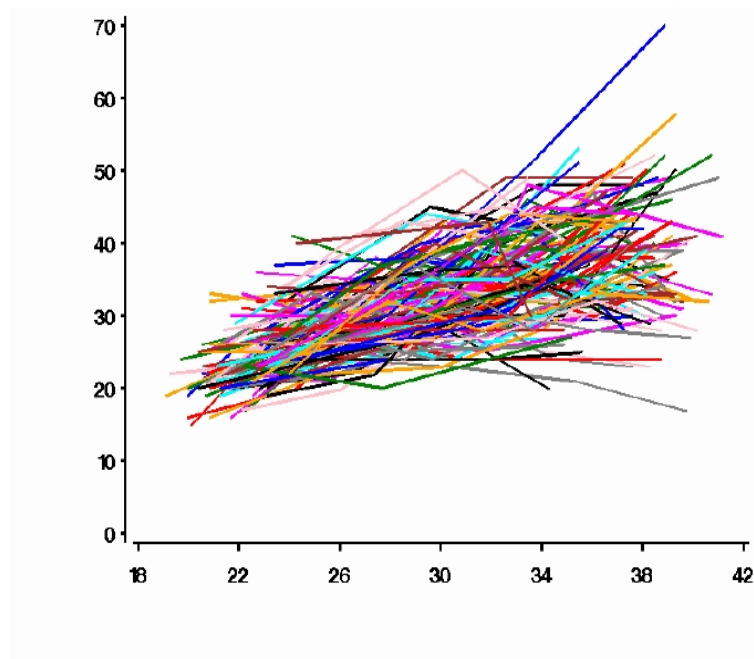


# *The Umbilical Circulation*

A Doppler Ultrasonographic Study



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## ABSTRACT

### Objective:

To test the hypothesis that umbilical artery (UA) absolute blood flow velocities reflect fetoplacental volume blood flow and to construct longitudinal reference ranges appropriate for serial Doppler ultrasonographic evaluation of umbilical circulation in the second half of pregnancy.

### Methods:

In a chronic sheep preparation, UA blood velocities and cardiac function were assessed by Doppler ultrasonography, and placental volume blood flow and resistance were measured directly using peri-vascular ultrasonic transit-time flow probe and intra-vascular pressure catheters in 16 normal fetuses, in 5 fetuses after maternal administration of phenylephrine, and in 5 fetuses after placental embolization.

In human fetuses, UA blood velocities and Doppler indices were obtained from the intra-abdominal portion, fetal and placental ends, and free loop of the umbilical cord and volume blood flow was measured at the intra-abdominal umbilical vein (UV) at approximately 4-week intervals in the second half of 133 low-risk singleton pregnancies.

### Results:

In fetal sheep, Doppler-derived UA pulsatility index (PI) and absolute velocities, except peak systolic velocity (PSV), were closely related to directly measured placental volume blood flow and resistance but not to the non-invasive parameters describing fetal cardiac function.

A significant positive association was found between UA blood velocities and UV volume blood flow in the second half of human pregnancy. However, no significant association was found between UA Doppler indices (PI, RI and S:D ratio) and UV volume blood flow.

Newly established longitudinal reference ranges of UA Doppler parameters and UV volume blood flow in the second half of human pregnancy showed that the blood velocities increase and normalized placental blood flow decreases with advancing gestational age, which confirms the findings of previous cross-sectional studies.

The blood velocities and PI decreased along the length of UA from the intra-abdominal portion towards the placental end, and they were significantly different at each specified standardized insonation site, i.e. intra-abdominal portion, fetal end, and placental end.

### Conclusion:

Umbilical artery absolute blood velocities reflect placental volume blood flow in late gestation fetal sheep and in the second half of human pregnancy. New reference ranges were established for the serial measurement of these parameters of fetoplacental circulation including common Doppler indices in the second half of pregnancy. The results warrant a second phase of studies to assess the usefulness of these methods in clinical contexts.