



ISUOG初级培训

脐动脉和子宫动脉多普勒

学习目的

完成本课程后应掌握：

- 描述如何正确进行脐动脉多普勒检查、评估和报告
- 描述如何正确进行子宫动脉多普勒检查、评估和报告

关键问题

1. 有助于临床决策的脐动脉多普勒检查的技术要求？
2. 利用多普勒进行脐动脉取样的主要难点？
3. 有助于临床决策的双侧子宫动脉多普勒检查的技术要求？
4. 利用多普勒进行子宫动脉取样的主要难点？

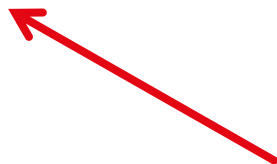
ISUOG Education Committee recommendations for basic training in obstetric and gynecological ultrasound

ISUOG教育委员会推荐的妇产科超声基础培训内容

- 脐动脉和子宫动脉多普勒

Second and third trimesters

- Determination of fetal position
- Assessment of fetal wellbeing, including fetal movements
- Amniotic fluid volume estimation and conditions associated with abnormal amniotic fluid volume
- Placental assessment, including relation to the internal cervical os
- Standard fetal biometry (biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur diaphysis length (FL)) and estimated fetal weight calculation
- Fetal growth and typical causes of abnormal fetal growth
- Fetal head (intact cranium, head shape, midline falx, cerebral ventricles, cavum septi pellucidi, cerebellum, cisterna magna) and typical anomalies
- Fetal face (orbits, nose and mouth in different planes) and typical anomalies
- Fetal thorax (lung morphology and relationship to heart size) and typical anomalies
- Fetal heart (situs, four-chamber view, outflow tracts, three-vessel view) and typical anomalies
- Fetal abdomen (stomach, liver with umbilical vein, kidneys and urinary bladder, diaphragm, bowel, abdominal wall and cord insertion) and typical anomalies
- Fetal spine in longitudinal and transverse planes and typical anomalies
- Fetal limbs (arms, hands, legs, feet) and typical anomalies
- Umbilical and uterine artery Doppler

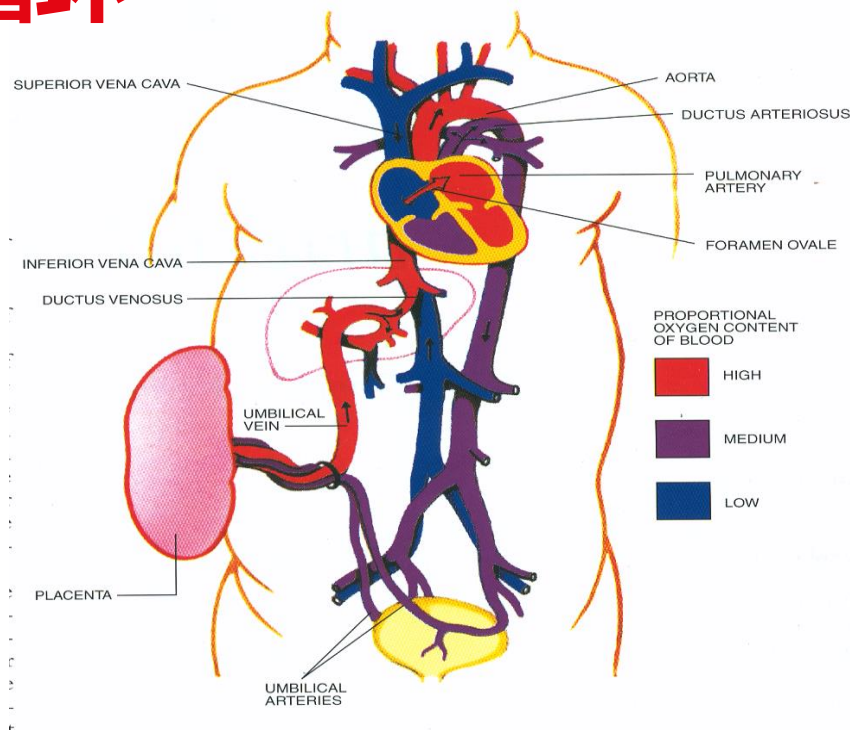


检查开始前一些基本要求

- 了解所使用的超声设备
- 具备流体力学相关知识
- 具备血流动力学相关知识
- 具备胎儿生理学相关知识
- 了解需测量的内容
- 了解应用哪些指标
- 了解应用多普勒的时机

