

Measurements – what do they tell you?

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Measurements across the trimesters

- Distinguishing between ongoing pregnancy & missed miscarriage
- Accuracy of combined screening risk(s)
- Estimation of expected date of delivery (EDD)
- Exclusion of abnormal findings
- Assessment of growth velocity & 'well being'
- Cervical length
- Relationship between placental site & os



CRL, NT & combined screening

- Correct sections for measuring CRL & NT
- Correct placement of the callipers
- What difference do they make to:
 - - dating
 - - NT risk
 - - combined screening risk?





*UK National
Screening Committee*



Screening Programmes

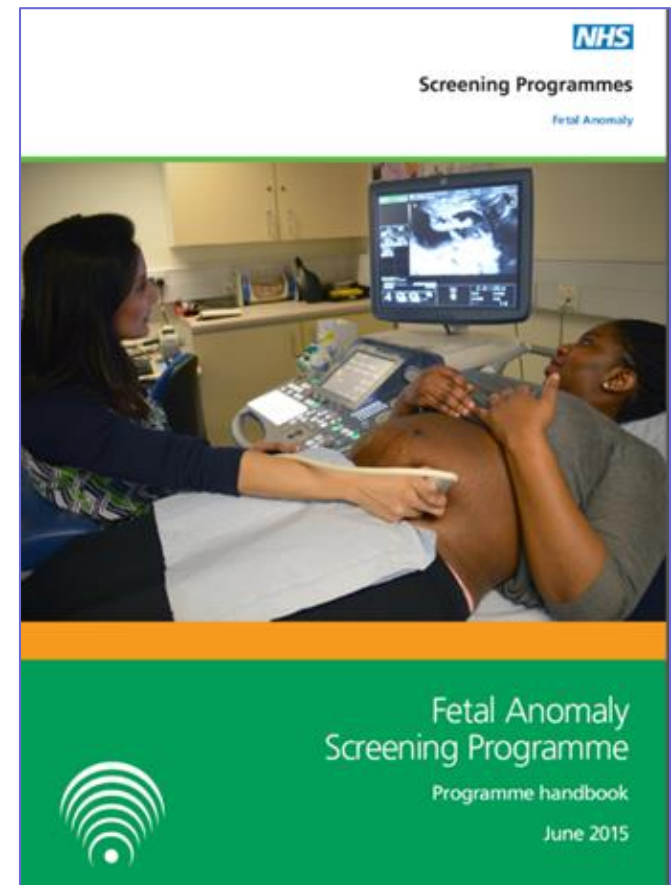
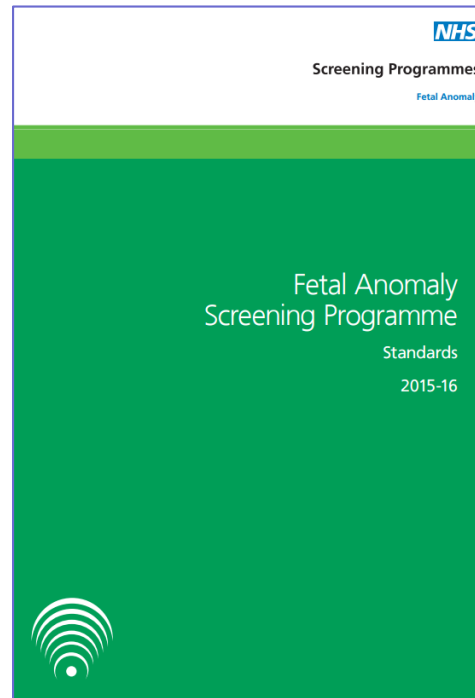
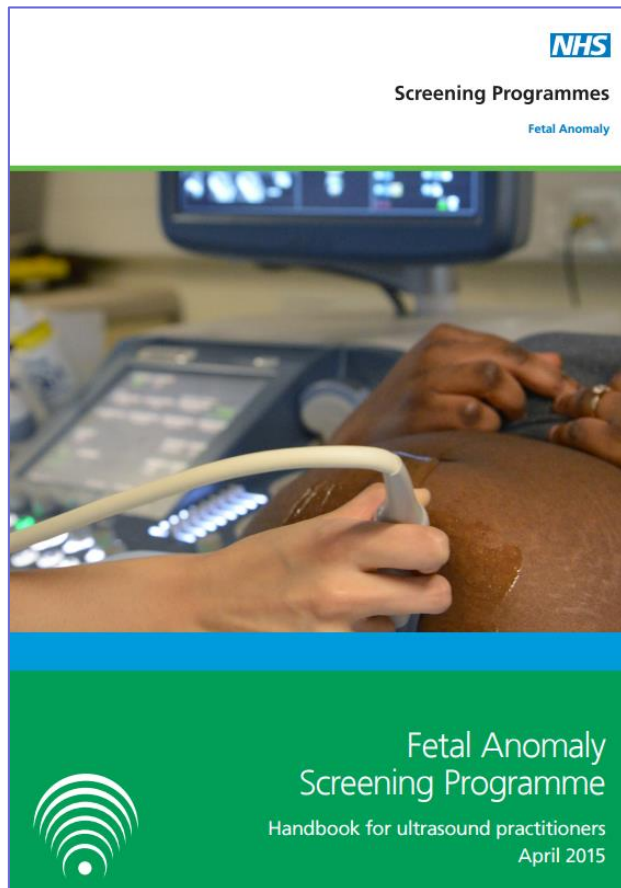
Fetal Anomaly

FASP Public Health England

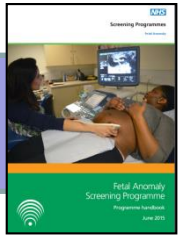
April 2013



Fetal Anomaly Screening Programme Guidance (England)



Early pregnancy scan - dating

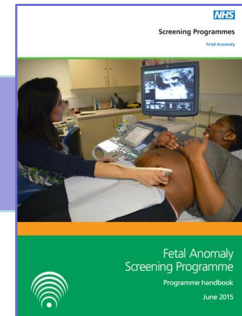


Purpose of dating scan

- confirm viability
- singleton or multiple
- estimate gestational age (CRL or HC)
- detect major structural abnormalities
 - e.g. anencephaly



Dating - national guidance (UK)



