

Umbilical vein vasomotion - detection and measurement by means of 3D-PixelFlux measurements in fetuses of the 17th to 20th gestational week

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Aim

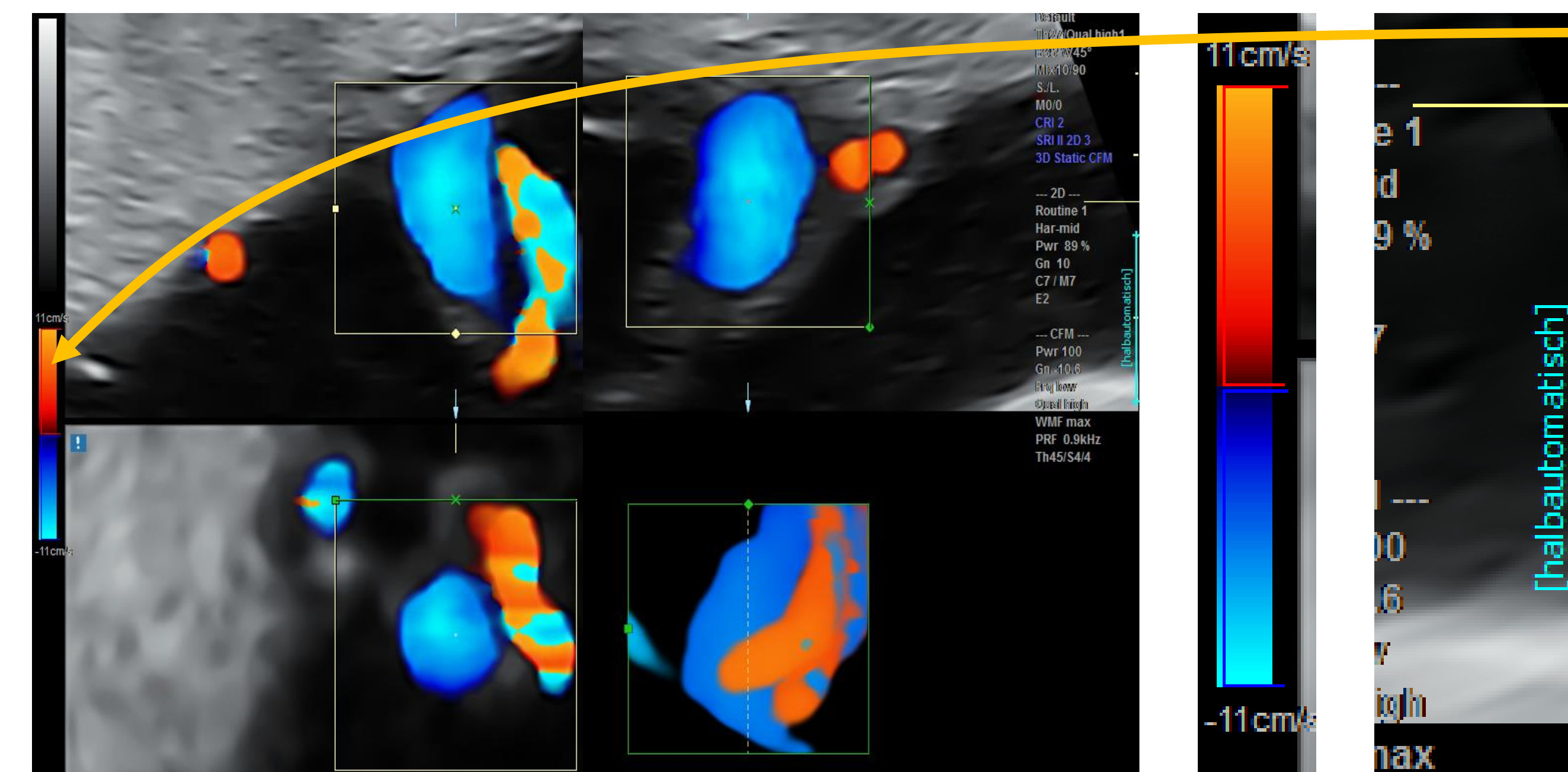
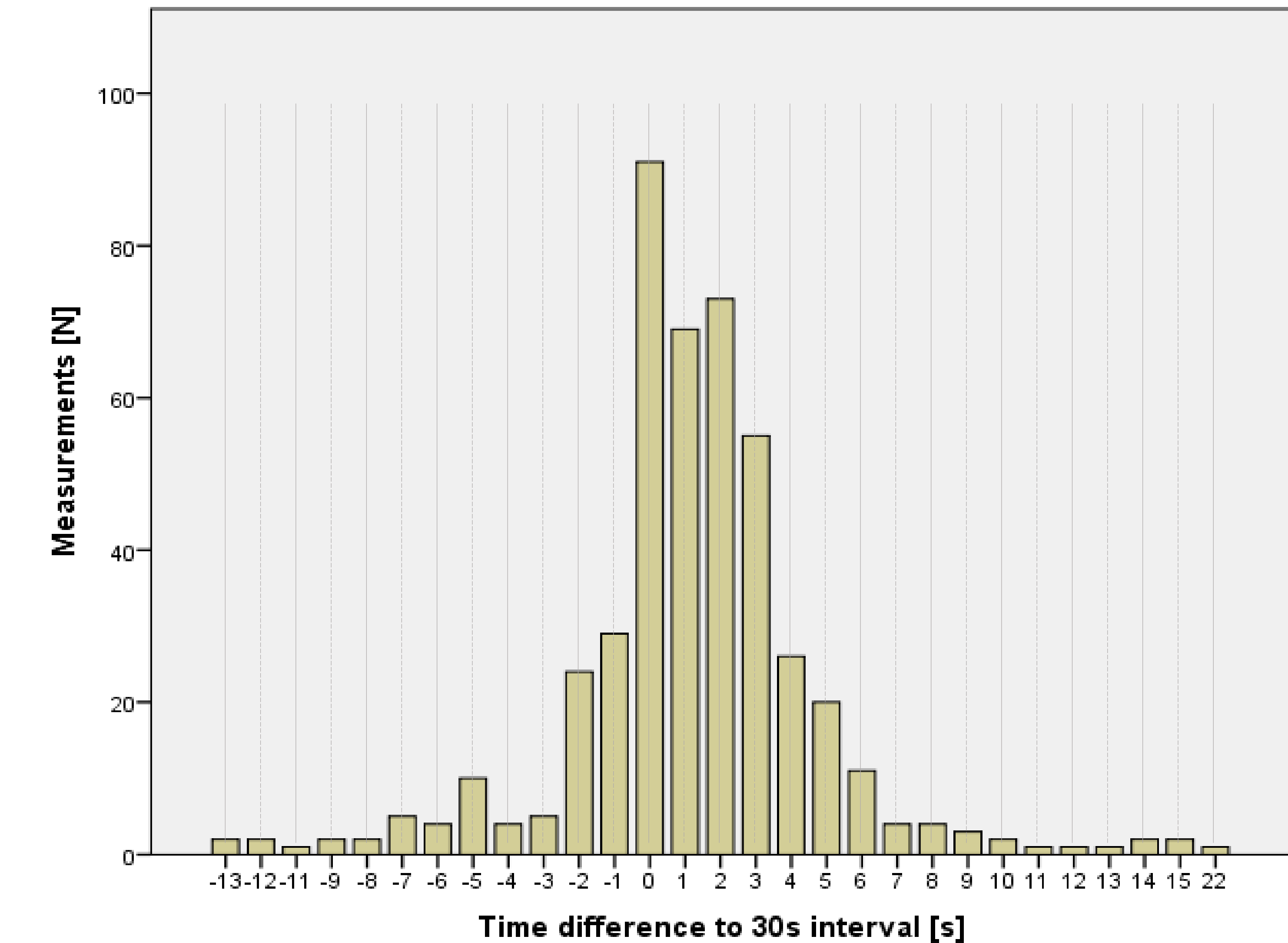
- Actual metabolic need and long-term demand of body growth determine the blood flow volume towards the fetus. So far, the regulation of this flow is attributed to the fetal heart, the maternal circulation and the placenta.
- We applied the novel 3D-PixelFlux-technique to the search for an additional factor, the umbilical vein vasomotion, which was described in human umbilical vein rings only in vitro.