胎儿循环

- 心率快
- 血压低
- 外周阻力低（胎盘）
- 稳定的胎盘循环（对血管活性物质无反应）
- 随孕周增加，胎儿血压及胎盘床动脉血流增加，外周阻力下降



胎儿及母体侧血管

Fetal side 胎儿侧

- 脐动脉
- 大脑中动脉
- 静脉导管
- 脐静脉



母体侧

- 子宫动脉

孕期多普勒检测指标

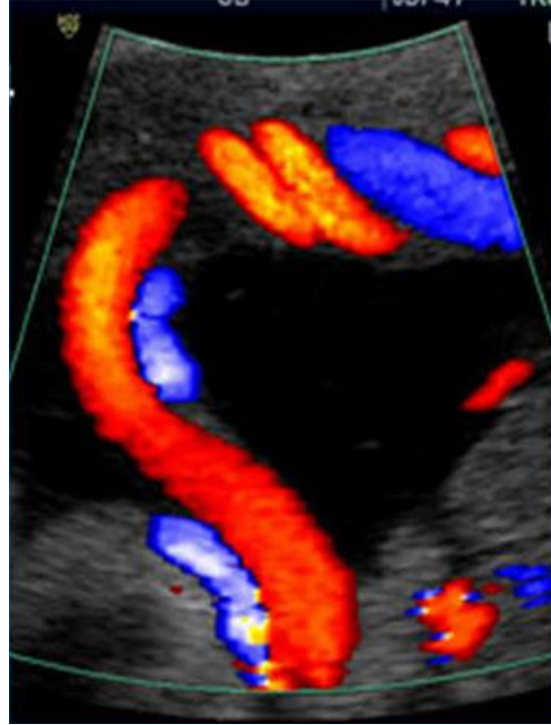
胎盘形成

- 滋养层侵入螺旋动脉

胎儿宫内状况

- 低氧血症
- 贫血
- 染色体异常（孕gong'nei期）
- 心脏异常（心脏功能）
- 单绒双胞胎
- 胎盘早剥
- 过期妊娠
- 糖尿病

脐动脉多普勒

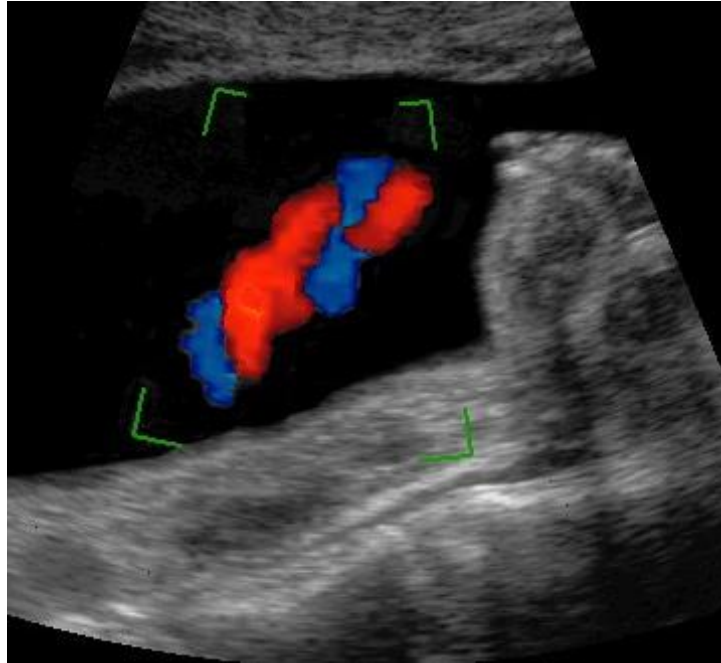


脐动脉多普勒



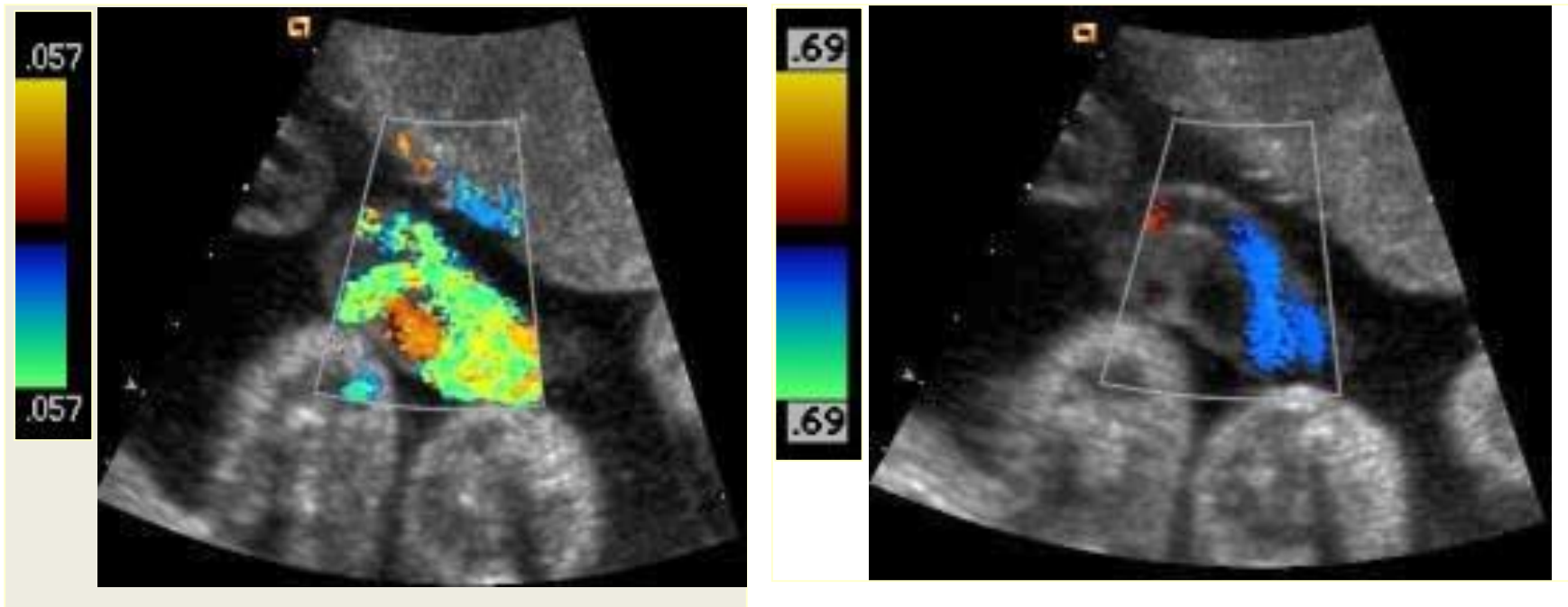
1. 显示脐带，选择游离段，不过分靠近胎儿脐带插入点或胎盘脐带插入点
2. 放大脐带区域

脐动脉多普勒



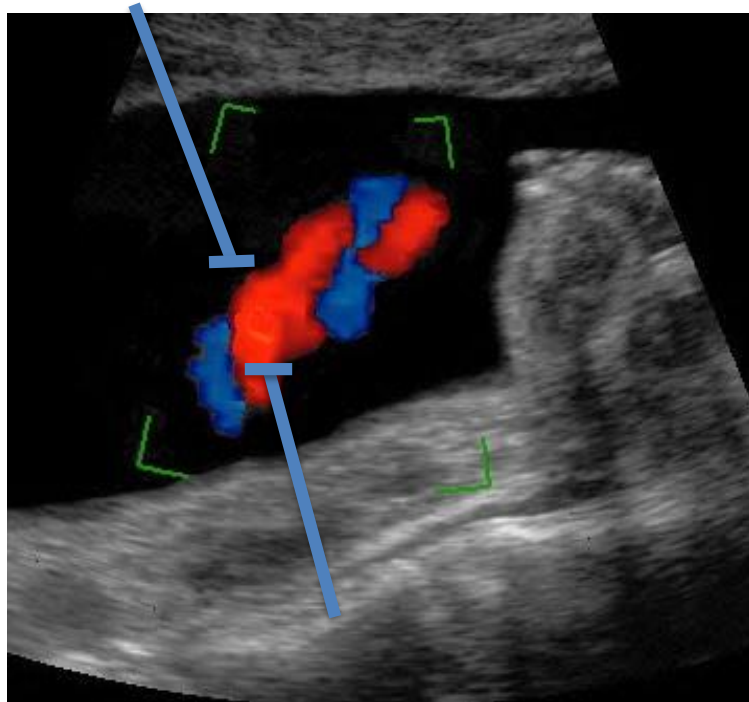
3. 切换彩色多普勒模式（非必须）

脐动脉多普勒



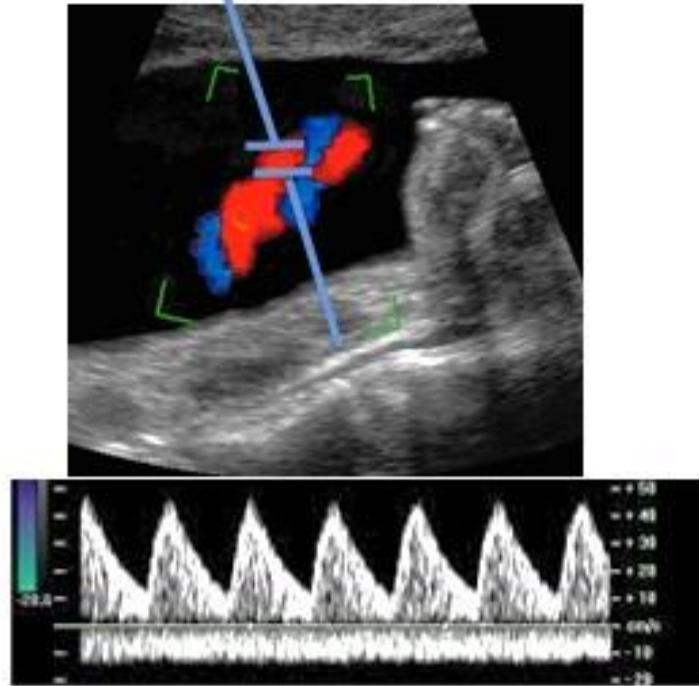
3a. 优化彩色血流图CFM标尺

脐动脉多普勒



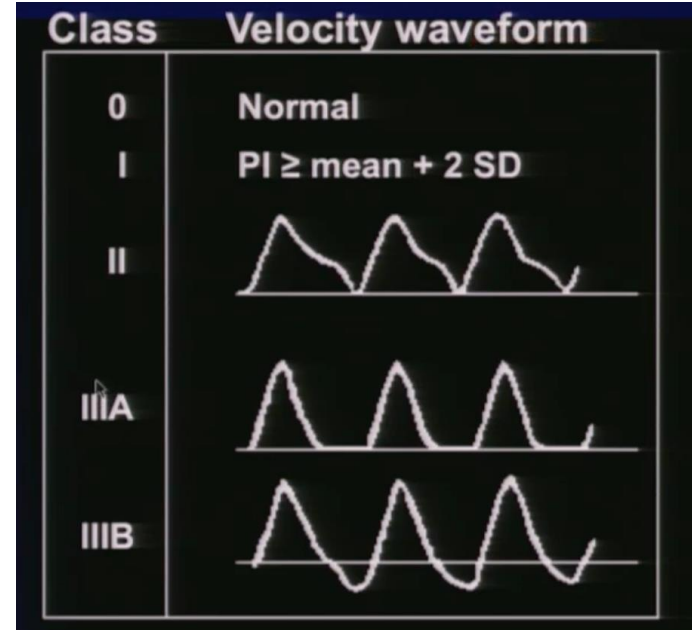
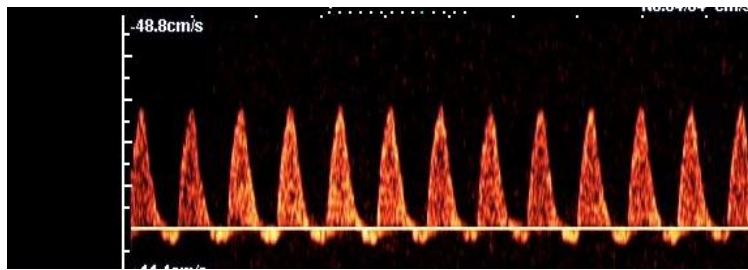
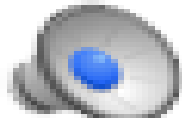
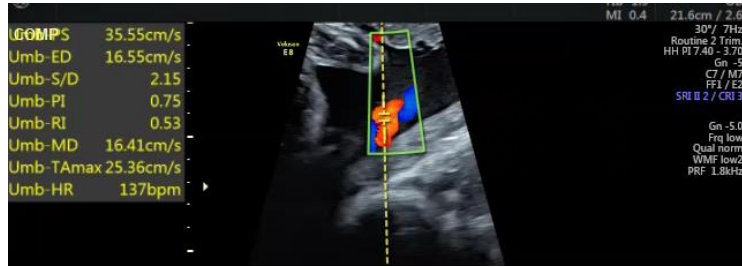
4. 将取样门放置在脐动脉上

