Fetal growth

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Outline

- Placental Function
- Influences to fetal growth
- SGA/IUGR
- LGA/Macrosomia
- Measuring fetal growth
- Fetal surveillance
A fetus’s growth is an expression of genetic potential that is not constrained by internal or external factors.

Normal singleton fetal growth is approximately:
- 5g/day at 14 to 15 weeks of gestation
- 10g/day at 20 weeks of gestation
- 30 - 35g/day at 32 to 34 weeks of gestation

After 34 weeks of gestation the growth rate decreases.
Utero-placental unit

- Adequate maternal circulation
- Adequate fetal circulation
- Healthy placenta
- Anything to interrupt these three can compromise the fetus
Influences on fetal growth

- Maternal factors
  - Maternal age
    - Extremes i.e. 16 yrs old / 45 yrs old (both IUGR and LGA)
  - Chronic disease
    - Hypertension (SGA)
    - Diabetes (LGA)
    - Autoimmune (SLE/thrombophilia) (assoc SGA)
    - Anaemia (SGA)
  - Weight (maternal weight gain ≥16 kg (OR 10.2)) – paternal BMI ≥30 (OR 3.7) (LGA)
  - Smoking/other drug use (SGA)
  - Socioeconomic status (SGA)
Influences on fetal growth

- Fetal conditions
  - Multiple gestation
  - Placental issues
    - IUGR
    - Abnormal placentation – Praevia, bilobed, unusual cord insertions
    - Placental biochemistry – low PappA (SGA)
  - Genetic - Aneuploidy, genetic syndromes (both SGA and LGA)
  - Infections - CMV, Syphilis, Rubella, Varicella, Toxo, Tuberculosis, HIV (SGA)
  - Gender (male more likely macrosomic (OR 2.2))
Influences on fetal growth

- Ethnicity
- Parity
  - Nulliparity → more IUGR
  - Increasing fetal weight with increasing parity (parity ≥3 (OR 4.8),)
- Obstetric conditions/history
  - Gestational hypertension/pre-eclampsia → increases IUGR
  - Gestational diabetes → increases macrosomia
  - Previous IUGR/SGA or Macrosomia
  - Previous IUFD
Growth trends

- Median BW for term babies of same gestational age, is between 0 and 25g higher for male infants and between 5 g and 45 g higher for female infants, than 10 years ago.

- Similar increases in 90th and most 10th percentiles for boys and girls were also observed.

- While these increases may seem small, at a population level they have a large impact.
  - A mean increase in BW of 23 g between 1990 and 2005 for male babies in NSW translated into an 18% increase in those identified as LGA.
  - For female babies, an increase of 25g translated into a 21% increase in those identified as LGA.
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<th>Gestational age (weeks)</th>
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<th>Birthweight percentile</th>
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What’s accounting for this change?

- Maternal age has increased
- The proportion of women reporting smoking during pregnancy has reduced
- Maternal overweight and obesity has increased
- The ethnicity of mothers in Australia has changed (more not born in Australia)
- IVF and assisted fertility increased
- More use of prenatal testing
- Paternal health more recognised as contributory to fetal health
IUGR/FGR (fetal growth restriction)
- FGR is defined by an estimated fetal weight or serial ultrasound evidence of growth restriction or growth arrest (antenatally) or
- a birthweight below the 10th percentile using the South Australian birthweight percentiles (at birth)

SGA
- BW below the 10 %ile of weight for gestation. Not necessarily IUGR/FGR
- Most fetuses with a BW below the 10%ile for gestational age are constitutionally small

Definition RANZCOG / RCOG
- SGA: EFW or AC <10\text{th} \text{ centile}
- Severe SGA: EFW or AC <3\text{rd} \text{centile}

Historically defined by population centiles but use of customised charts identifies small babies at higher risk of morbidity and mortality than those identified by population, though this is under debate
Outcomes among SGA infants is largely due to the high rate of FGR among them (20% are below the 5th percentile) (RCOG 2002; Walkinshaw and Cochrane 2003).