Patients

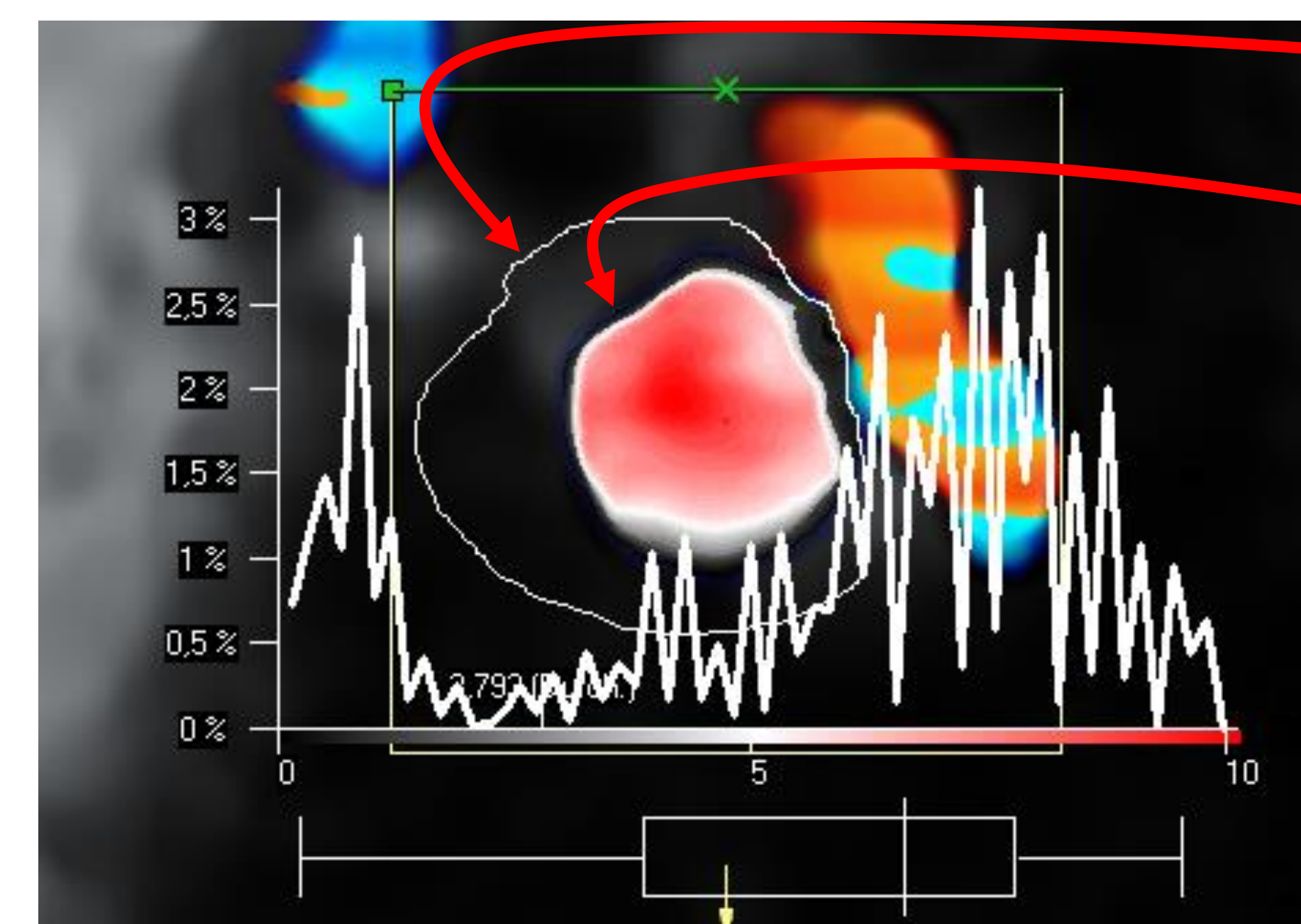
- We examined 43 low risk single fetuses attending their routine second trimester ultrasound examination at a gestational age of 17 to 20 weeks.