脐动脉多普勒



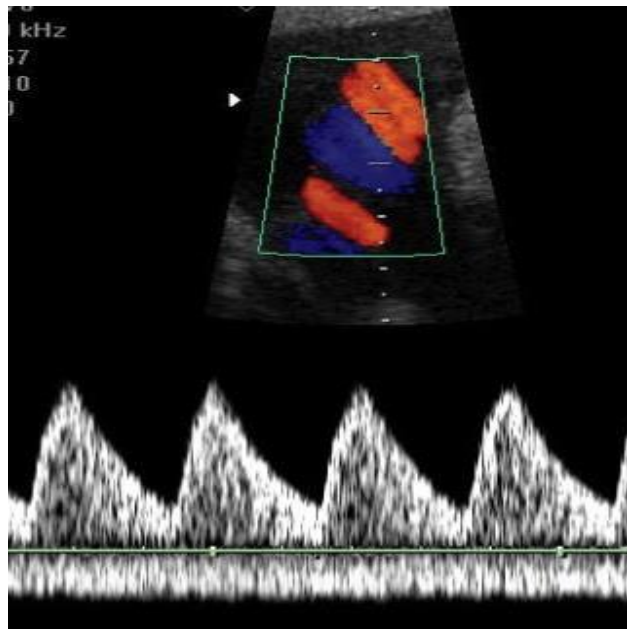
5. 开启脉冲多普勒功能

脐动脉多普勒



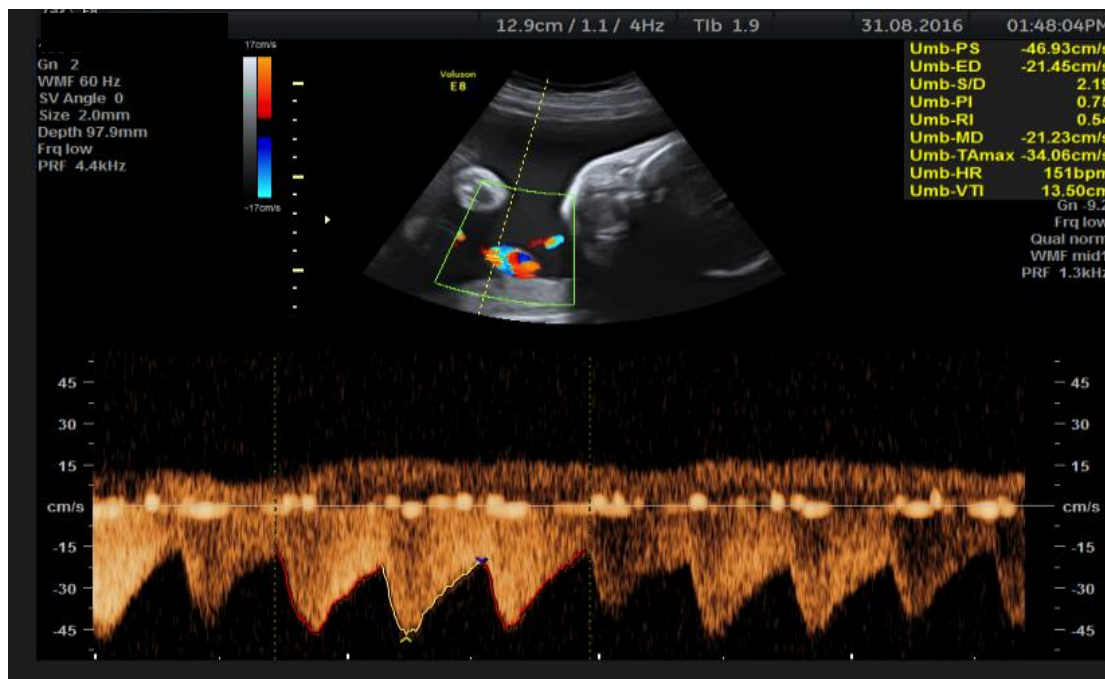
Laurin et al. Ultrasound measurement of fetal blood flow in predicting fetal outcome, BJOG, 1987, 94(10): 940-948

二维/脉冲多普勒

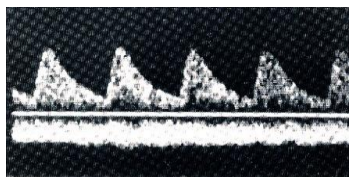


- 2D image in freeze mode provides better Doppler signals
- 二维图像在冻结模式下可提供更好的多普勒信号

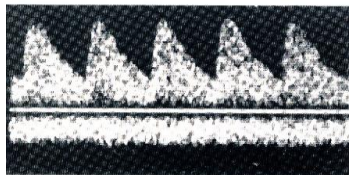
受胎儿呼吸动作影响，脐动脉血流速度波形可不规则



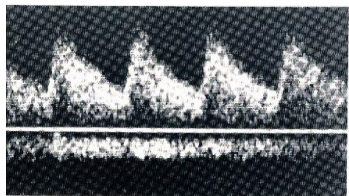
脐动脉多普勒



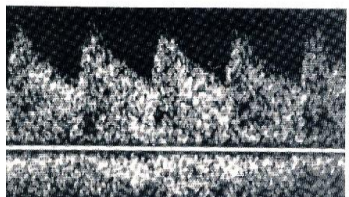
16周



24周



32周

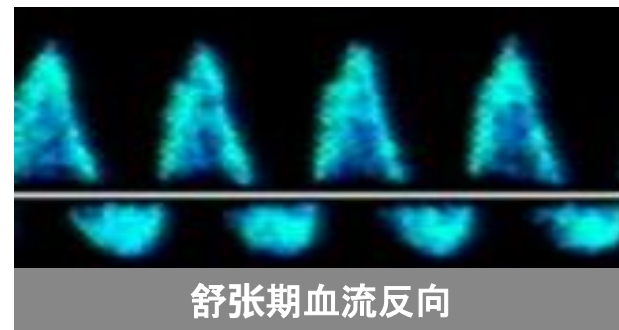
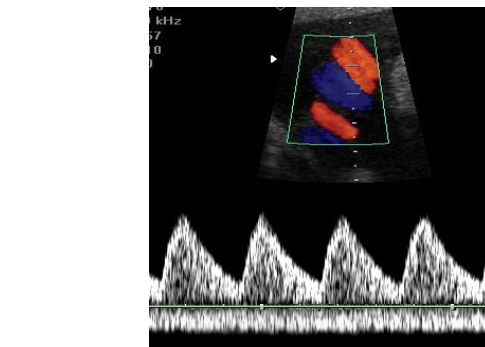
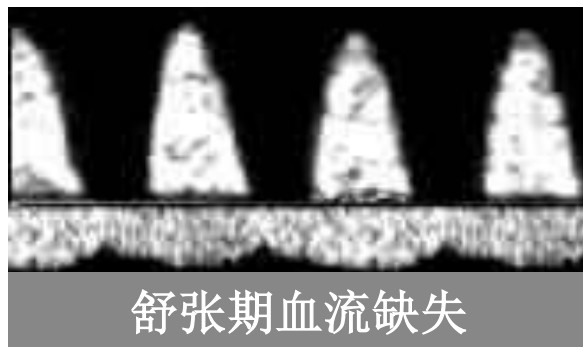
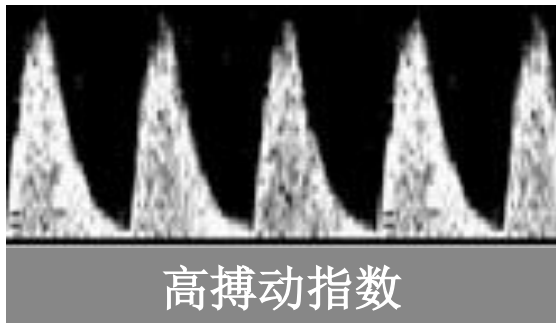


