Correlation between growth rate and arterial & venous Dopplers

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Ultrasound Obstet. Gynecol. 6 (1995) 19–28

Changes observed in Doppler studies of the fetal circulation in pregnancies complicated by pre-eclampsia or the delivery of a small-for-gestational-age baby. I. Cross-sectional analysis

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Key words: PRE-ECLAMPSIA, SMALL FOR GESTATIONAL AGE, INTRAUTERINE GROWTH RETARDATION, UMBILICAL ARTERY DOPPLER, MIDDLE CEREBRAL ARTERY DOPPLER, AORTA DOPPLER, FETAL DOPPLER RATIOS

*A total of 105 pregnancies had a complicated outcome. They were divided into three categories: **PPIH** only (pregnancies complicated by **PPIH** with the delivery of an AGA fetus, n = 17), **SGA** only (delivery of an SGA baby, with no evidence of **PPIH**, n = 55), and **PPIH + SGA** (pregnancies complicated by pre-eclampsia and delivery of an SGA baby, n = 37). The **PPIH + SGA** group represented true clinical intrauterine growth retardation.*

The MCA and UA PI values showed the greatest deviation for any single-vessel parameter. The ratios of fetal Doppler indices (MCA/UA PI ratio, MCA/AO PI ratio and the MCA PI/AO TAV index) demonstrated greater deviation from normal than any individual vessel. The UA PI z-score for PPIH + SGA delivering < 34 weeks gestation (2.92) was significantly greater than the z-score for PPIH + SGA delivering ≥ 34 weeks (1.20, p < 0.05).

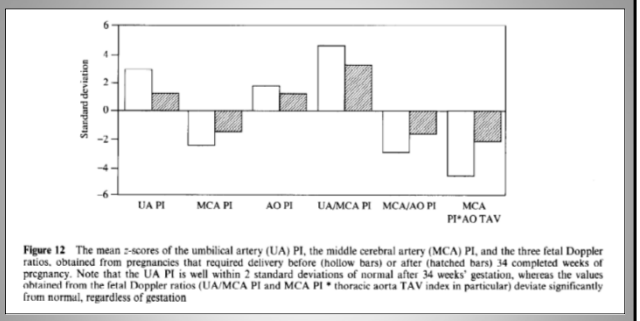


Figure 12 The mean z-scores of the umbilical artery (UA) PI, the middle cerebral artery (MCA) PI, and the three fetal Doppler ratios, obtained from pregnancies that required delivery before (hollow bars) or after (hatched bars) 34 completed weeks of pregnancy. Note that the UA PI is well within 2 standard deviations of normal after 34 weeks' gestation, whereas the values obtained from the fetal Doppler ratios (UA/MCA PI and MCA PI * thoracic aorta TAV index in particular) deviate significantly from normal, regardless of gestation

Dopplers show greatest changes early in gestation
Arterial Doppler is of limited utility after 34 weeks gestation in IUGR

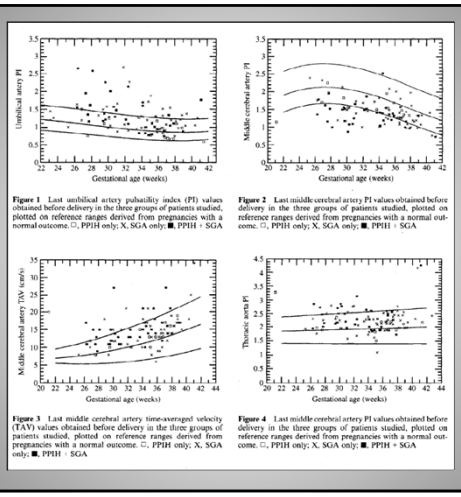
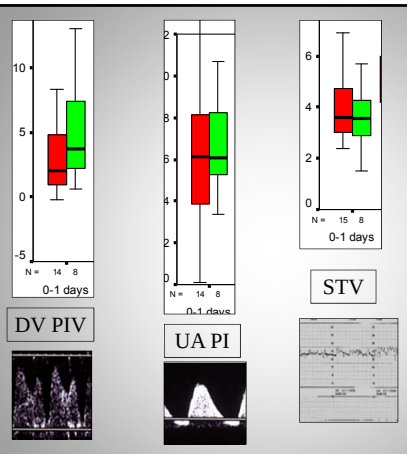


Figure 1 Last umbilical artery pulsatility index (PI) values obtained before delivery in the three groups of patients studied, plotted on reference ranges derived from pregnancies with a normal outcome. □, PPIH only; X, SGA only; ■, PPIH + SGA

Figure 2 Last middle cerebral artery PI values obtained before delivery in the three groups of patients studied, plotted on reference ranges derived from pregnancies with a normal outcome. □, PPIH only; X, SGA only; ■, PPIH + SGA

Figure 3 Last middle cerebral artery time-averaged velocity (TAV) values obtained before delivery in the three groups of patients studied, plotted on reference ranges derived from pregnancies with a normal outcome. □, PPIH only; X, SGA only; ■, PPIH + SGA