Methods

- 3D-color Doppler images of the umbilical cord were recorded in 30 seconds intervals during an examination lasting for 5 min.



3D still image of the umbilical vein calibrated automatically for distances and color hue-values by the PixelFlux-software  (www.chameleon-software.de)



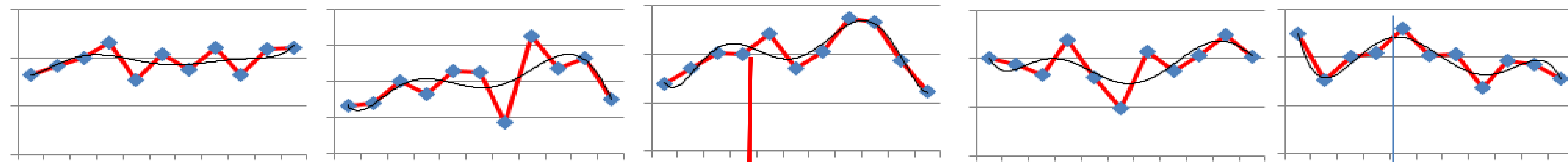
Steps of the measurement

1. Free-hand encircling of the umbilical vein in the horizontal plane
2. Automatic capture of the vessel walls and translation of pixel-velocity into a false color map
3. Automatic correction of the Doppler-angle in all three dimensions (3D)
4. Flow volume measurement pixel-by-pixel inside the vein
5. thus unprecedented exact 3D flow volume measurements become feasible



Determination of flow minima and maxima

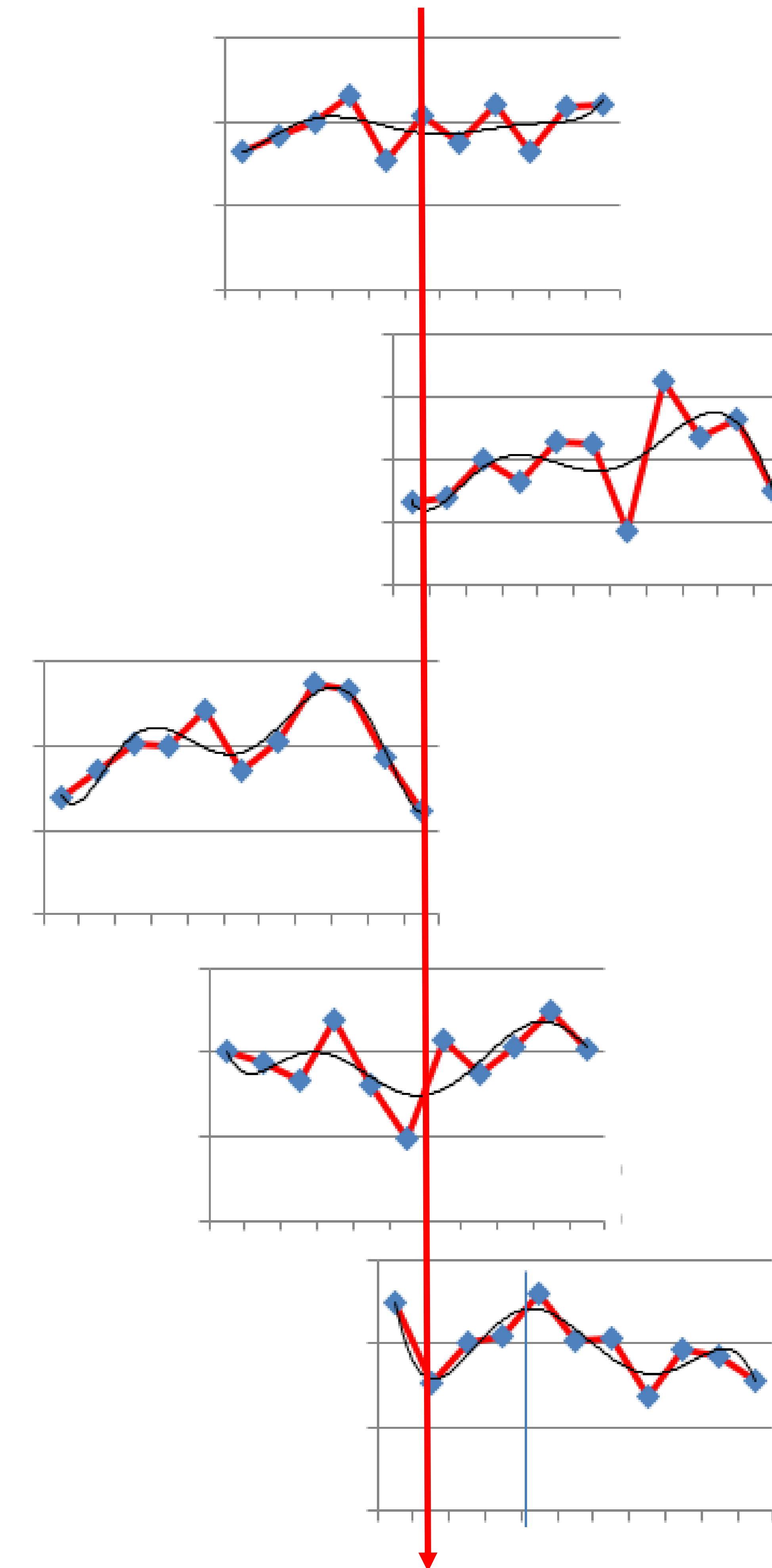
Examples of flow volume changes over 5 min in 5 fetuses