40周

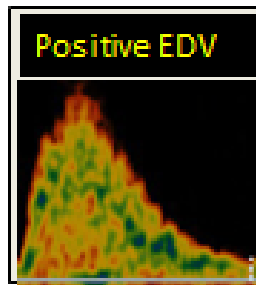
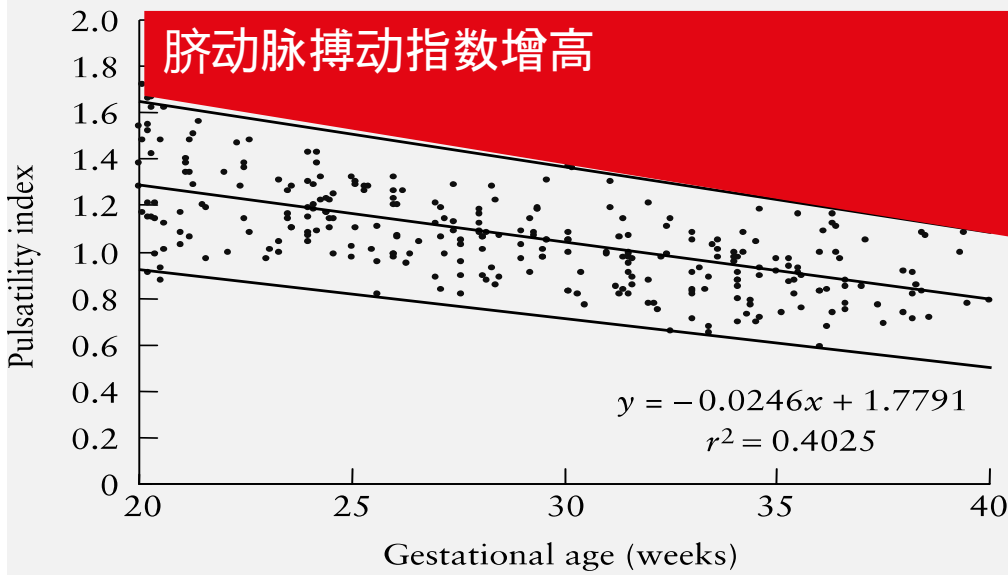
随着孕周的增加，胎盘阻力逐渐下降



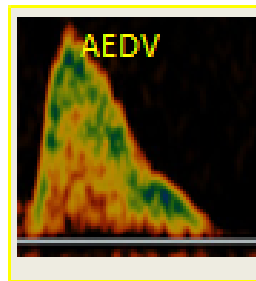
病理妊娠时的脐动脉血流



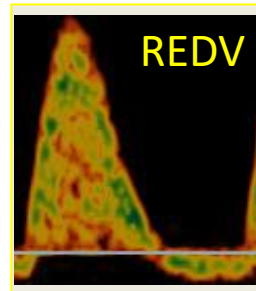
异常脐动脉超声表现



舒张末期血流可见：
30%的绒毛血管灌注不足



舒张末期血流消失：
50%的绒毛血管灌注不足



舒张末期血流反向：
70%的绒毛血管灌注不足

Baschat A, Gembruch U, UOG 2003, 21: 124-7

Trudinger BJ, Giles WB, Br J Obstet Gynaecol, 1996, 105: 487-9

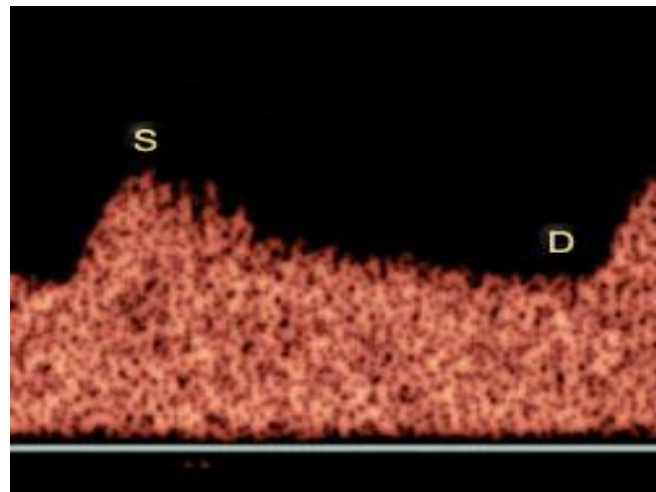
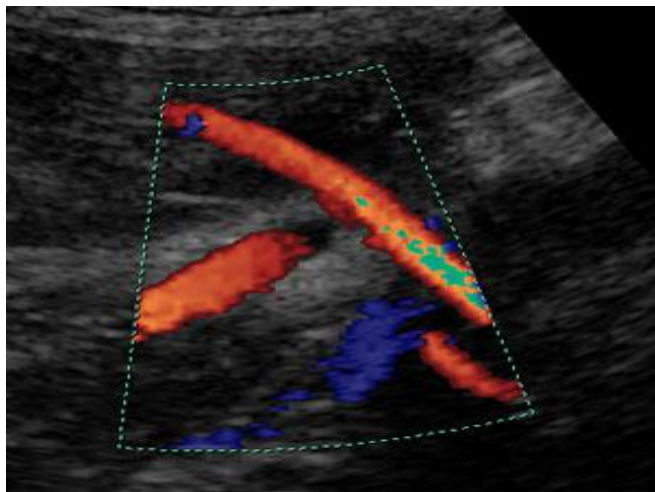
脐动脉波形变异

- 测量位置不同（胎儿端、游离段、胎盘端），脐动脉多普勒参数有明显差异
- 为简便和一致性，测量应在游离段进行
- 多胎妊娠时和/或纵向对比多次测量结果时，在固定位置（胎儿侧、胎盘侧或腹内段）取样结果更可靠
- 参考范围应与不同检查位置相匹配

