DOI: 10.14260/jemds/2014/2574

ORIGINAL ARTICLE

ASSESSMENT OF DUCTUS VENOSUS BY DOPPLER ULTRASOUND IN LOW RISK PREGNANCIES OF 20-38 WEEKS GESTATION

Mukta Mital[1], Vineet Nanda[2], Prashant Gupta[3], Gauri Garg[4]

HOW TO CITE THIS ARTICLE:
Mukta Mital, Vineet Nanda, Prashant Gupta, Gauri Garg. "Assessment of Ductus Venosus by Doppler Ultrasound in Low Risk Pregnancies of 20-38 Weeks Gestation". Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3, Issue 19, May 12; Page: 5201-5206, DOI: 10.14260/jemds/2014/2574

ABSTRACT: BACKGROUND: The ductus venosus evaluation during 20-38 weeks low risk pregnancies can reveal gradual reduction of the mean PI and S/A ratio, with advancing gestation. **AIM**: To evaluate the ductus venosus between 20-38 weeks gestation in Indian women without any complication related to pregnancy, using Doppler ultrasound and to present a normal range of the pulsatility index during this period of gestation. **SETTINGS AND DESIGN**: This is a controlled, randomized, prospective cohort observation study. Material & Methods- 127 pregnant women [20-38weeks gestation] were scanned in this prospective study. The peak systolic velocity, the pulsatility index and S/A ratio of the ductus venosus were measured. Results-Out of 127 patients, 116 patients were successfully scanned [91.3%]. The peak systolic velocity was more than 50cm/sec throughout gestation. The mean PI decreased from 0.67 at 20-25 weeks to 0.44 at 36-38 weeks and the mean S/A ratio decreased from 2.33 at 20-25 weeks to 1.59 at 36-38weeks. **CONCLUSION**: As normal pregnancy advances, the Pulsatility index and the S/A ratio decreases.

KEYWORDS: ductus venosus, Doppler, ultrasound, normal pregnancy.

INTRODUCTION: The ductus venosus is a small funnel shaped vessel which is found in the fetal liver connecting the intra-abdominal umbilical vein and the inferior vena cava. It is one of the three physiological shunts in the fetus responsible for circulating adaptation to intrauterine life and transports oxygenated blood from the umbilical vein directly through the right atrium and foramen ovale to the left atrium and ventricle and then to the myocardium and brain without any mixing with poorly oxygenated blood.[1-4] The ductus venosus originates from the portal sinus and thus the frequently expressed concept that it originates from the left portal vein or umbilical vein is anatomically inaccurate.[5]

The diameter of the ductus venosus is 2mm throughout pregnancy.[6] This focal narrowing causes a jet effect - at least 50% of the umbilical venosus blood is shunted towards the foramen ovale which ensures that blood with higher oxygen saturation goes to ascending aorta.[4] Due to the importance of ductus venosus, the aim of the present study was to evaluate the ductus venosus by doppler ultrasound in healthy pregnant Indian women of 20-38 weeks gestation and to present the reference ranges of waveform indices of the vessel.

The typical ductus waveform shows a triphasic forward flow with a peak during ventricular systole (S wave), a second peak during ventricular diastole (D-wave) and a nadir during the atrial contraction(A wave). The flow remains antegrade, in contrast to the vena cava or the hepatic veins.[7]
Many different angle-independent indices form the ductus venosus have been proposed. The pulsatility index for veins has proved to be the most reproducible parameter.[8]

Ductus venosus parameters have an increasing important role in the assessment of the fetus in the second and 3rd trimesters of pregnancy. Abnormal ductus venosus flow velocity waveforms are

DOI: 10.14260/jemds/2014/2574

associated with cardiac disease and severe fetal compromise due to placental dysfunction and the importance of ductus venosus in continuous monitoring of the growth restricted fetus has been reported.[9-11]

In IUGR fetuses, reversed flow in ductus venosus is an ominous sign and has been reported to be the only significant parameter associated with perinatal death.[12] Recently, the possible role of abnormal ductus venosus flow velocity waveform at 10-14 weeks of gestation in the detection of chromosomal abnormalities, congenital heart disease has also been reported.[13, 14]

SUBJECTS AND METHODS: A prospective study was conducted on one hundred and twenty seven singleton pregnant women attending the Department of Radio-Diagnosis, Imaging and Interventional Radiology of N.S.C.B. Subharti Medical College, Meerut and Meerut Scan centre, Meerut, for a routine antenatal ultrasound examination.