Figure 4 Last middle cerebral artery PI values obtained before delivery in the three groups of patients studied, plotted on reference ranges derived from pregnancies with a normal outcome. □, PPIH only; X, SGA only; ■, PPIH + SGA



Small numbers but in assessment of techniques the day before delivery ,

DV PIV showed most promise in differentiating between neonatal outcomes

(green=death or severe morbidity)

Hecher K, Bilardo CM, Ville Y, Wolf H, Visser G UOG 2001 & 2002 ***graphs courtesy of Hans Wolf***

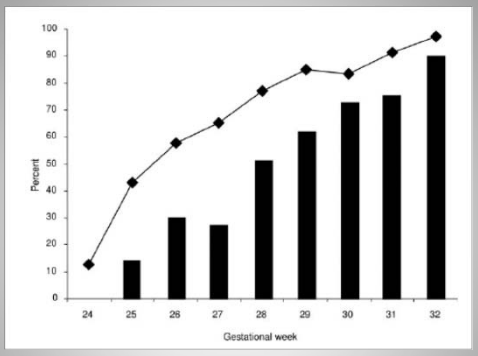
Predictors of neonatal outcome

N= 604, multicenter observational study

IUGR born <33 wks (median 29 wks)

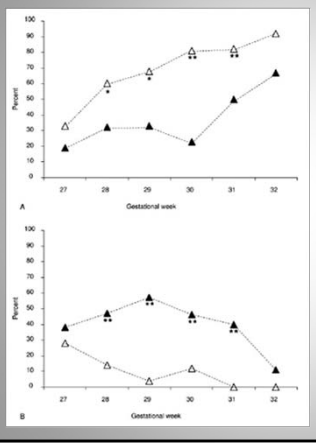
Relationship between gestational age, birth weight, Dopplers, acid-base status, Apgar and major neonatal complications/neonatal death

Baschat et al O&G, 2007;109:253-61



Neonatal survival *(black diamonds)* and intact survival rates *(black bars)* per gestational week with advancing gestational week.

Baschat. Neonatal Outcome in Fetal Growth Restriction. Obstet Gynecol 2007.



A. Intact survival
B. Neonatal mortality

related to the ductus venosus a-wave:

open triangles= forward flow in atrial systole
solid triangles= absent or reversed flow in atrial systole

Baschat. Obstet Gynecol 2007.

Prediction of pH< 7.20 by individual parameters (n=58)

Test	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	FPR (%)	FNR (%)	OR	95% CI	P
Abnormal biophysical parameters									
Absent tone	24	90	50	73	10	76	2.69	0.59–12.4	0.23
Absent movement	41	85	54	77	15	59	3.85	1.05–14.1	0.046
Absent breathing	59	64	42	78	36	41	2.55	0.79–8.19	0.15
Amniotic fluid pocket < 2 cm	41	85	54	78	15	59	4.08	1.12–14.94	0.04
Non-reactive non-stress test	94	27	35	92	73	6	5.87	0.69–49.62	0.09
Biophysical profile score	53	74	47	78	26	47	3.26	0.99–10.76	0.07
Abnormal Doppler parameters									
UA-AREDV	65	54	37	79	46	35	2.12	0.66–6.83	0.26
Brain sparing	71	44	34	78	56	29	1.88	0.56–6.31	0.38
Elevated DV Doppler index	65	76	52	84	24	35	5.68	1.67–19.32	0.006
Absent/reversed DV a-wave	12	98	67	73	2	88	5.33	0.45–63.22	0.20
Umbilical venous pulsation	53	98	90	83	2	47	45.0	4.98–406.54	<0.0001
cCTG short-term variation									
< 2.5th percentile	71	49	36	80	51	29	2.29	0.68–7.66	0.25
< 3.5 ms	47	83	53	79	17	53	4.32	1.23–15.11	0.025
Biophysical profile score with cCTG < 3.5 ms	47	79	50	78	21	53	3.44	1.01–11.78	0.058

- Venous Dopplers provide best prediction of acid-base status.
- cCTG (<3.5ms) performs best when combined with venous Doppler
- FHR analysis correlates more closely with chronic hypoxemia, than with its progression to deepening acidaemia

Turan S et al, UOG,2007;30:750-6

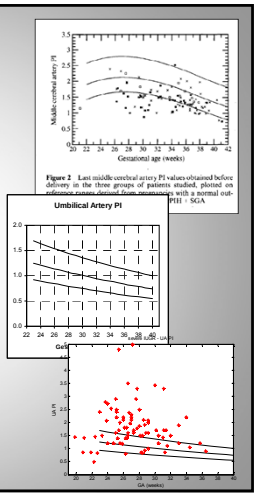
Difficulties in relating Doppler values to growth:

Doppler PI changes with gestation
can't compare a case at 24 weeks with one at 32 weeks

Until recently no PI charts existing for all arterial PIs in a mixed risk population
impossible to 'normalise' for gestation

Most longitudinal research included and or analysed all data points
statistically incorrect

Or used only 'first' or 'last' measures to avoid co-dependence
wasteful of data-lose potentially significant relationships