何时进行脐动脉评估

- 胎儿生长速度减慢/胎儿生长受限（FGR）
- 单绒毛膜双胎
- 胎儿水肿
- （舒张末期血流缺失或反向）比PI值更敏感

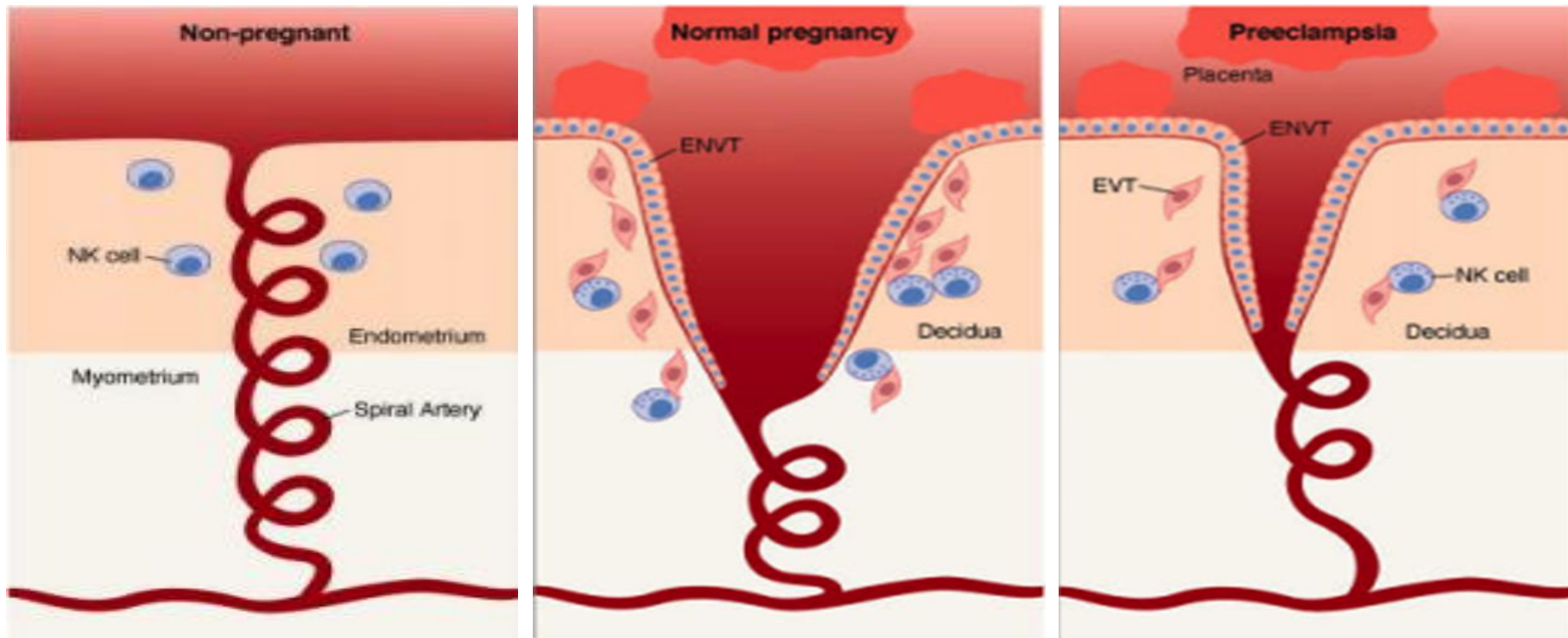
子宫动脉多普勒



子宫动脉多普勒-检查技巧

- 经腹途径，将探头纵向放置于腹部下外侧象限，并向内侧倾斜
- 血流有助于识别跨越髂外动脉的子宫动脉
- 取样容积放置于交叉点下方约1cm处
- 如果子宫动脉在髂外动脉与其交叉点前分支，则取样容积应放置于分支前的子宫动脉主干上

滋养层侵入



子宫动脉

THE LANCET

Volume 322, Issue 8351, 17 September 1983, Pages 675

Originally published as Volume 2, Issue 8351

评估子宫胎盘血流的多普勒新技术

New doppler technique for assessing uteroplacental blood flow.

Campbell S, Diaz-Recasens J, Griffin DR, Cohen-Overbeek TE, Pearce JM, Willson K, Teague MJ.

Abstract

Gated, pulsed, doppler ultrasound was used to study blood flow velocity profiles in the uterine vessels (arcuate arteries) during the second and third trimesters of pregnancy. A frequency index profile nomogram was constructed from 30 normal pregnancies; this demonstrated high diastolic velocity and low pulsatility. Among 31 pregnancies with complications 14 showed waveform changes suggesting raised vascular resistance; these pregnancies were complicated with a high frequency of proteinuric hypertension, poor fetal growth, and fetal hypoxia. This non-invasive technique may give early warning of impaired uteroplacental perfusion and can be used to evaluate methods of improving uterine blood flow.

PMID: 6132039 [PubMed - indexed for MEDLINE]

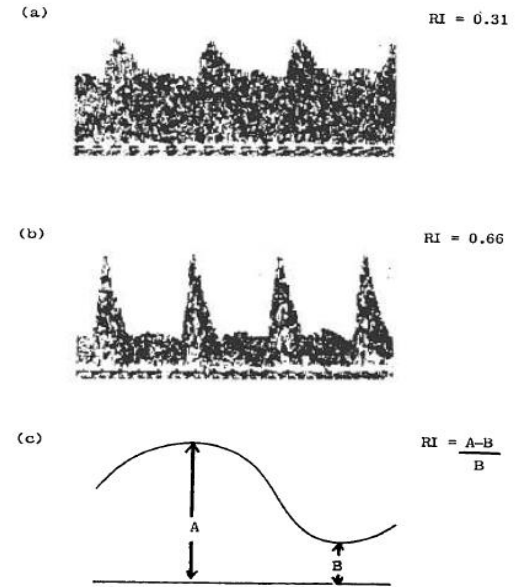
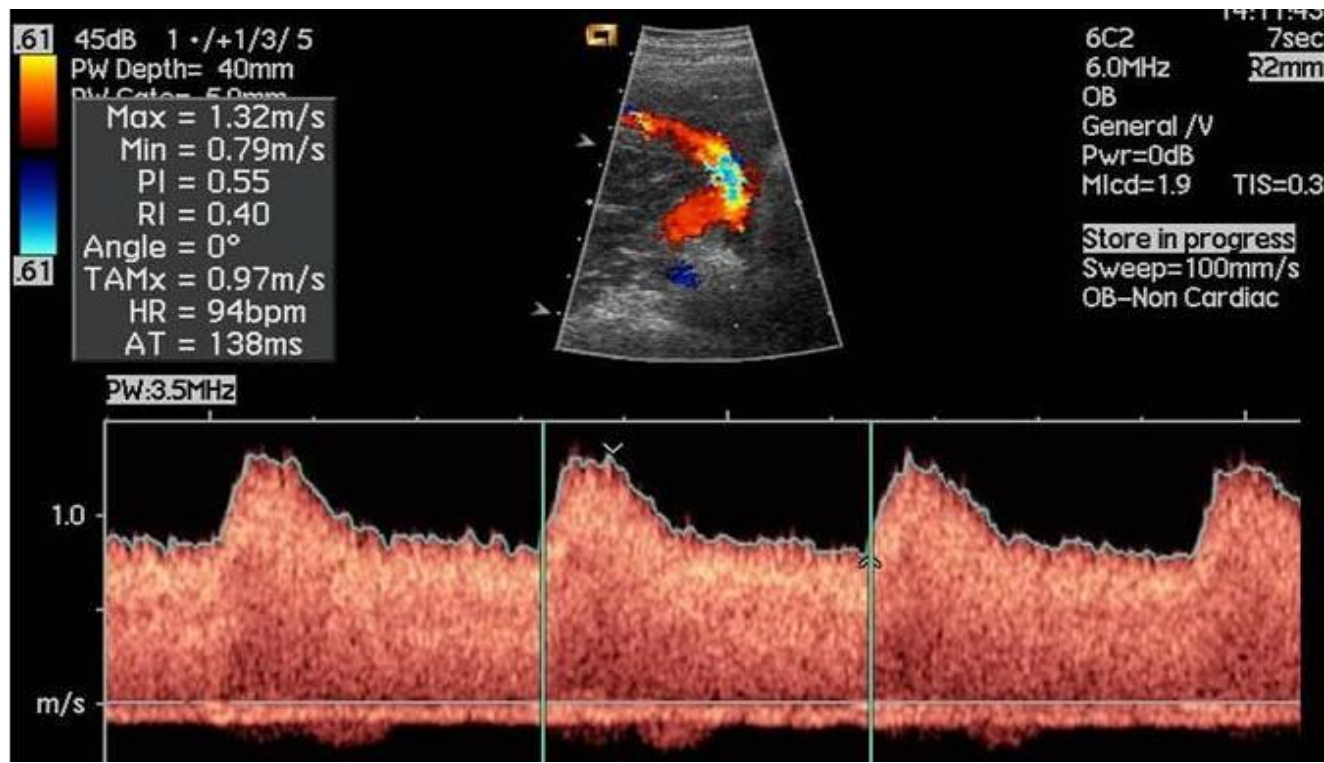
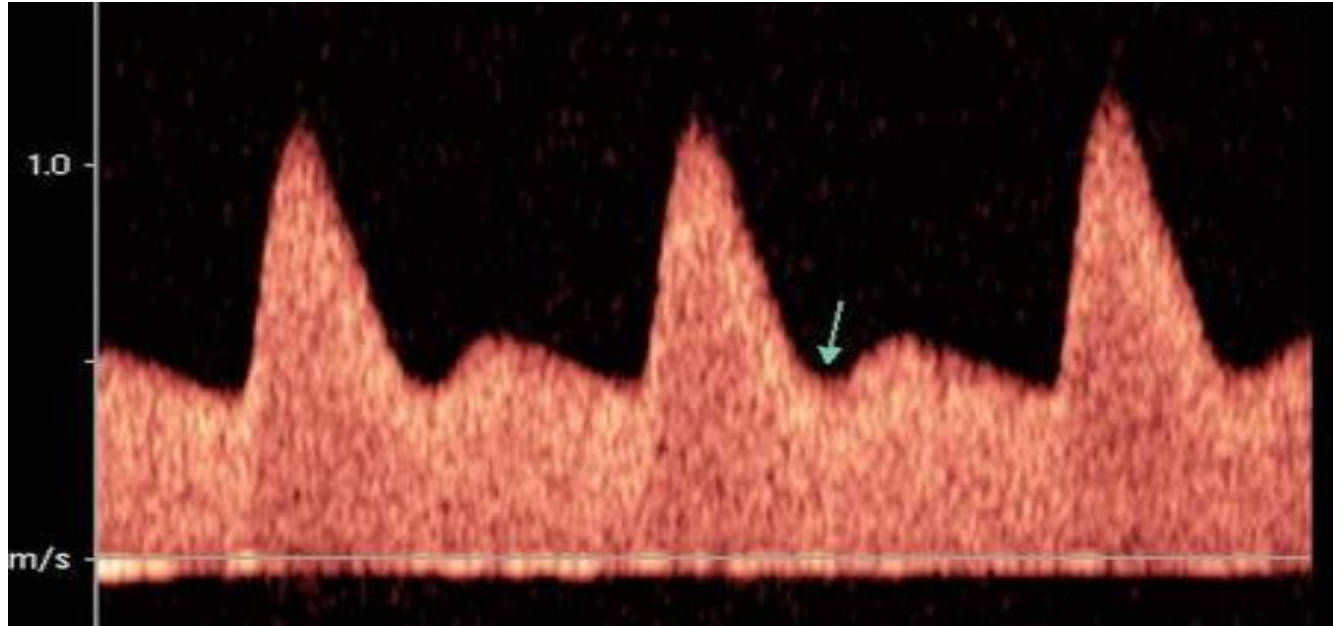