Ultrasound • August 2009 • Volume 17 • Number 3

Fetal size and dating: charts recommended for clinical obstetric practice

Pam Loughna¹, Lyn Chitty², Tony Evans³ & Trish Chudleigh⁴

¹Academic Division of Obstetrics and Gynaecology, Nottingham University Hospitals NHS Trust, ²Genetics and Fetal Medicine, Institute of Child Health and University College London Hospitals NHS foundation Trust, London, ³Medical Physics, University of Leeds, Leeds and

⁴The Rosie Hospital, Cambridge, UK

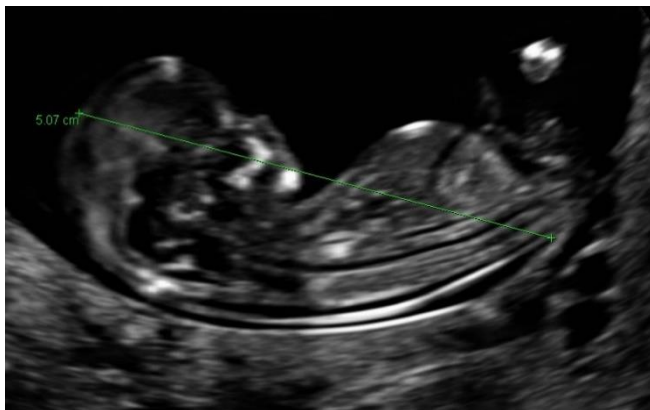
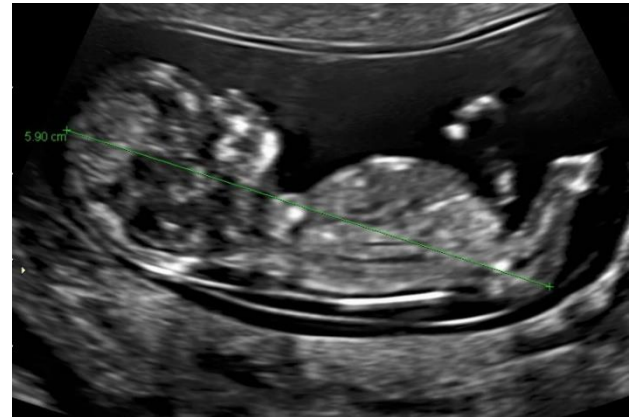
- British Medical Ultrasound Society - BMUS.org
- FASP – www.gov.uk/topic/population-screening-programmes/fetal-anomaly
- cpd.screening.nhs.uk

CRL - practical issues

- appreciation of 'unflexed' length - sagittal not coronal
- rotate or slide past selected section
- better or worse?
- freeze or return to optimal section
- measure using linear callipers
- CRL from 3 separate images +/- 1-3mm



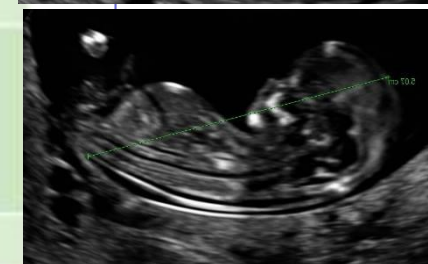
CRL – practical issues



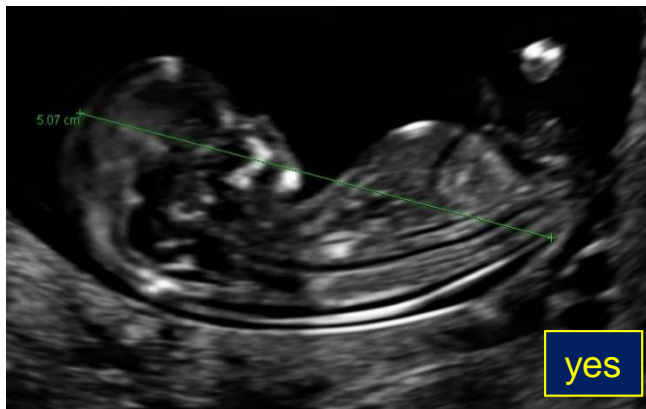
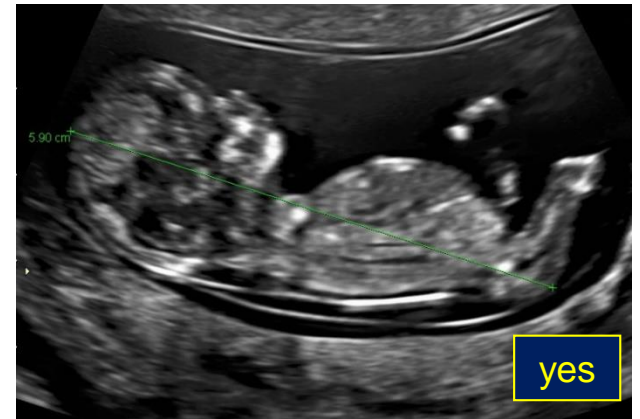
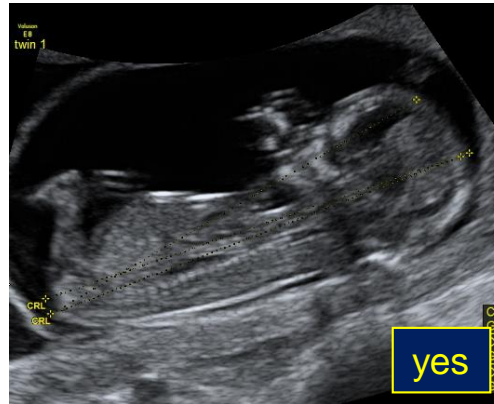
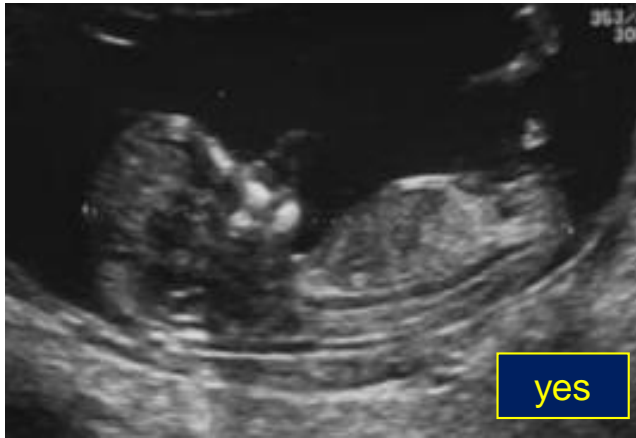
Fetal Anomaly Screening Programme Guidance - CRL