- Reduction in maternal perception of fetal movements → IOL
- Prematurity → might be iatrogenic
- Meconium stained liquor → lower thresholds in labour
- Abnormal heart rate patterns intrapartum → CS
- Intrauterine fetal death/stillbirth
- Hypoxic ischaemic encephalopathy
- Poor neurological development
- Delay in cognitive development
- Sudden infant death syndrome

In adult life:
- Type 2 diabetes and hypertension (RCOG 2002)
  - Good catch up growth in the first few months of life may predict a healthy outcome
SGA/IUGR types

- Symmetrical
  - Head size and trunk are reduced in parallel
  - Usually represents lower end of normal range for size
  - May indicate insult that has occurred in the early antenatal period during general organ growth
- Main associated conditions
  - Chronic maternal illness
  - Chromosomal / Congenital / Inborn errors of metabolism
  - Intrauterine infections
  - Environmental factors – Poor nutrition / BMI <20 or >25 / Age >35 / Daily vigorous activity
SGA/IUGR types

- Asymmetrical
  - Fetus responds to inadequate nutrition by redistributing blood flow
    - More to brain, heart and adrenal
    - Less to liver and kidney
  - Results in abdominal girth and fat stores reduced more than head → brain sparing
- Associated with later onset pathology
  - Maternal medical – hypertension, pre-eclampsia / diabetes / anaemia, pulmonary, cardiovascular or renal disease
  - Placental – abruption, infarction, praevia, chorionamnionitis
Trick is to determine the small baby at risk of IUFD or ill health.
Which baby had the most neonatal concerns?
LGA/Macrosomia

- Interchangeable terms
- Fetal growth beyond a specific weight
  - RCOG: weight over 4000g or above 90th centile of weight for gestation
  - SA PPG: weight over 4000g (or over 4500g!) or above 90th centile for gestation
- Australian, non-indigenous population, 90th centile at 40 weeks
  - Female 4000g
  - Male 4170g
- Considered “different” in diabetics – see shoulder dystocia
  - Macrosomic infants of Diabetic mothers (>4000g)
LGA/Macrosomia outcomes

- Maternal
  - Meconium stained liquor
  - Abnormal heart rate patterns
  - Cephalo-pelvic disproportion
  - Shoulder dystocia
    - Clavicular fracture
    - Brachial plexus injuries and paralysis
    - Low Apgar score
  - Genital tract laceration
  - Caesarean section
  - Uterine rupture
  - PPH
LGA/Macrosomia outcomes

- Fetal/neonatal
  - Mostly related to mode of delivery and shoulder dystocia, but without
  - Metabolic – low BSL
  - Low apgar
  - Non-compliant lungs – more TTN
  - Birth trauma
  - Stillbirth (especially in diabetics)
  - Long term metabolic syndrome
Shoulder dystocia

Most shoulder dystocias occur after a normally progressive labour with spontaneous delivery or a low pelvic assisted delivery, with babies weighing less than 4000g – 50–60%

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<tr>
<th>Birthweight (g)</th>
<th>Non-Diabetic (%)</th>
<th>Diabetic (%)</th>
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<td>3750-4000</td>
<td>1.0</td>
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<td>4000-4250</td>
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<td>4250-4500</td>
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<td>4500-4750</td>
<td>7.5</td>
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<td>&gt;4750</td>
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Shoulder dystocia outcomes

- Maternal
  - As for macrosomia

- Fetal/neonatal
  - Low BSL
  - Lung compliance
  - TTN
  - Asphyxia/Hypoxic ischaemic encephalopathy
  - Brachial plexus injury – Erb’s palsy
  - Fractures
  - Jaundice
  - Mortality
Macrosomia at 37+ weeks
How do we monitor fetuses?

- Antenatal care
- Kick charts
- Symphysio-fundal height
- Cardio Tocogram (CTG)
- Ultrasound
  - EFW, Doppler, AFI
  - Biophysical profile
- Make sure dates are accurate!
Which fetuses need surveillance?

- Known abnormalities
  - Clinical indication
    - high or low SFH
    - Early onset pre-eclampsia
    - Previous severe or early onset IUGR
    - GDM
    - Suspected Rhesus disease or anaemia producing infection
    - Obesity BMI >40
  - Decreased fetal movements
- Post maturity
  - Severe prematurity expecting delivery
  - Trauma or APH
  - Maternal chronic illness
  - Sure to have missed some!
Dating

- EDC as determined by LMP (allowing for cycle length) and or the AUA (average US age from scans)

- CRL <12 weeks gestation

- BPD and CRL 12-14 weeks

- Fetal biometry > 15 weeks gestation
  - Hadlock
Early pregnancy and dating

- **Gestational Sac**
  - Needs to have a yolk sac and a bright rim (decidual reaction) – otherwise consider pseudosac
  - Fluid should be echo free
  - Quant>2000 should see a sac on TV scan

- **Pregnancy failure**
  - Gestational sac with no fetus, mean sac diameter ≥ 2cm
  - Fetus ≥ 6mm with no fetal heart watching for > 30 seconds
  - Often irregular