6th polynomic data extrapolation to determine the vasomotion periodicity

- The flow volume changes were compared with the individual minimal flow volumes. All minima were synchronized and thus a periodicity of relative flow volume changes due to rhythmical constrictions of the umbilical vein (vasomotion) could be tracked down.

Alignment of flow volume changes according to the individual minima

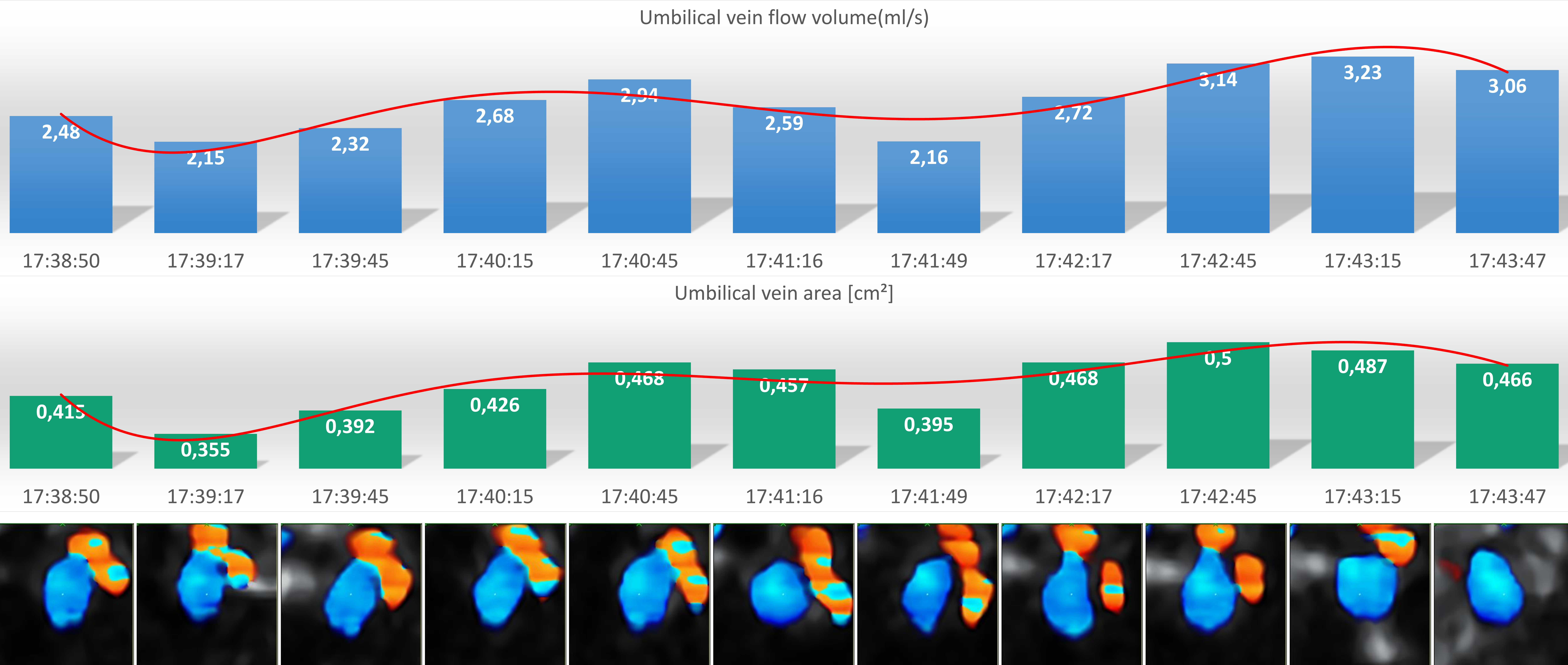


Calculation of mean periodicity of vasomotion