Table 4 - Recommended criteria for measurement of CRL for pregnancy dating and combined screening (Loughna P et al (2009))

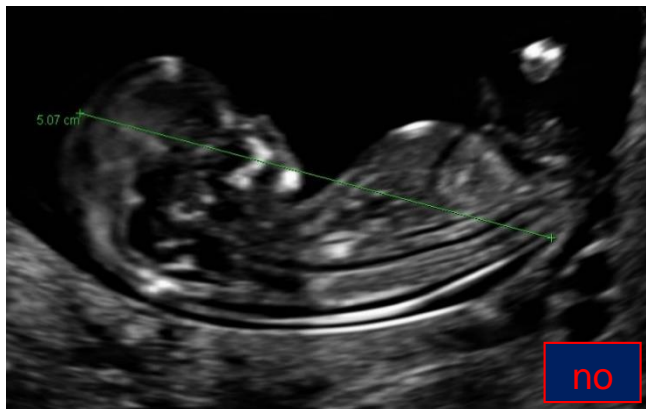
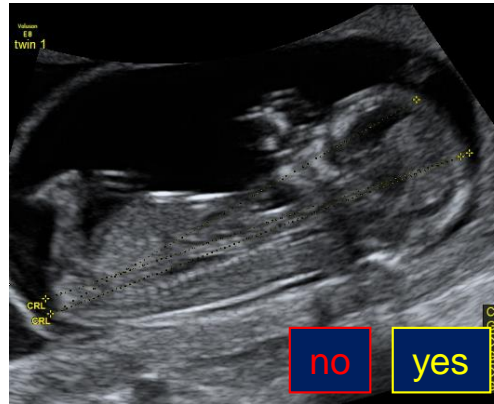
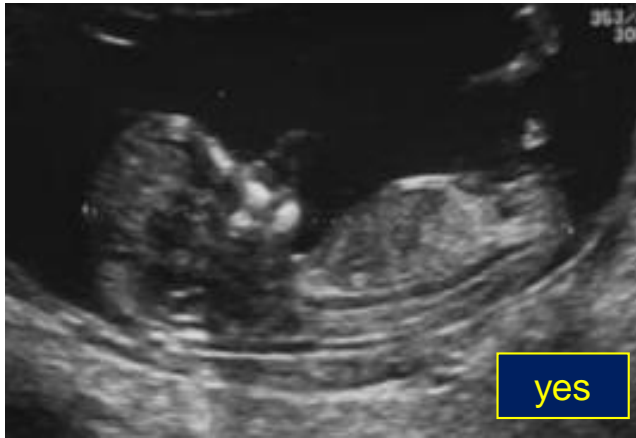
CRL	Detail to be demonstrated
Midline section	<ul style="list-style-type: none"> • Sagittal section of the fetus with the head in line with the full length of the body • Echogenic tip of the nose • Rectangular shape of the palate • Translucent diencephalon • CRL axis should be between 0° and 30° to the horizontal • Clearly defined crown and rump
Position	<ul style="list-style-type: none"> • Pocket of fluid, at least equivalent in size to the width of the palate, should be visible between the fetal chin and chest • Fetal palate angle should be 30° to 60° relative to the horizontal • Nasal tip should be level or above the anterior abdominal wall
Magnification	<ul style="list-style-type: none"> • Entire CRL section should fill over 60% of the screen
Calliper placement	<ul style="list-style-type: none"> • Correct calliper placement on outer borders of crown and rump • Longest length of the fetus should be measured
Image archiving	<ul style="list-style-type: none"> • The CRL should be measured at least twice and the maximum measurement that meets the criteria should be recorded • The image demonstrating the measured CRL which has been reported should be archived



CRL – correct section

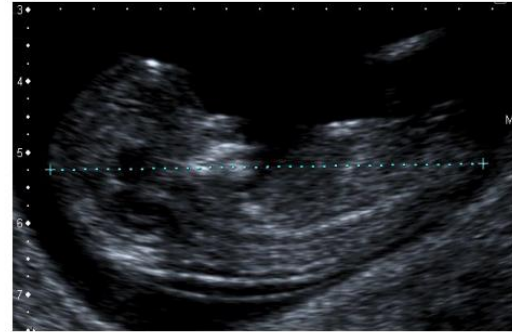


CRL – calliper placement



Fetal Anomaly Screening Programme
Handbook for ultrasound practitioners
April 2010

Image 4 Good



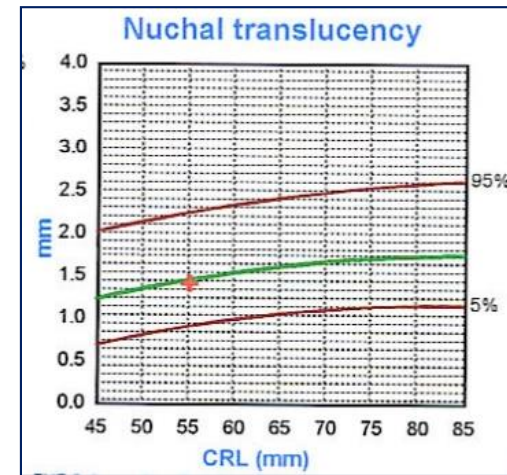
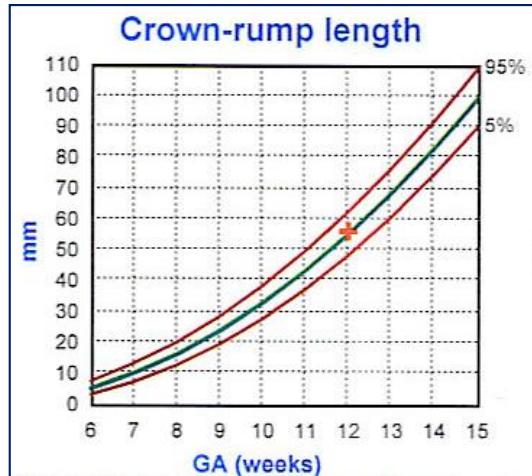
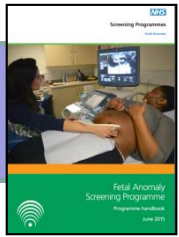
Midline section						Position			Mag	Callipers		Overall
1	2	3	4	5	6	7	8	9	10	11	12	
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
12/12 components present												Good