- **Dating**
  - CRL between 6 -13 wks
  - Should see a FH at 5-6 mm
Average ultrasound age

- Best assessed by:
  - CRL at < 12 weeks gestation
    - Wisser J et al, UOG 1994
    - Kalish R et al, AJOG 2004
  - **CRL and BPD** at 12-14 weeks gestation (such as at NT scan)
    - Sladkevicus P et al UOG 2005 26: 504-511
  - BPD/HC/AC/FL at >/= 15 weeks gestation
- With advanced gestation, make sure all four measurements are registered in the AUA.
Estimated fetal weight from time of viability (> 23 weeks gestation)

- There is good data that accurate EFW is reasonable at less than 3500 grams
  - Hadlock 4-5 (in most new ultrasound machines)
    - EFW within 10% over 80% of the time
    - EFW within 15% over 90% of the time

Newborn percentile weight charts underestimate the incidence of low birth weight in preterm infants, thus fetal percentiles should be noted.

- Burkhardt T et al, AJOG 2008
Estimated fetal weight and AFI

- Biparietal Diameter and Head circumference
- Abdominal circumference
- Femur length
- AFI
  - Measure of depth of amniotic fluid in four quadrants of the uterus
  - Pool of liquor needs to be >1cm wide and have no cord in it
  - Single deepest pool >8cm → polyhydramnios
  - Single deepest pool <2cm → oligohydramnios
Biometry

- Biparietal Diameter and Head Circumference
Biometry

- Abdominal circumference
Biometry

- Femur length
The Doppler effect is the name given to the perceived change in frequency of a sound wave, detected by an 'observer' moving relative to the source of the sound wave.

The frequency is perceived as higher as you approach the source, is identical at the moment of passing the source and it is perceived as lower as you move from the source.

I was first described by Christian Doppler in 1842 and first applied to ultrasound physics in the 1964, when continuous wave Doppler was used to first detect fetal cardiac pulsations. The first fetal pulse detector was marketed in 1965.

Work was begun on pulse wave doppler in the late 60s and the first 2D and M-Mode cardiac echographic machine was developed from 1970-1972.
Umbilical artery dopplers

- A measure of downstream placental vascular resistance
- Fetal placenta is usually one of low resistance and the resistance decreases further approaching term
- Increased placental vascular resistance is either the result of a poorly implanted placenta and/or a loss of tertiary placental stem villi
- There is a subsequent reduction in surface areas for gas and nutrient exchange in the fetus and therefore the UmAD can be used to identify the growth restricted fetus at risk of hypoxia, acidosis and death
Uterine artery dopplers

- Can be used as an assessment tool to predict pre-eclampsia
- Usually elevated early in pregnancy and when non-pregnant
- Uterine arteries become low resistant vessels in normal pregnancy
  - In normal placental development, there is trophoblast invasion into maternal spiral arteries in two phases
    - 1) decidual and then
    - 2) myometrial, thus establishing placental blood supply.
- The uterine arteries concurrently dilate and become low resistant vessels
- Uterine arteries become high resistant vessels in Pre-Eclampsia – with notching
  - In pre-eclampsia, there is impaired placentation, poor invasion of trophoblast into maternal spiral arteries and they remain tight and narrow. Subsequently the uterine arteries remain constricted providing high pressure just to maintain placental perfusion
Uterine Artery Dopplers

- **Normal**
  - Notch should disappear
  - Low resistance

- **Abnormal**
  - Presence of notch after 23 weeks
  - High resistance waveform as defined by RI or PI (>95%)
Be aware of risk factors (RF) for abnormal fetal growth
Both LGA and SGA are RF for fetal loss
  - Watch for changes in growth velocity
See them regularly (20, 24, 28, 32, 34, 36, 38, 40)
Palpate the belly and do SFH height
  - it is more relevant when same operator
Refer when concerned
Know your friends – and call for advice!
Resources

- SA Perinatal Practice Guidelines
  - Fetal Growth (restricted)
  - Fetal Growth (accelerated)
  - Low PappA
- Australian national birthweight percentiles by sex and gestational age. MJA 2012; 197: 291-294
- Fetal Growth and Risk of Stillbirth - https://doi.org/10.1371/journal.pmed.1001633
- Dating document Dept US WCH
- Sonographic Solutions Ultrasound course
- Fetal Surveillance – A Practical Guide
- Obstetric and Gynaecological Ultrasound Made Easy
- Various papers quoted within
- Useful tools
  - SA PPGs
  - Greentop guidelines
  - http://perinatology.com/calculators/Estimation%20of%20Fetal%20Weight%20and%20Age.htm#AGECALC