

Purpose

This protocol provides a standardized imaging and interpretation protocol for umbilical artery Doppler assessment.

To provide guidance to sonographers and reporting physicians with respect to:

- a. Indications for umbilical artery Doppler assessment
- b. Technical aspects of image acquisition
- c. Qualitative and quantitative interpretation and reporting of umbilical artery Doppler waveform assessment

Site Applicability

This protocol is applicable to BCW Hospital + Health Care inpatient and outpatient examinations.

Principles

Umbilical artery Doppler is a fetal surveillance modality used to identify evidence of fetal compromise that has been demonstrated to improve perinatal outcomes of high risk pregnancies at risk for placental insufficiency (Fetal growth restriction, preeclampsia) through timely intervention and delivery (1).

****Key changes from current practice****

- I. Waveform indices are generated through “autotrace” function
- II. Average pulsatility index (PI) of 3 representative images is recorded for the purpose of interpretation

Procedure

1. Indications for umbilical artery Doppler

- Fetal growth restriction as defined by:
 - fetal abdominal circumference (AC) <10th percentile by Lessoway chart (2) at gestational age 18 weeks or > in singleton, or multiple pregnancy
- Pre-eclampsia/ gestational hypertension in current pregnancy
- Complex monochorionic twins in the context of:
 - Twin Twin Transfusion syndrome (TTTS staging)
 - Selective IUGR (sIUGR) defined at AC <10th %ile in one twin
 - Monoamniotic twins, as per MFM requisition
- When clinically pertinent, as per MFM discretion

2. Frequency of testing

- Frequency as per BCW's “Antepartum Nonstress Testing Frequency And Ultrasound Surveillance” as available on [ePOPS](#)
- Follow up individualized as per MFM, depending on overall clinical picture:
 - Complex monochorionic twins, including monoamniotic twins
 - Subjectively (intermittently or consistently absent or reversed end diastolic flow) abnormal umbilical artery Doppler waveforms
 - PI >95th percentile for gestational age (suggestive of placental insufficiency)

3. Technical Protocol

General principles: Doppler recording should be performed at the lowest possible energy levels in order to minimize exposure to ultrasound thermal energy. When performing Doppler imaging, the displayed thermal index (TI) should be ≤ 1.0 and exposure time should be kept as short as possible, usually no longer than 5–10 min and not exceeding 60 min (3)

Pulsed wave Doppler interrogation of umbilical arteries:

1. Recordings should be obtained in the absence of fetal breathing or body movements
2. Measurements are obtained in a free loop of cord unless otherwise specified
3. Color flow is used for identification of the vessel and in defining the direction of blood flow.
4. The area with the vessel of interest is magnified
5. PRF (velocity scale) should be adjusted according to the flow velocity of the vessel studied
6. Color box is kept as small as possible to include only the studied area to avoid negative impact on processing time and frame rate
7. Insonation angle is (optimally) in complete alignment with direction of blood flow (up to 30 degrees is acceptable)
8. Sample volume (usually 2mm) matches size of the diameter of the vessel and includes one artery only.
9. "Wall motion filter" or "high pass filter" is set as low as possible (≤ 60 Hz) in order to avoid exclusion of low velocities leading to spurious effect of absent end diastolic flow (aEDF)
10. Waveforms should be similar; ideal display of 6+/-2 waveforms and fits approximately 75% of the Doppler screen
11. Frequent update of the real-time color Doppler image should be performed; simultaneous real time color Doppler scanning should not be used as it negatively impacts framerate and WMF.
12. Doppler display on the ultrasound screen should not be inverted
13. The autotrace function is used to generate resistance indices averaged over 4-6 waveforms. If technically not feasible, manual tracing can be used.
14. Subjective interpretation is recorded (present, absent or reversed end diastolic flow)
15. Average PI of 3 representative images are recorded

Special considerations:

- A. Subjectively decreased, absent, or reversed end diastolic flow:
 - The umbilical artery is sampled separately from the vein to ensure that reversed flow is not present
 - Both umbilical arteries are sampled
 - Sampling is repeated at 2 different sites
- B. Site of interrogation:
 - There is a significant difference in Doppler indices when measurements are obtained at the fetal end, the free loop and the placental end of the umbilical cord (4). Absent/reversed end-diastolic flow being more likely to be first identified at the fetal end.
 - Reference ranges for umbilical artery Doppler indices at a free loop, placental and fetal ends have been published (5,6)
 - Recordings from fixed sites, i.e. fetal end, placental end or intraabdominal portion, may be more reliable in the context of multiple pregnancies, and/or when comparing repeated measurements longitudinally.
 - Umbilical artery free loop is the most commonly used site by convention.
 - Unless otherwise specified, a free loop of umbilical cord is the usual site of interrogation at BCW.
- C. Single umbilical artery:
 - Of note, the diameter of the single umbilical artery is larger than when there are two arteries and the impedance is thus lower at any gestational age (7).
- D. IUGR in *Monochorionic twins*:
 - Umbilical artery Doppler interrogation is performed in both twins when an AC measurements $< 10^{\text{th}}$ percentile is obtained in either or both twins

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- When end diastolic flow is subjectively reduced, absent or reversed:
 - One or more images of “Low sweep speed” Doppler tracing is/are obtained to rule out the presence of cycling Doppler waveform indicating the presence of a large Artery to artery (A-A) anastomosis, diagnostic of “Type 3 selective IUGR”.

E. Monoamniotic twins

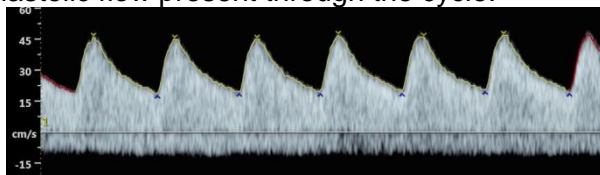
- Subjective interpretation is commented on the presence or absence of “umbilical artery notching” (10).
- Autotrace is used to calculate PI.

4. Interpretation

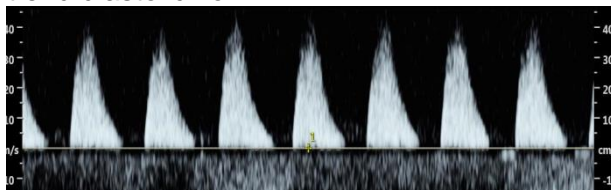
Qualitative interpretation:

- The waveform is interpreted according to the presence, absence or reversed end diastolic flow

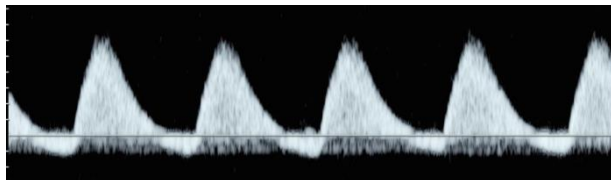
End diastolic flow present through the cycle:



Absent end diastolic flow



Reversed end diastolic flow



- The waveform is interpreted according to the presence, absence or reversed end diastolic flow
- The sonographer informs the reporting physician prior to discharging the patient from the ultrasound unit when a qualitatively abnormal umbilical artery Doppler (absent, intermittent absent or reversed end diastolic flow) is documented.
- A new finding of qualitatively abnormal umbilical artery Doppler waveform above gestational age of 20 weeks is needs to be communicated directly to the referring care provider by the reporting physician in order to ensure patient has timely counselling and follow up plans made

Quantitative interpretation:

- Pulsatility index (PI) is favored for objective interpretation of the umbilical artery Doppler waveform. It is the most suitable index for comparing measurements longitudinally:
 - PI shows a linear correlation with vascular resistance as opposed to both S/D ratio and RI, which show a parabolic relationship with increasing vascular resistance (8).
 - PI does not approach infinity when there are absent or reversed diastolic values
 - PI is the most commonly used index in contemporary IUGR literature.

5. Exceptions

At the discretion of the reporting physician, this protocol may be altered for individual patients.

References

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6. G. Acharya, T Wilsgaard, G. K. R. Bernsten, J. M. Maltau and T. Kiserud: Reference ranges for serial measurements of umbilical artery Doppler indices in the second half of pregnancy: *American Journal of Obstetrics and Gynecology* (2005) 192, 937–44

Version History

DATE	DOCUMENT NUMBER and TITLE	ACTION TAKEN
22-Jan-2019	C-06-13-60016 Obstetrical Imaging Protocol: Umbilical Artery Doppler	Approved at: Perinatal Best Practice Committee

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