Figure 1. (a) and (b) arcuate artery flow velocity waveforms from two study patients; (c) diagrammatic representation of the resistance index.

正常子宫动脉频谱波形

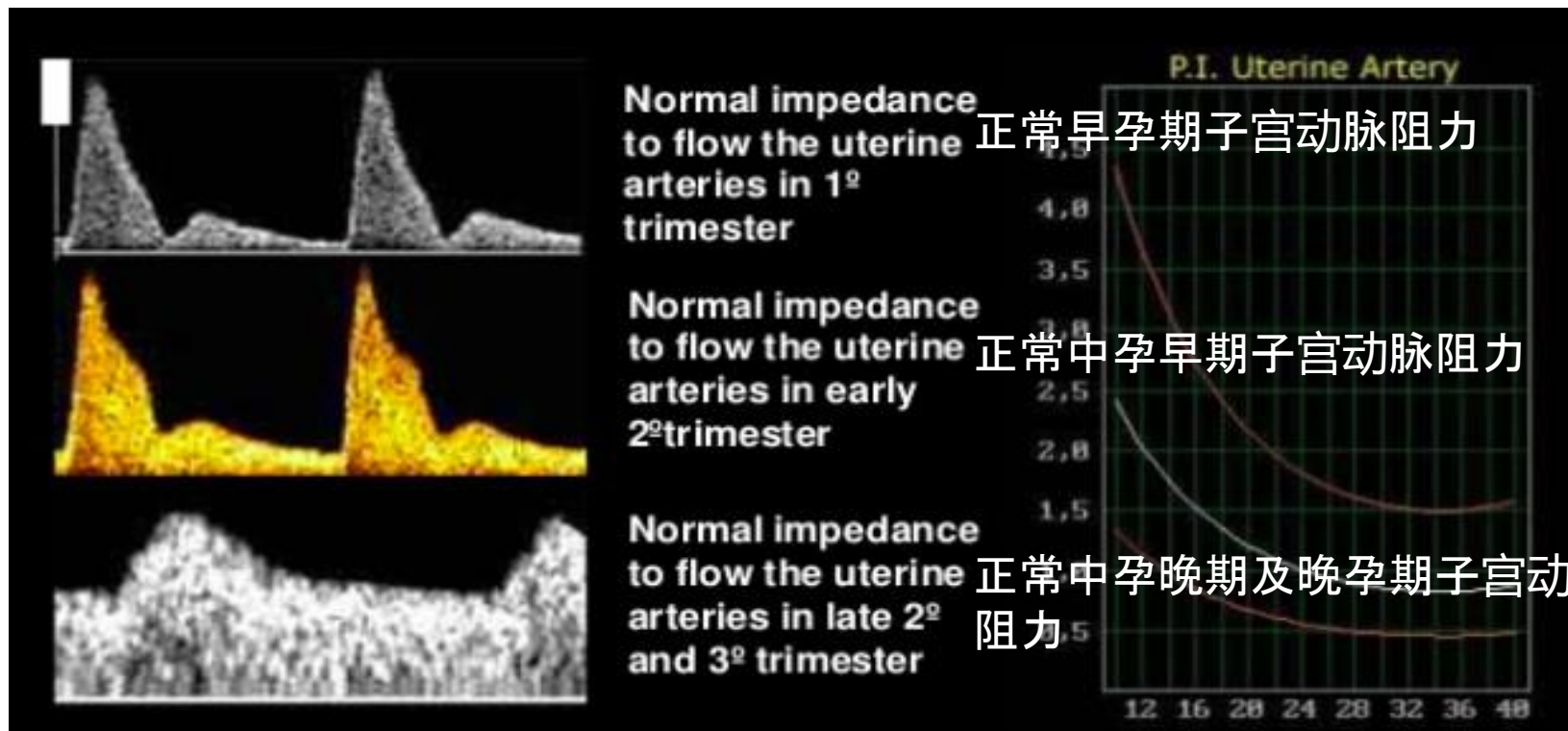


异常子宫动脉波形

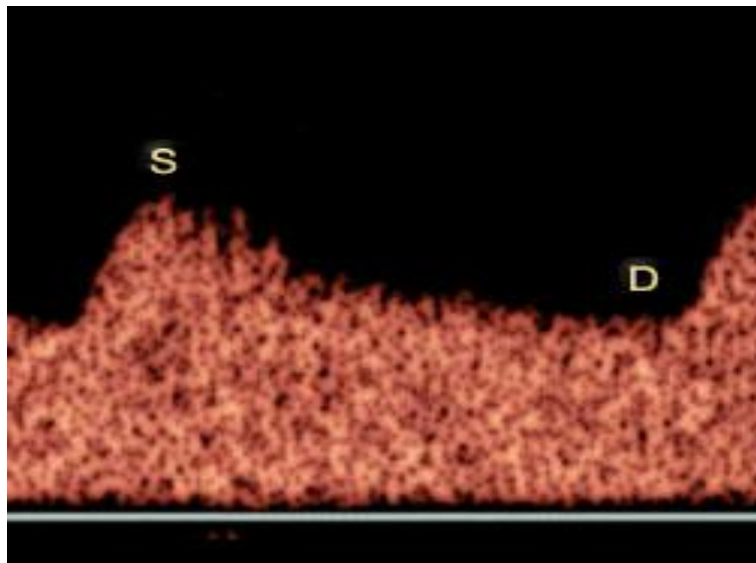


注意子宫动脉出现切迹（箭头处），提示阻力增高

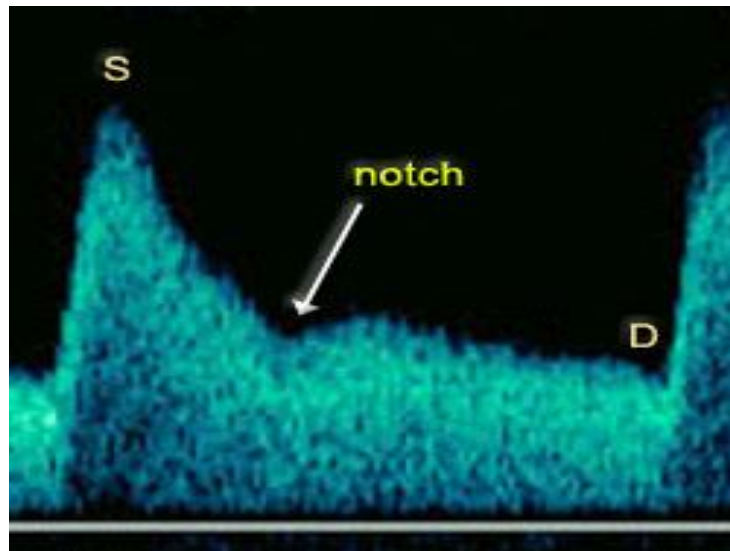
子宫动脉PI值正常范围



22-24周子宫动脉筛查

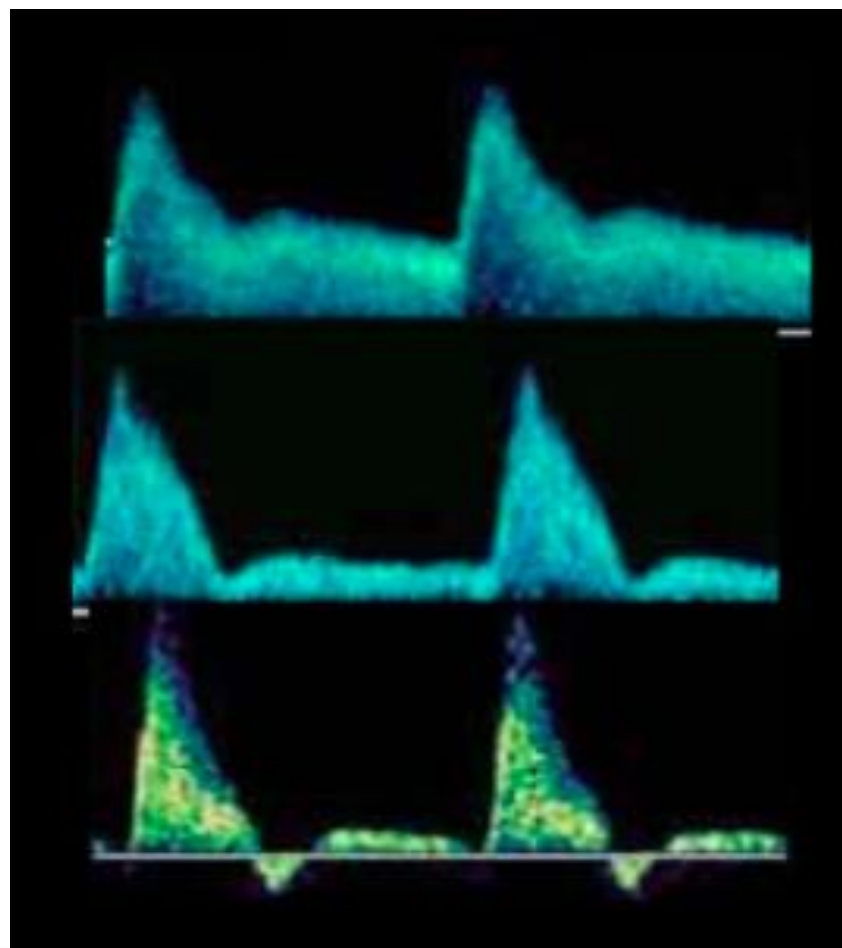


子痫前期及宫内生长受限低风险

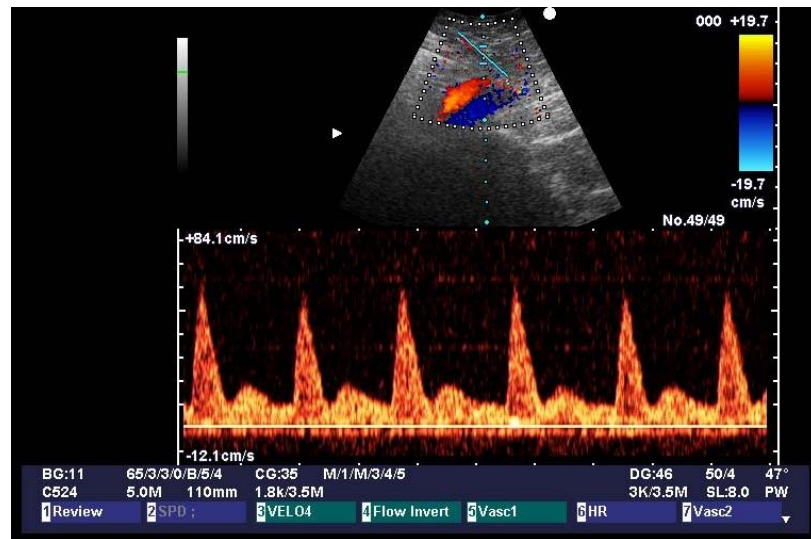
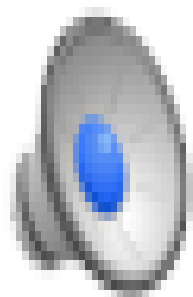


子痫前期及宫内生长受限高风险

22-24周后，异常子宫动脉波形