Midline section						Position			Mag	Callipers		Overall
1	2	3	4	5	6	7	8	9	10	11	12	
✓	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	✓	
11/12 components present												Acceptable
4) Diencephalon absent												

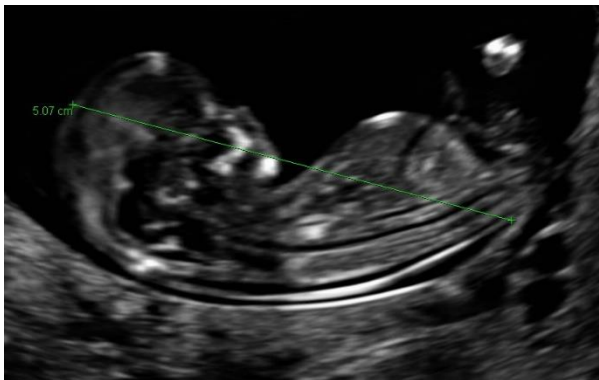
Figure 1 shows a B-mode ultrasound image of a fetal head. A green line is drawn across the fetal head, indicating the measurement of the biparietal diameter (BPD). The image shows the skull bones and internal brain structures. On the right side of the image, there is a vertical scale with markings from 2 to 8. At the bottom, there is a technical information bar.

Midline section						Position		Mag	Callipers		Overall	
1	2	3	4	5	6	7	8	9	10	11	12	
x	✓	✓	✓	✓	x	✓	✓	✓	✓	x	x	
8/12 components present												Poor
1) the full length of the body is not present												
6) the rump is not clearly defined												
11) callipers are not correctly placed on the rump												
12) the longest measurement has not been taken												

Combined screening



- risk algorithm only for CRL 45.0 – 84.0mm (11^{+2} – 14^{+0} wks)
- NT normal range 1.0 - ~ 2.5mm
- NT increases with CRL (& therefore gestational age)



Fetal Anomaly Screening Programme Guidance - NT



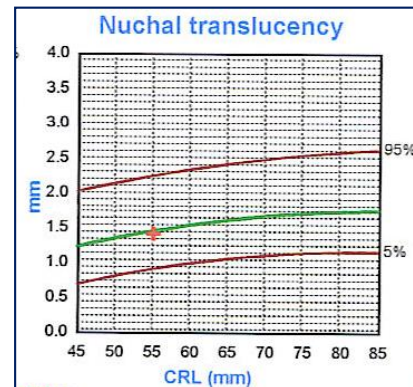
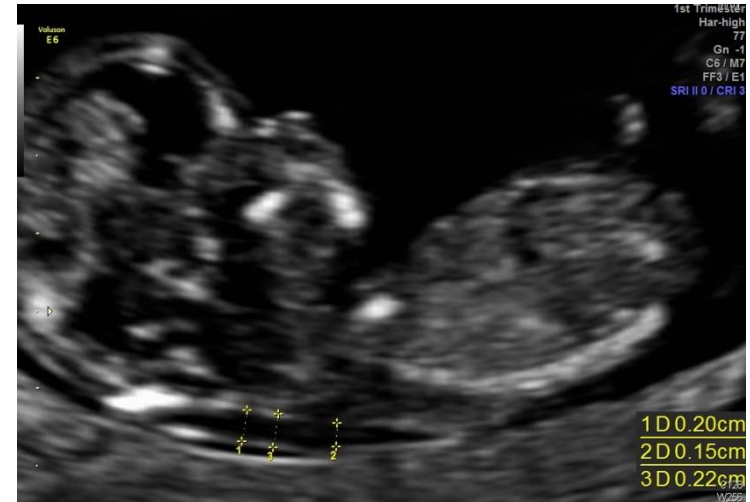
Table 3 - Recommended criteria for measurement of NT for combined screening

NT	Detail to be demonstrated
Midline section	<ul style="list-style-type: none">• Horizontal sagittal* section of the fetus extending from crown to upper aspect of the heart which may be supine or prone**• Head in line with the body with the NT visible along the length of the neck• Echogenic tip of the nose• Rectangular shape of the palate• Translucent diencephalon• Frontal process of the maxilla should not be visible
Position	<ul style="list-style-type: none">• Pocket of fluid, at least equivalent in size to the width of the palate, should be visible between the fetal chin and chest• Angle of the palate relative to the horizontal should be between 30° and 60°• Nasal tip should be level with, or above, the anterior chest wall
Magnification	<ul style="list-style-type: none">• The section should fill over 60% of the screen
Calliper placement	<ul style="list-style-type: none">• Callipers should be placed on the upper and lower edges of the NT• Widest part of the NT should be measured
Image archiving	<ul style="list-style-type: none">• The NT should be measured at least twice and the maximum measurement that meets the criteria should be recorded• The image demonstrating the measured NT which has been reported should be archived

* In all criteria the term sagittal describes a midline longitudinal section

** FASP does not recommend screening for nasal bone absence or hypoplasia, thus allowing measurement of the NT with the fetus in the prone position

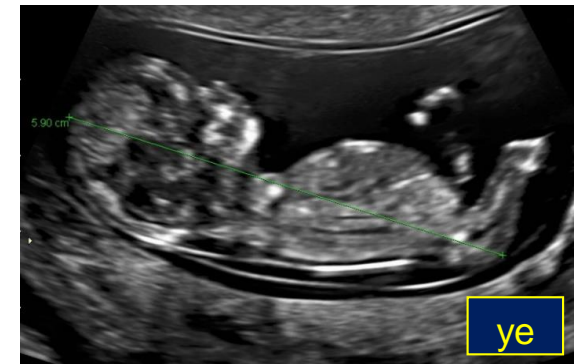
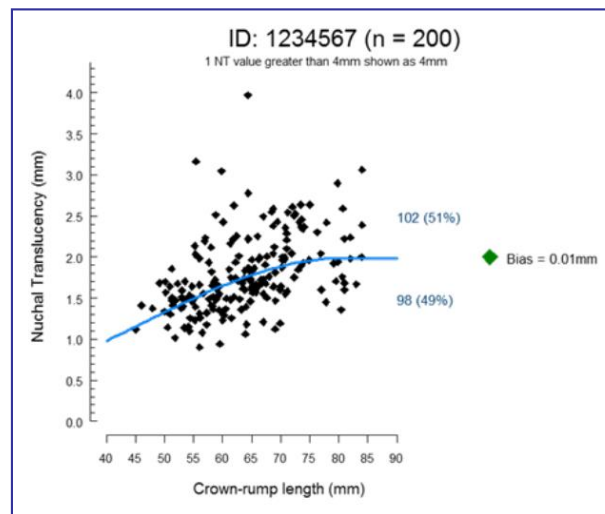
NT – correct section & caliper placement