The gestational ages of patients varied between 20weeks and 38 weeks, as per the LMP of the patient... The ultrasound examination was done on GE Logique book XP unit and Medison unit with a convex 3.5MHz transducer.

All the patients were informed before the ultrasound scan and gave their consent to the Doppler examination. Exclusion criteria were the presence of an anomaly or the presence of abnormal fetal growth.

The ductus venosus was visualized in mid sagittal section by following the umbilical vein intra-abdominally towards the left portal vein on color doppler and identifying the color aliasing produced by the turbulent flow at the origin of the vessel [Fig. 1-2]. The ductus venosus velocity was measured by placing the sample volume at the initial or middle portion of the vessel with an angle of insonation $<60^0$.

The flow velocity waveform demonstrated a continuous forward flow throughout the cardiac cycle. (Fig. 3-4) Cases in which a satisfactory waveform could not be recorded and in which there was a reversed flow of the A wave were not included in the study. All ultrasound studies were performed by a single examiner.

During Doppler studies, the patients lay in recumbent position with a slight lateral tilt to minimize the risk for developing supine hypotension due to caval compression. All the examinations were conducted during fetal apnea and in absence of fetal hiccup or excessive movements (to reduce variations in flow velocity waveforms due to breathing movements). The exposure to Doppler ultrasound was limited to maximum of 5 minutes.

The peak systolic velocity i.e. the maximum velocity during S wave, pulsatility index for the vein [i.e. S-A/ Tmax where S is peak velocity in S wave, A is peak velocity in A wave and Tmax is the time averaged maximum velocity] were analyzed and S/A ratio [peak velocity S wave/peak velocity A wave] were measured.

RESULTS: Out of 127 patients included, 116 patients could be successfully scanned [91.3% success rate]. The peak systolic velocity, pulsatility index and S/A were calculated [table I, II & III] for these 116 patients. The mean maternal age was 24 years [range between 19-32 years]. Majority of patients were post 28 weeks gestation [62.06%]. Ductus venosus pulsatility index [(S-A)/ Tmax].

DOI: 10.14260/jemds/2014/2574

GESTATIONAL AGE IN WEEKS	MEAN PI +-SD
20-25 weeks	0.67 (0.61- 0.78)
26-30 weeks	0.64 (0.60-0.72)
31-35 weeks	0.51 (0.45-0.69)
36-38 weeks	0.44 (0.36-0.61)

Ductus venosus S/A ratio

GESTATIONAL AGE IN WEEKS	MEAN S/A RATIO +SD
20-25 weeks	2.33 (2.1-2.8)
26-30 weeks	2.1 (1.9-2.3)
31-35 weeks	1.78 (1.6-2.2)
36-38weeks	1.59 (1.5-1.9)

Fig. 5-10 show the indices at different gestational ages

DISCUSSION: In this study, we have demonstrated that using the combination of grey scale and color doppler ultrasound there is good success rate in identifying the ductus venosus at different gestational ages in the 2nd & 3rd trimester. With a success rate of 91.3% for sampling the ductus venosus, it is feasible to incorporate this measurement into routine obstetric ultrasound. In our study, the limiting factors for identifying ductus venosus were fetal movements especially breathing movements and excessive maternal fat. The success rate is nearly at par with previous studies like that of Gilani et al[6] who quoted a success rate of 94% and that of Chanthasenanont et al[15] who quoted it as 88.48%.