Calculation of a vasomotion period

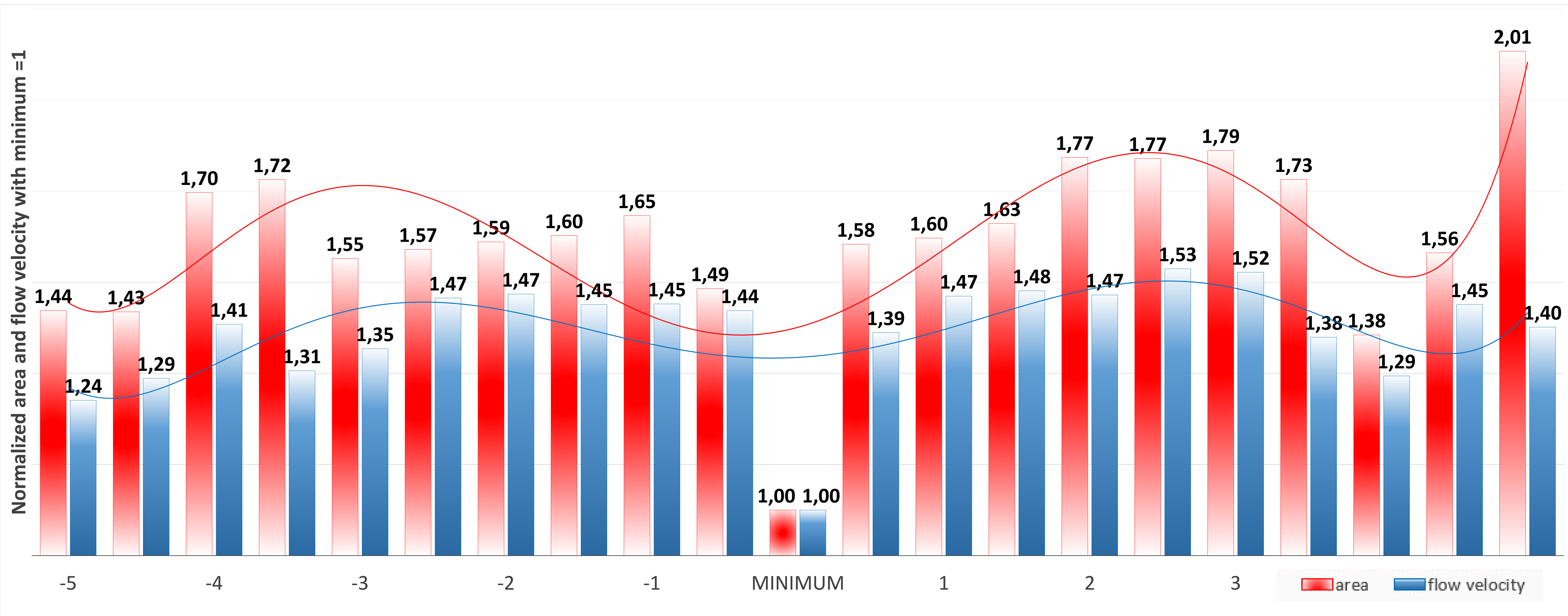
1. Polynomic trend 6th grade smoothes the time-course of vasomotic contractions
2. First turning point of the trend is localized at a certain time slot (each of 30 s duration)
3. Full periods are counted beginning at the first turning point (acc. to 2)
 1. From minimum to minimum or
 2. From maximum to maximum
4. Number of all periods is divided by the time from first to last recorded turning point
5. The result is the frequency of vasomotion