Midline section						Position			Mag	Callipers		Overall
1	2	3	4	5	6	7	8	9	10	11	12	
✓	✓	✓	✓	✓	x	x	✓	x	✓	x	x	
7/12 components present 6) Frontal process of the maxilla is present 7) No pocket of fluid under the chin 9) Nasal tip below anterior chest wall 11) Callipers are not correctly placed on the skin lines 12) Widest part of the NT not measured												Poor

National audit of combined screening programme

- all providers must be DQASS registered
- All CRL & NT data sets submitted to DQASS, by lab
- annual DQASS audit
 - individual, departmental, regional, national
- 3 monthly departmental review – individual NT & CRL images (3 x 2)



Audit of combined screening programme - flags

Table 9 - Flag category and bias

Flag type		Bias
Green flag	◆	Assigned when bias is less than or equal to 0.10mm
Amber Flag	◆	Assigned when bias is between 0.11mm and 0.40mm
Red Flag	◆	Assigned when bias is greater than 0.40mm
Red Flag with 4	◆ ⁴	Assigned if fewer than 25 paired CRL/NT measurements over 4 cycles
No Flag		Assigned if a trainee sonographer has fewer than 25 paired NT/CRL measurements

- each individual report demonstrates the NT and CRL measurements relative to the FMF reference curve
- bias describes the number of measurements above and below the FMF reference curve
- the bias is either negative in terms of under-measurement (below the FMF reference curve) or positive which refers to over-measurement (above the FMF reference curve)
- the evidence used to develop the flag status was derived from the impact on screening performance. For positive biases greater than 0.40mm, the standardised screen positive rate (SPR) exceeds 5% and increases the number of pregnancies exposed to the potential risks and anxieties associated with a screen positive result which may lead to invasive diagnostic procedures

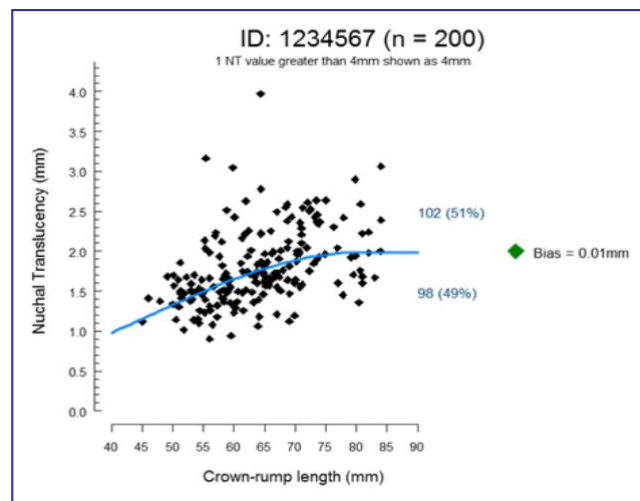
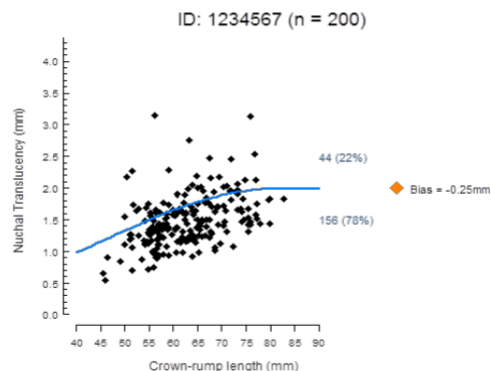
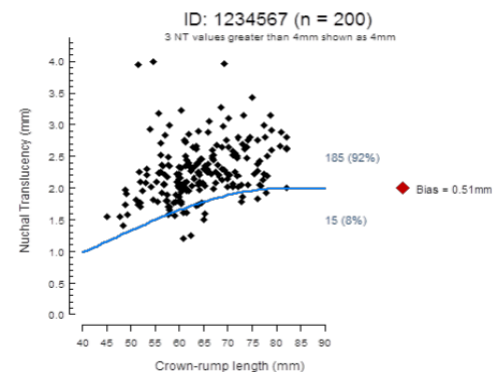


Diagram 6 Amber bias



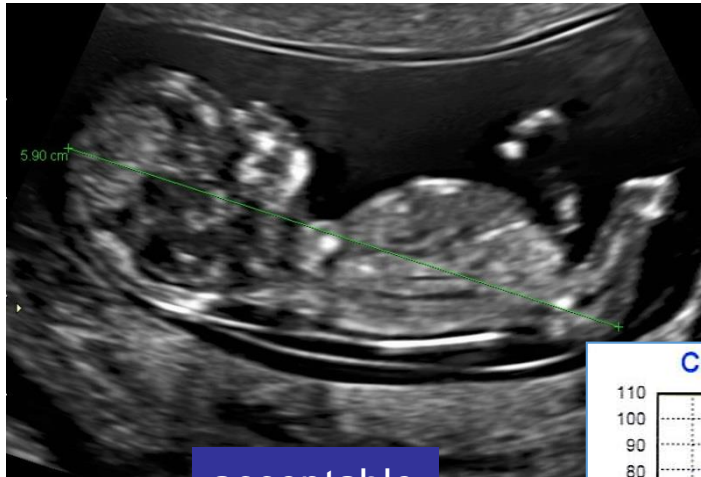
This report indicates a negative bias of 0.25mm relative to the FMF reference curve and satisfies the criteria for an amber flag. This means there are more measurements below the curve (156 – 78%) than there are above (44 – 22%).