The most common misevaluations include incorrect tracing, overestimation of end diastolic velocity and thus incorrect calculation of the pulsatility index, facilitated by human or soft-ware error.[16] To avoid this kind of difficulty, we selected manual tracings in all cases and we marked with attention the end-diastolic velocities.

When comparing the hemodynamic parameters obtained from our study with data previously published, [11, 14, 17] a good agreement between normal values were seen. The PSV was found to be more than 50cm/s. Similar pattern has also been reported earlier.[18]

The pulsatility index was found to be less than 1 which is similar to reported by previous authors [6, 15, 18] and was found to decrease with advancing gestational age. The S/A ratio was also found to decrease with advancing gestation.

The main limitation of the study is related to the impossibility to monitor the pregnant woman until delivery and lack of appreciation of inter-observer variability.

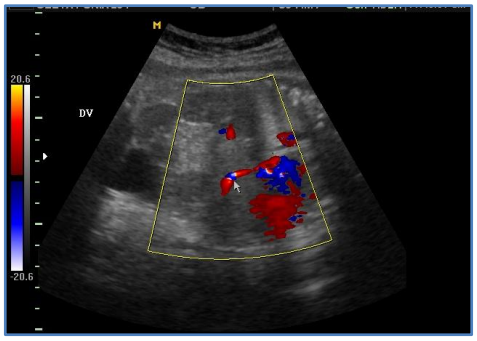
CONCLUSION: Evaluation of the ductus venosus by Doppler ultrasound is a successful, though slightly time consuming procedure and should be a part of the routine obstetric ultrasound examination in 2nd and 3rd trimester of pregnancy.

The normal values of PI less than 1, and PSV more than 50cm/s may serve as a standard to investigate the cardiovascular changes in pregnancies with fetuses at risk for hypoxia and academia because of anemia, congenital heart disease, congenital heart failure and IUGR.

REFERENCES:

1. Kiserud T, Eik –Nes SH, Blass HG. Ultrasonographic velocimetry of the foetal ductus venosus. Lancet 1991; 338: 1412-14.
2. Kiserud T. The ductus venosus. Semin Perinatol 2001; 25: 11-20.
3. Kiserud T, Hellevik LR, Eik-Nes SH. Estimation of the pressure gradient across the foetal ductus venosus based on doppler velocimetry. Ultrasound Med Biol. 1994; 20: 225-32.
4. Al Ghazali W, Chita SK, Chapman MG, Allan LD. Evidence of redistribution of cardiac output in asymmetrical growth retardation. Br J Obstet Gynaecol. 1989; 96: 697-704.
5. Mavrides E, Moscoso G, Carvalho JS. The anatomy of the umbilical, portal and hepatic venous systems in the human foetus at 14-19 weeks of gestation. Ultrasound Obstet Gynecol 2001; 18:598-604.
6. Gilani SA, Javaid A, Bala AA. Foetal Doppler ultrasound assessment of ductus venosus in 20-40 weeks gestation normal foetus in the Pakistani population. Medical ultrasonography 2010; 12: 110-113.
7. Axt. Fliedner R, Diler S, Georg T, Friedrich Diedrich K. Reference values of ductus venosus blood flow velocities and waveform indices from 10 to 20 weeks of gestation. Arch Gynecol Obstet 2004; 269:199-204.
8. Hecher K, Camppell S, Snijders R, Nicolaides K. Reference ranges for foetal venosus and atriventricular blood flow parameters. Ultrasound Obstet Gynecol 1994; 4: 381-390.
9. Hecher K, Camppell S, Doyle P, Harrington K, Nicolaides K. Assessment of foetal compromise by doppler ultrasound investigation of the foetal circulation. Circulation 1995; 91: 129-138.
10. Hecher K, Snijders R, Camppell S, Nicolaides K. Foetal venous, intracardiac and arterial blood flow measurement in intra uterine growth retardation: relationship with foetal blood gases. Am J Obstet Gynecol 1995; 173:10-15.
11. Kiserud T, Rasmussen S, Skulstad S. Blood flow and the degree of shunting through the ductus venosus in the human foetus. Am J Obstet Gynecol 2000;182: 147-153.
12. Ozcan T, Sbracia M, d 'Ancona RL. Arterial and venous Doppler velocimetry in severely growth restricted foetus and associations with adverse perinatal outcome. Ultrasound Obstet Gynecol 1998;12: 39-44.
13. Bilardo CM, Muller MA, Zikulnig L, Schipper M, Hecher K. Ductus venosus studies in foetuses at high risk for chromosomal or heart abnormalities: relationship with nuchal translucency measurement and foetal outcome. Ultrasound Obstet Gynecol 2001;17:288-294.
14. Hung JH, Fu CY, Lu JH, Hung CY. Ductus venosus blood flow resistance and congenital heart defects in second trimester J. Clin Ultrasound 2008; 36:72-78.
15. Chanthasenanont A, Pongrojpaw D, Somprasit C. Foetal Ductus venosus Pulsatility index and diameter during 20-30 weeks gestation. J Med Assoc Thai 2008; 91: 794-8.
16. Szunyogh N, Renate Becker C, Visnovsky J. Human and soft-ware error in ductus venosus doppler waveform analysis. J Clin Ultrasound 2008; 36:427-29.
17. Bellotti M, Pennati G, De Gasperi C, Battaglia FC, Ferrazzi E. Role of ductus venosus in distribution of umbilical Blood flow in human fetuses during second half of pregnancy. Am J Physiol Heart Circ Physiol 2000; 279: 1256-1263.
18. Marcolin AC, Bercowski AT, Crott GC, Gonclaves CV, Duarte G. Longitudinal reference values for ductus venosus in low risk pregnancies. Ultrasound Med Biol 2010; 36: 392-6.

