2.2. Ultrasonography

All ultrasonography procedures were performed using a Voluson 730 ultrasound machine (GE Healthcare, Milwaukee, WI, USA) equipped with a 4- to 8-MHz transducer, and color Doppler was used for evaluation of the DV. The flow velocities from the DV were identified using color Doppler imaging in a right ventral midsagittal plane (Fig. 1A). The pulsed Doppler gate was placed in the distal portion of the umbilical sinus (Fig. 1B). Care was taken to avoid contamination from the umbilical vein, left hepatic vein, and inferior vena cava.[13] When the typical DV waveform was obtained, at least three consecutive waveforms were recorded with insonation angle $\leq 30°$. The following variables were measured: S-wave, D-wave, pulsatility index for veins (PIV), and resistance index (RI).

2.3. Statistical analysis

Data were collected in an Excel spreadsheet (Microsoft, Redmond, WA, USA) and analyzed using the software SPSS for Windows, version 15.0 (SPSS Inc., Chicago, IL, USA).

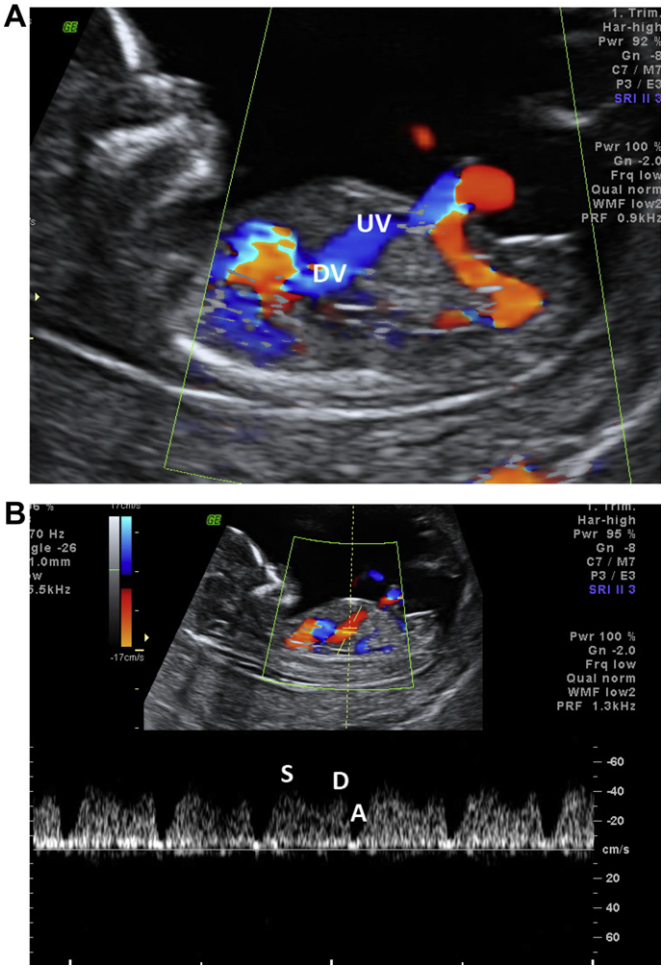

Fig. 1. (A) DV with color Doppler in a right ventral midsagittal plane; (B) pulsed Doppler gate was placed in the distal portion of the umbilical sinus. DV = ductus venosus.

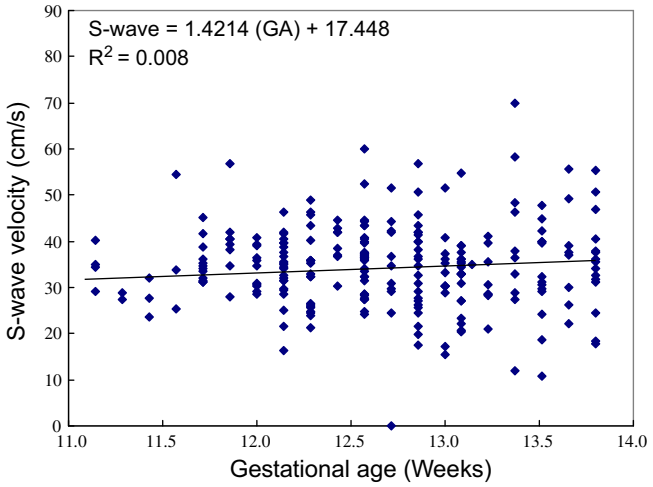

Fig. 2. Individual values for the peak systolic velocity (S-wave) in the ductus venosus in normal pregnancy [S-wave = 1.4214 (GA) + 17.448, $r = 0.09$, $p = 0.154$]. GA = gestational age (wk).