Umbilical artery

Anatomical landmarks

The umbilical cord is easy to identify in 2D mode or colour Doppler mode. In the Fetal Cardiology unit at CHU Ste-Justine, the umbilical Doppler spectrum is systematically recorded at both the placental and fetal ends of the cord. The umbilical artery Doppler spectrum is characterized by an antegrade systolodiastolic flow. However, diastolic flow is always greater at the placental extremity.

It should be noted that in umbilical Doppler velocimetry evaluation, we routinely add the intra-abdominal site on each side of the bladder, to check for the presence of both left and right umbilical arteries. Finding a single umbilical artery justifies a more in-depth investigation protocol.

Technical aspects

Doppler recordings of the umbilical artery must be performed on a fetus at rest with no respiratory movement and a normal heart rate between 120 and 160 beats per minute. Indeed, end-diastolic velocities are increased during tachycardia (>160 bpm) while bradycardia reduces the end-diastolic velocities. This influence is essentially linked to diastolic perfusion pressure, which rises in tachycardia and drops in bradycardia. Diastolic flow can also be reduced artificially if the angle between the artery and the ultrasound beam is close to 90º or if the filter level is too high, exceeding 150 Hz.
Parameters and indices

Recording blood wave velocities at the level of the umbilical artery is essentially intended to evaluate how easily blood travels through the placenta. As with the uterine artery, Doppler spectrum analysis can be qualitative or quantitative.

Qualitative analysis is essentially based on the appearance of blood velocities in diastole. Depending on placental resistance, diastolic flow can be antegrade, absent, or retrograde. In this last instance, two subgroups are described: telediastolic retrograde flow and holodiastolic retrograde flow, this latter reflecting the most severe form of placental damage.

As with the uterine artery, the pulsatility index or the resistance index are proposed for the quantitative analysis of umbilical artery Doppler waveforms. In clinical settings, pulsatility index is most commonly used. Contrary to the resistance index, it remains quantifiable, even when diastolic flow is absent or retrograde. As mentioned previously, the level of diastolic velocities, and thus of the pulsatility index, differs according to the recording site along the cord. In fact, the pulsatility index is always higher at the fetal end compared with the placental end. We have taken into account this difference between the two extremities of the cord when we established our normal reference curves in our Fetal Cardiology unit.
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Charts with normal reference values for the pulsatility index, the resistance index, and the S/D ratio represent the percentile curves according to gestational age and to Doppler sampling site, placental or fetal end of the cord. Two findings are worth highlighting: first, placental resistances are higher at the beginning of the 2nd trimester and decrease progressively until they reach a plateau around the 3rd trimester, and, second, the indices are always higher at the fetal extremity compared with the placental extremity as previously mentioned. This means that the same site must be consistently chosen for the same fetus if we want to evaluate the chronological evolution of placental resistances. This rule applies also to comparisons between different fetuses, in multicentre studies for example.

**Pulsatility index**

\[
PI = \frac{(V_s - V_d)}{V_m} = \frac{(S - D)}{m}
\]

\(V_s\) (S) = Peak systolic velocity
\(V_d\) (D) = Peak telediastolic velocity
\(V_m\) (m) = Mean velocity

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Pulsatility index

![Graphs of Pif and Pip against Menstrual age (weeks)]

Resistance index

![Graphs of RIf and Rp against Menstrual age (weeks)]

S/D Ratio

![Graphs of S/D ratio against Menstrual age (weeks)]


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