DOI: 10.14260/jemds/2014/2574



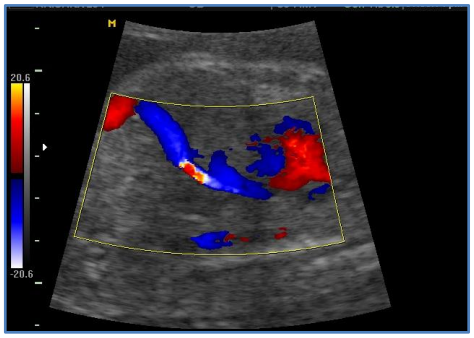
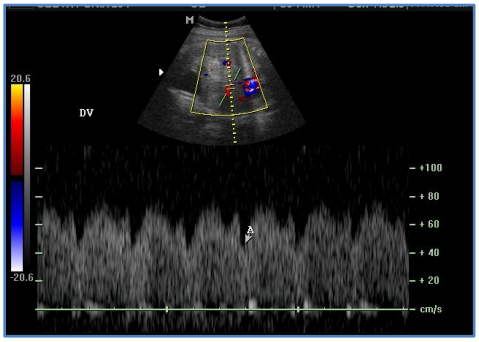


Figure 1 & 2: Identification of ductus venosus by colour aliasing



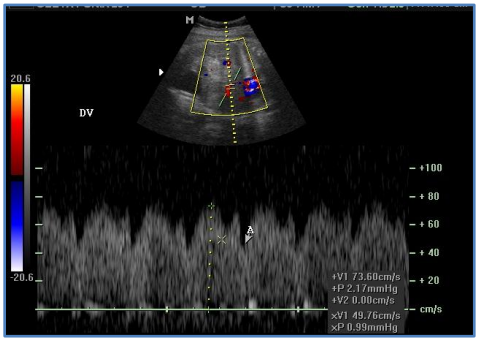


Figure 3 & 4: Normal triphasic forward flow with S, D & A waves

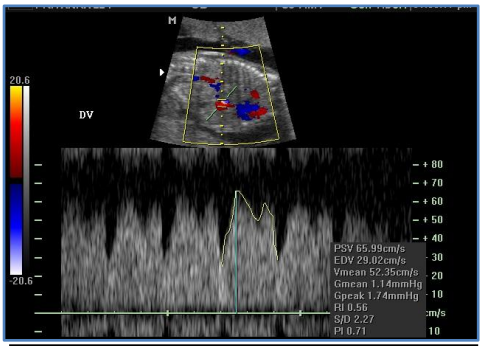


Figure 5: Ductus venosus flow at 20 weeks gestation

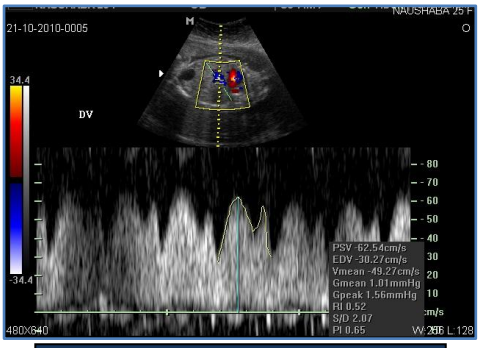


Figure 6: Ductus venosus flow at 24 weeks gestation

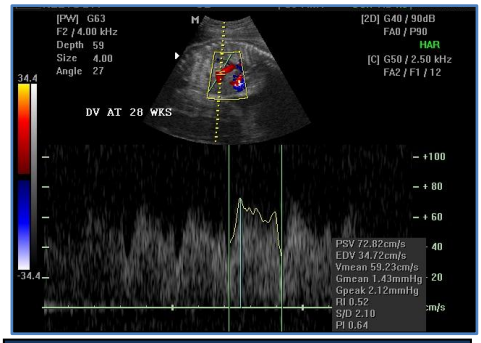


Figure 7: Ductus venosus flow at 28 weeks gestation

Figure 8: Ductus venosus flow at 32 weeks gestation

DOI: 10.14260/jemds/2014/2574

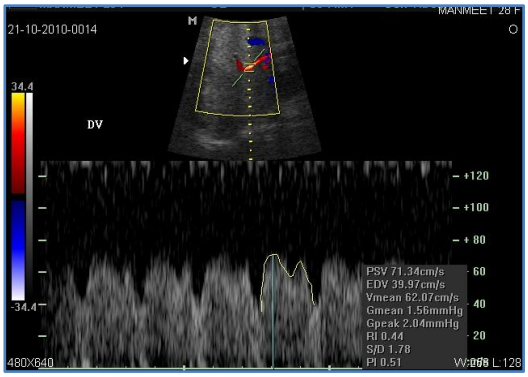