Example of vasomotion of the umbilical vein



Example of the vasomotoric changes of the area of the umbilical vein in horizontal cuts during an examination time of 5 minutes

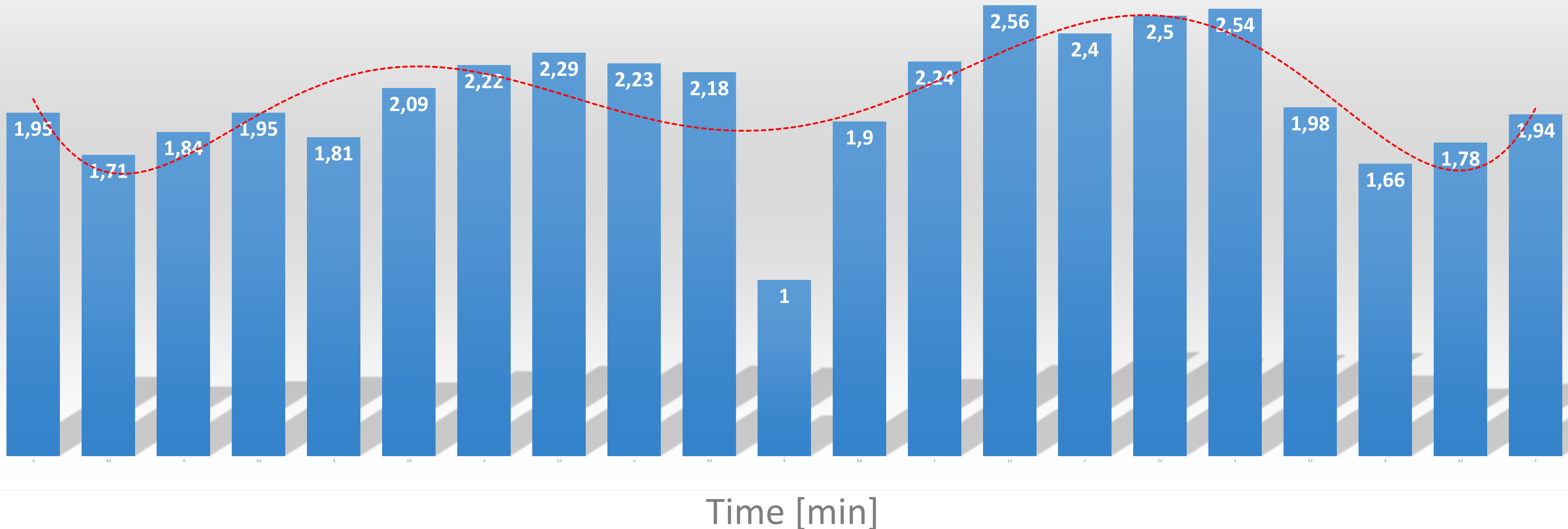
Correlation of vasomotoric changes of flow velocity and transsectional area of the umbilical vein in 43 healthy fetuses



Vasomotion of the umbilical vein in 43 healthy fetuses in the 17th to 20th gestational week

Relative flow volume compared to minimum as 1,0

Average vasomotion period of 4.5 minute duration



Conclusion

- For the first time vasomotion of the umbilical vein becomes measurable in vivo with the PixelFlux-technique (www.chameleon-software.de)
- Vasomotion may contribute as an autochthonous fetal mechanism to the adaptation of fetal volume blood flow
- Subtle and fast flow volume changes may reflect a normal fine-tuning of blood flow volumes according to the actual metabolic needs of the fetus

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