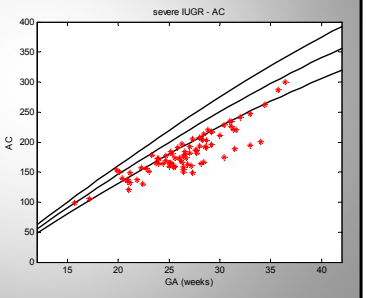


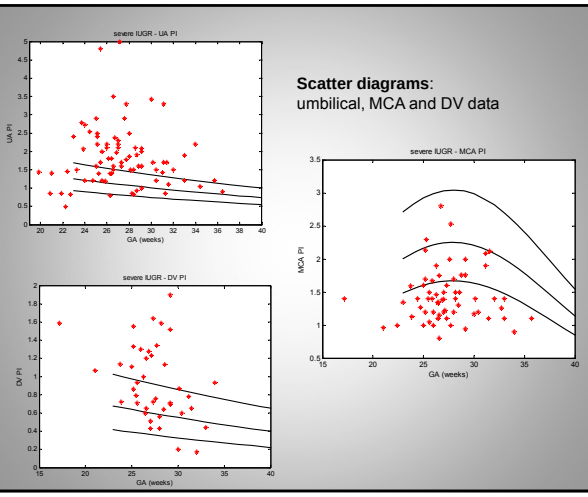
Methods:

Women with:
-AC<10th centile at 24 weeks
-abnormal umbilical artery Doppler
(2003-2007)

Serial arterial and venous Doppler and AC measurements were recorded, expressed as z-scores and longitudinally analyzed using FLDA.

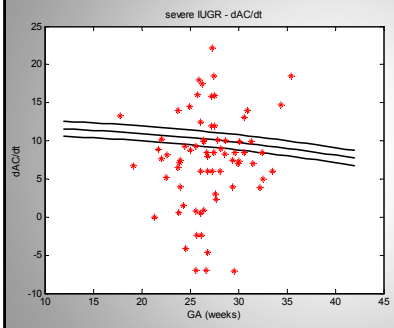
FLDA curves converted into a correlation coefficient expressing the relationship between the Doppler with both absolute AC measurements and the rate of AC growth with time

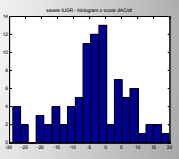




Scatter diagrams:
umbilical, MCA and DV data

Growth rate superimposed on the 'normal' rate derived from AC normal ranges





mean -3.9948; median -3.1042

Results:

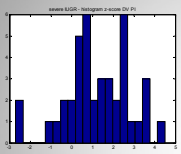
16 women comprising 70 scans.

Negative correlation between umbilical artery PI z-score and AC z-score (Spearman correlation coefficient=-0.367; p=0.0008)

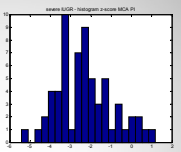
Positive correlation between MCA PI z-score and both z score AC and rate of AC growth.

No relationship observed between z score DV PI and either z-score AC or z-score AC growth.

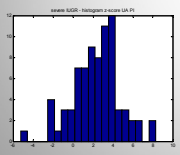
Conversion of fetal Doppler PI indices to gestation normalized 'z' scores, and conversion of abdominal circumference values to gestation normalised 'z' scores



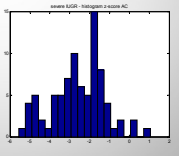
mean 1.2282
median 1.2077



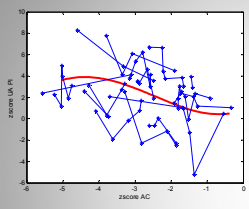
mean -2.2782
median -2.3892



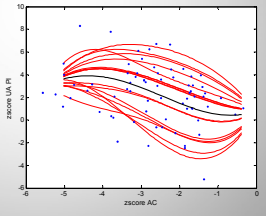
mean 2.3270
median 2.4620

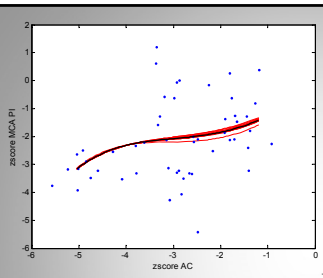


mean -2.5610
median -2.5253

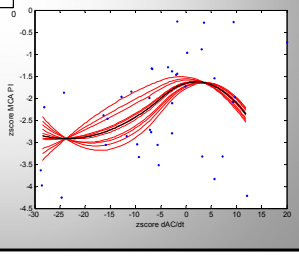


Umbilical artery PI:
relationship with AC





MCA PI:
relationship with z AC
and z d(AC)/dt



Conclusions:

A relationship exists between fetal arterial PI and the degree of fetal growth restriction and fetal growth rate as assessed by z-scores

This requires robust PI charts (to enable z-score conversion) and a new method of longitudinal analysis (FLDA) to take account of interdependent variables

These relationships may enable a clearer understanding of fetal physiological changes in response to progressive hypoxia and growth restriction and a more rational basis for follow up of these babies.

Co-workers: *Anneleen Daemen, Dirk Timmermann, Tom Bourne (Leuven); Edile Murdoch, Hannah Missfelder -Lobos, Alon Talmor (Addenbrookes Hospital); Dino Giussani (Cambridge University)*

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