Diagram 7 Red Flag

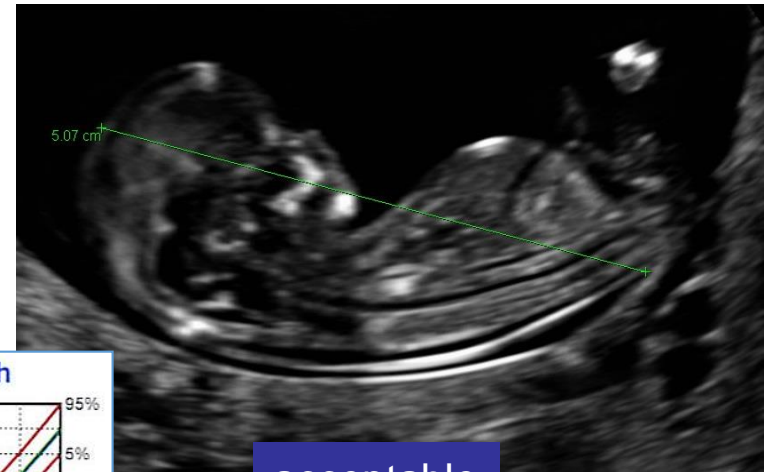


This report indicates a positive bias of 0.5mm relative to the FMF reference curve; therefore the data set is assigned a red flag. This means 92% (185) measurements plotted above the curve, with only 8% (15) plotted below. Bias can directly impact on the risk calculation women receive. This dataset indicates that there will be an increase in detection rate (91%), however, the

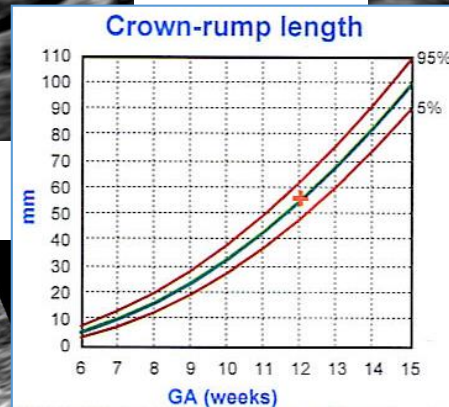
Combined screening – relies on accurate CRL



acceptable



acceptable



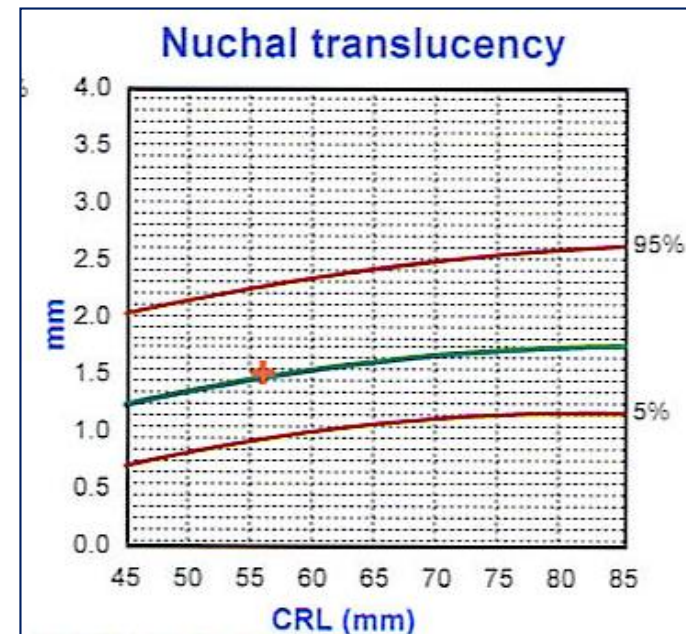
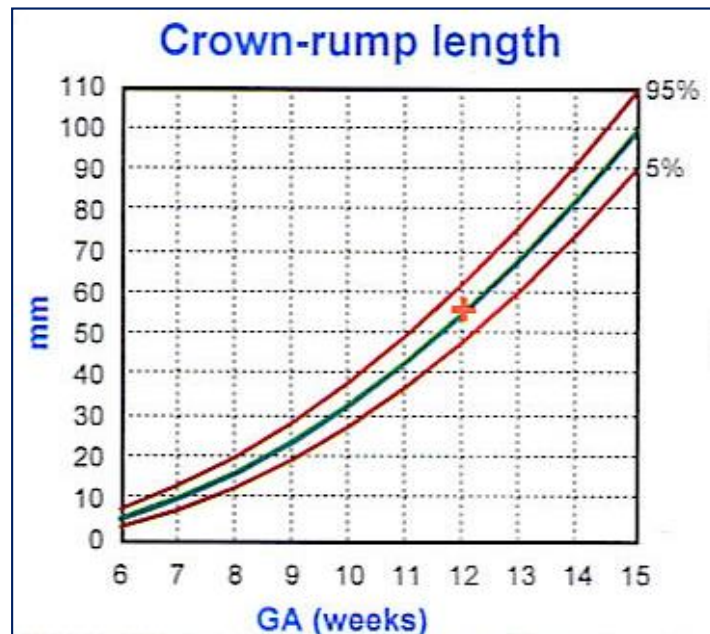
unacceptable



unacceptable

Impact of CRL in combined screening

- CRL determines gestational age
- CRL determines maternal age (at conception)
- *underestimating CRL:*
 - increases MA risk (older at conception)
 - increases risk from NT



Practical implications of poor technique for Tri 21 - CRL



CRL 48.9mm



CRL 52.8mm

30 yrs, NT 2.4mm, dating by CRL (*Tri 21 risks at term*)