子宫动脉



临床应用

Constitutionally Small

no increased perinatal death or morbidity

先天性偏小
不增加围产死
亡率和发病率

AC < 10th
centile

Doppler

FGR

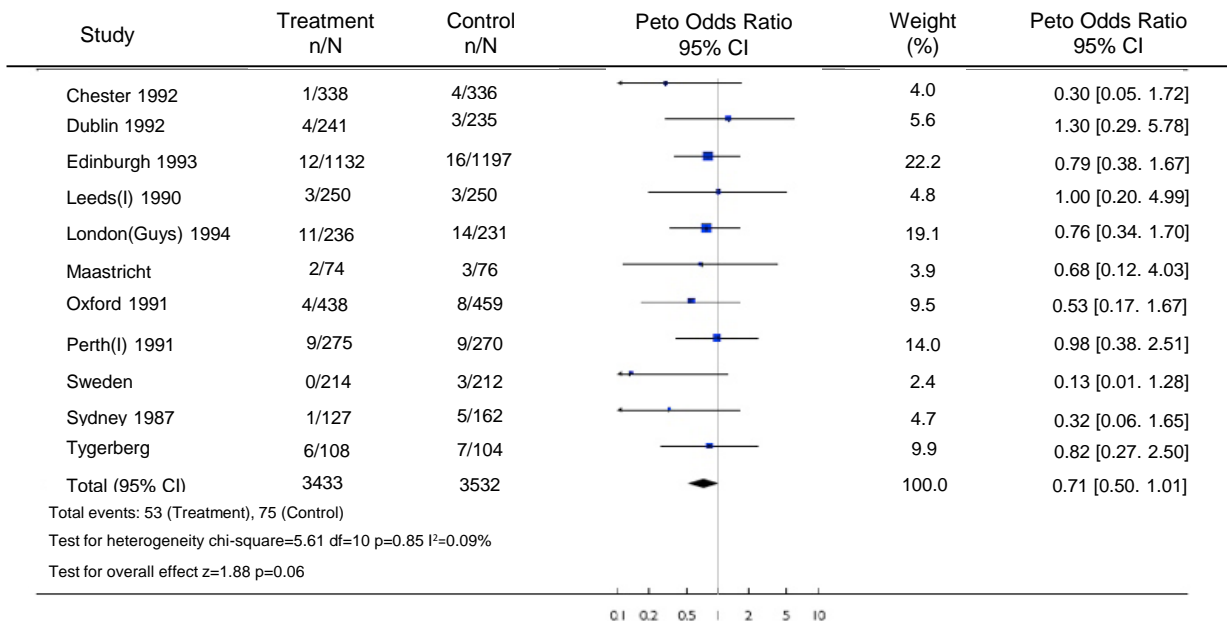
uteroplacental insufficiency
hypoxemia, acidosis

腹围 < 第十百分位数

胎儿生长受限
子宫胎盘宫内不全、
低氧血症、酸中毒

Soothill, 1999

多普勒检查可减少38%的围产期死亡



Nelson JP, The Cochrane Library 2005, Issue 1

何时该测量子宫动脉

- 可疑胎盘功能不全/FGR
- 前次妊娠出现FGR
- 母体患有系统红斑狼疮、V因子突变或其他可能引起胎盘循环不良的情况

经腹测量子宫动脉的可重复性

Table 1 Studies assessing repeatability of uterine artery Doppler during pregnancy