Figure 9: Ductus venosus flow at 35 weeks gestation

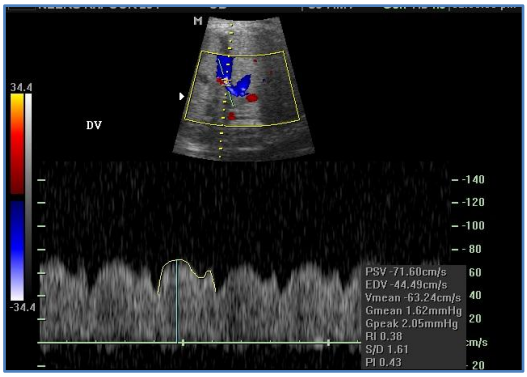


Figure 10: Ductus venosus flow at 37 weeks gestation

AUTHORS:

1. Mukta Mital
2. Vineet Nanda
3. Prashant Gupta
4. Gauri Garg

PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Radiology, SIMS,
2. Consultant, Department of Radiology, MSC.
3. Professor, Department of Radiology, SIMS.
4. Assistant Professor, Department of Radiology, SIMS.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Mukta Mital,
B-13, Damodar Colony,
Garh Road,
Meerut – 250004, U. P.
Email: muktamital@yahoo.com

Date of Submission: 14/04/2014.
Date of Peer Review: 15/04/2014.
Date of Acceptance: 25/04/2014.
Date of Publishing: 09/05/2014.