CRL	GA	Background risk	Adjusted risk
52.8	11+6	1:906	1:182
48.9	11+4	1:905	1:143

NT & Adjusted risk CRL 60mm = 12 wks + 2 days

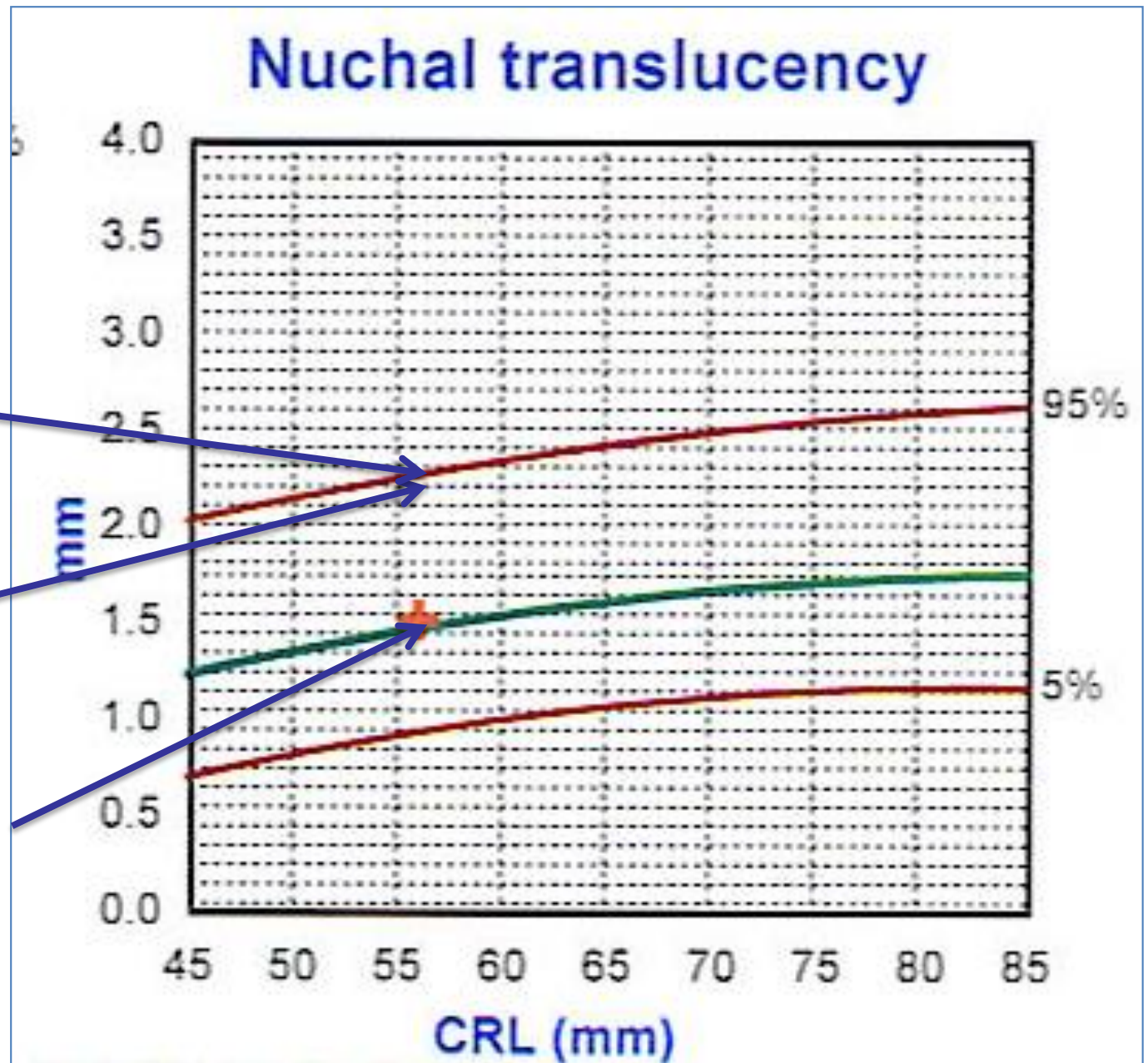
NT (mm)	25yrs (1:1378)	35yrs (1:425)	40yrs (1:28)
1.5 (50 th c)	7418	2289	679
2.0	3439	1060	315
2.1	2688	823	244
2.2	2005	619	184
2.3 (95 th c)	1082	333	100
2.4	635	133	59
2.5	431	95	40
2.6	309	71	29
2.7	230	71	22
2.8	177	55	17