Reference	n	Doppler technique	Doppler index	Repeatability	Statistical method
Intraobserver					
Schulman <i>et al.</i> 1986 ¹⁰	NR	CW	S/D	4%	NR
Mulders <i>et al.</i> 1988 ¹¹	21	PW	PI	6.4%	CV
Gagnon <i>et al.</i> 1988 ¹²	11	CW	S/D	6.1%	CV
Long <i>et al.</i> 1988 ¹³	20	CW	PI	6%	CV
Oosterhof <i>et al.</i> 1992 ¹⁴	15	PW	PI	10.8%	CV
Bower <i>et al.</i> 1993 ¹⁵	5	Color	RI	7%	CV
Ferrier <i>et al.</i> 1994 ¹⁶	5	Color	RI	4%	CV
Weissman <i>et al.</i> 1995 ⁸	20	TV, CW	S/D	5%	CV
Chan <i>et al.</i> 1995 ¹⁷	9	CW	RI	5.9%	CV
Harrington <i>et al.</i> 1997 ¹⁸	10	TV, Color	PI	2.6%	CV
Liberati <i>et al.</i> 1997 ¹⁹	5	Color	RI	5.1%	CV
Interobserver					
Trudinger <i>et al.</i> 1985 ²⁰	10	CW	S/D	No difference	CV
Schulman <i>et al.</i> 1986 ¹⁰	NR	CW	S/D	4%	NR
Mulders <i>et al.</i> 1988 ¹¹	13	PW	PI	11.1%	CV
Oosterhof <i>et al.</i> 1992 ¹⁴	10	PW	PI	10.1%	CV
Bower <i>et al.</i> 1993 ²¹	10	CW	RI	-0.24 to 0.28	95% prediction interval
Bewley <i>et al.</i> 1993 ²²	20	CW	RI	-0.18 to 0.22	95% prediction interval
Ferrier <i>et al.</i> 1994 ¹⁶	8	Color	RI	6.6%	CV
Yan <i>et al.</i> 1995 ²³	20	Color	RI	-0.24 to 0.16	95% prediction interval
Weissman <i>et al.</i> 1995 ⁸	20	TV, CW	S/D	8%	CV
Chan <i>et al.</i> 1995 ¹⁷	8	CW	RI	13.6%	CV
Liberati <i>et al.</i> 1997 ¹⁹	10	Color	RI	7.4%	CV

NR, not reported; CW, continuous wave; PW, pulsed wave; Color, color-flow Doppler; TV, transvaginal; S/D, systolic/diastolic ratio; PI, pulsatility index; RI, resistance Index; CV, coefficient of variation.

Second-trimester uterine artery Doppler screening in unselected populations: a review

A. T. Papageorghiou, C. K. H. Yu, S. Cicero, S. Bower and K. H. Nicolaides

Harris Birthright Research Centre for Fetal Medicine, King's College Hospital, London, UK

Table 2 Results of uterine artery Doppler screening studies for the prediction of pre-eclampsia, providing data on the definition of pre-eclampsia used, screen-positive rate, prevalence, sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV)

	Screen-positive	Prevalence	Sensitivity	Specificity	PPV	NPV
Notar et al., 1997 ²⁴	11.5	5.1	21	89	8	94
Harrington et al., 1996 ²⁵	9.1	3.7 [‡]	77	93	31	99
Frusca et al., 1997 ²⁶	8.6	1.9 [†]	50	92	11	99
Irion et al., 1998 ²⁷	12.8	3.3 [†]	26	88	7	97
Kurdi et al., 1998 ²⁸	12.4	2.2 [*]	62	89	11	99
Albaiges et al., 2000 ²⁹	7.3	3.7 [†]	45	94	23	98
Aquilina et al., 2001 ³⁰	9.8	5.5 [†]	60	93	33	98
Papageorghiou et al., 2001 ³¹	5.1	1.4 [†]	41	95	12	99

*Blood pressure \geq 140/90 and proteinuria > 150 mg/24 h

†Blood pressure \geq 140/90 and proteinuria > 300 mg/24 h

‡Blood pressure rise (systolic > 30 mmHg and diastolic > 25 mmHg) with proteinuria > 500 mg/24 h

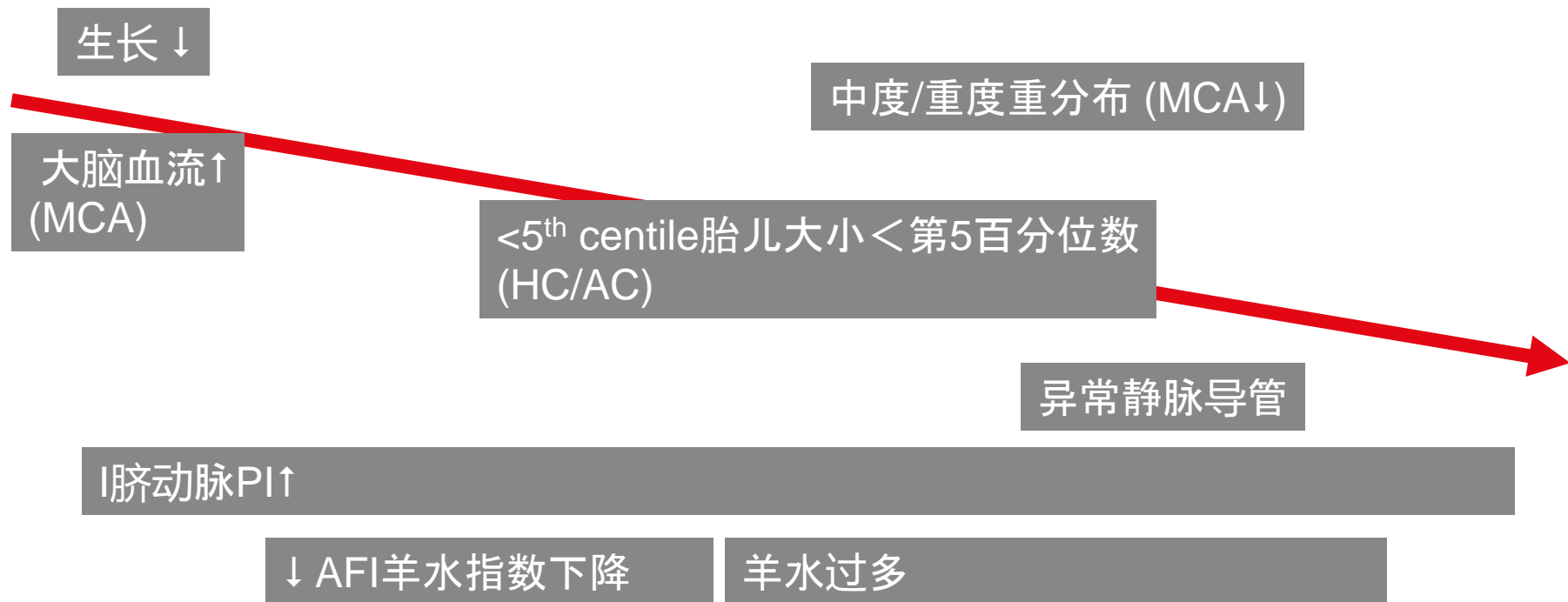
孕期常规纳入产前管理的孕妇出现子宫动脉血流阻力升高时，可识别出约40%（似然比.6.0）后期发展为子痫前期及20%（似然比.3.5）后期发展为胎儿生长受限的胎儿

搏动指数的临床应用

- 结局正常与发展为子痫前期的患者相比，11-13⁺⁶周及21-24⁺⁶周期间的子宫动脉PI值下降更快
- 11-13⁺⁶周进行子宫动脉PI值测量以及比较两个时期的变化可对子痫前期进行有效筛查

Plasencia, Maiz, Poon, Yu, Nicolaides, UOG, 2008, 32:138-146.

子宫胎盘功能衰竭-胎儿状态系列变化



关键点

- 多普勒检查可帮助深入了解胎儿及妊娠病理生理学
- 多普勒的应用是胎儿医学的重要突破
- 多普勒可在所有孕期使用，用于不同的适应证
- 视情况不同，多普勒可作为筛查或诊断工具
- 中晚孕多普勒检查结果可提示胎盘形成异常，胎儿低氧血症、贫血及行将发生的心衰
- 操作者应熟练应用多普勒，并知晓其优缺点及可能带来的危险

ISUOG Basic Training translated by **Juan Zhang**;

Revised by **Lijun Yuan**

2nd revision by **Qingqing Wu**



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