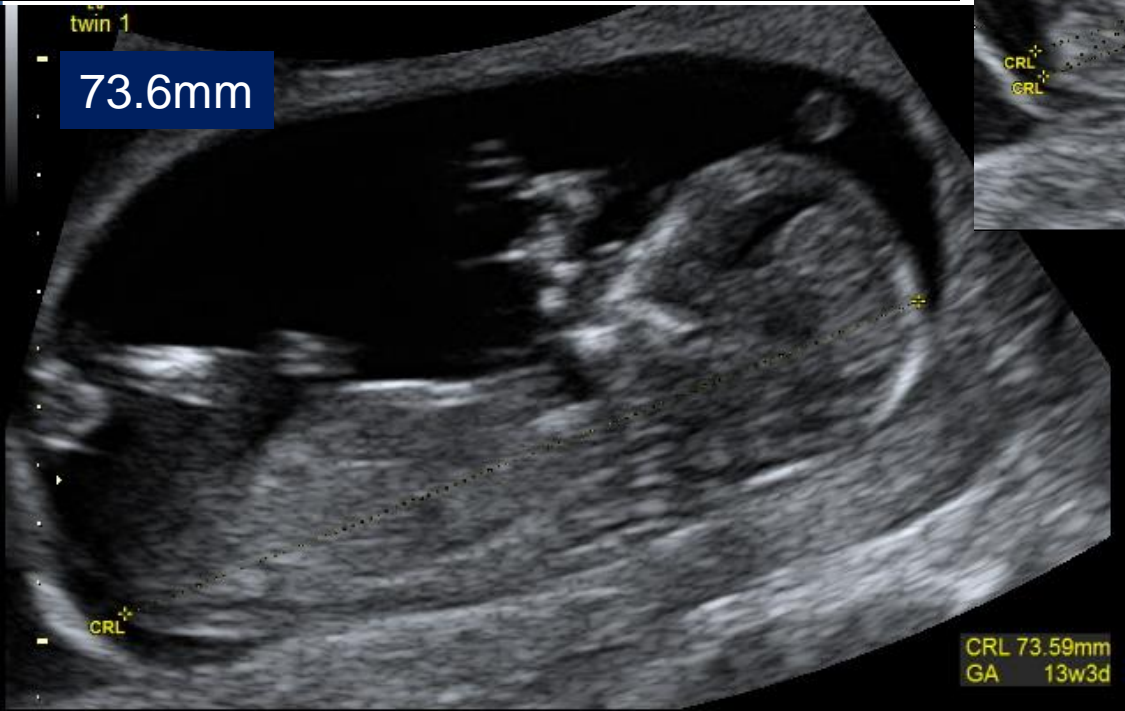
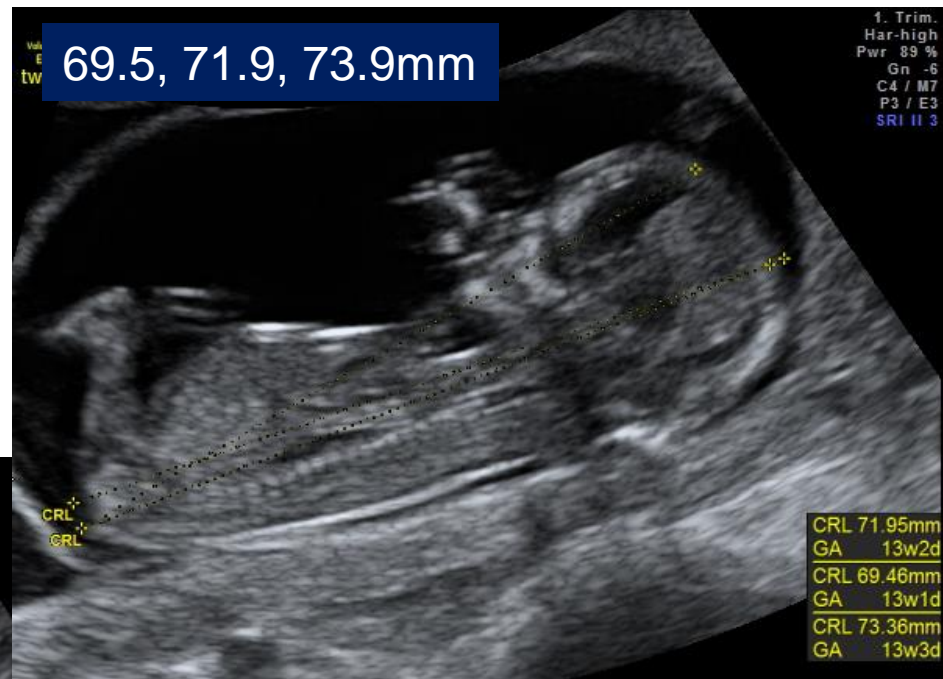
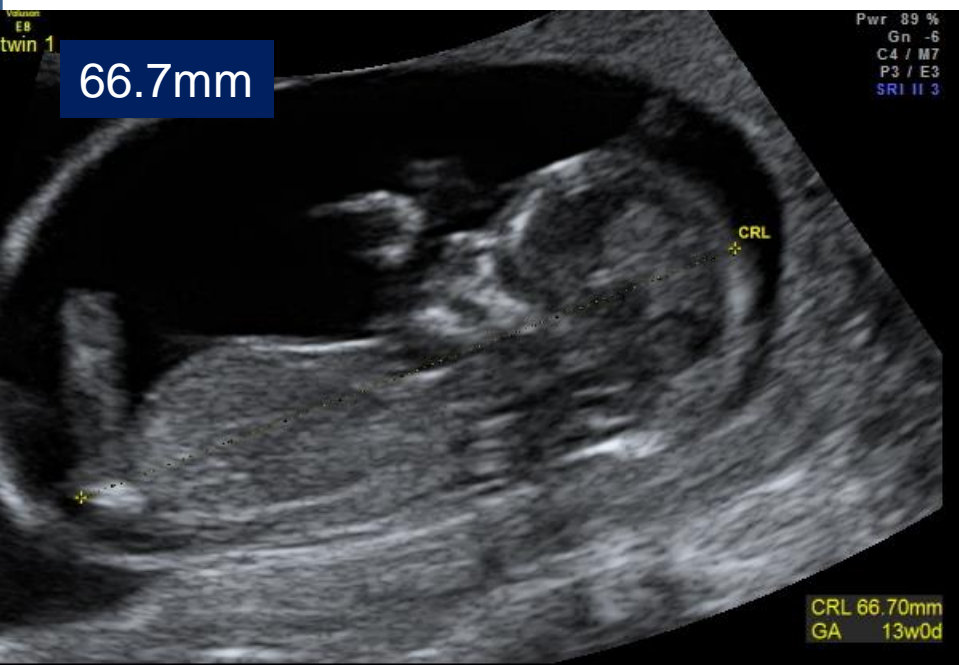
Tri 21 risks

risk doubles

risk neutral

5x reduction
in risk





CRL & Risk (NT 2.0mm)

CRL (mm)	Gest Age (wks + days)	35 yrs Maternal risk	35 yrs Adjusted risk	40yrs Maternal risk	40 yrs Adjusted risk
66.7	12+6	1:383	1:1208	1:112	1:352
69.5	13+0	1:383	1:1297	1:112	1:378
71.9	13+2	1:383	1:1362	1:112	1:397
73.6	13+2	1:383	1:1393	1:112	1:406

Effects of CRL biases on biochemistry MoM values (Tri 21)

CRL Error (mm)	Error in GA (days)	Median MoM		DR	FPR
		PAPP-A	hCG beta		
-5	-2.7	1.17	0.93	80%	1.4%
-4	-2.2	1.13	0.94	81%	1.6%
-3	-1.6	1.10	0.96	82%	1.9%
-2	-1.1	1.06	0.97	83%	2.0%
-1	-0.5	1.03	0.99	84%	2.4%
0	0.0	1.00	1.00	85%	2.7%
1	0.5	0.97	1.01	86%	3.1%
2	1.0	0.94	1.03	86%	3.7%
3	1.6	0.92	1.04	87%	4.1%
4	2.1	0.89	1.06	88%	4.8%
5	2.6	0.87	1.07	89%	5.5%

Note that Down's syndrome presents as biochemical immaturity so effects of errors on PAPP-A and hCG combine.

Data provided by Prof D Wright, lead statistician for DQASS, NHS FASP

Effects of NT bias on FPR & DR for Tri 21

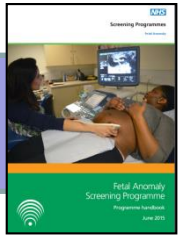
Bias (mm)	FPR	DR
-0.4	2%	79%
-0.3	1.8%	80%
-0.2	2.0%	82%
-0.1	2.2%	83%
0	2.6%	85%
0.1	3.1%	86%
0.2	3.7%	87%
0.3	4.6%	88%
0.4	5.7%	90%

Data provided by Prof D Wright, lead statistician for DQASS, NHS FASP

2nd trimester



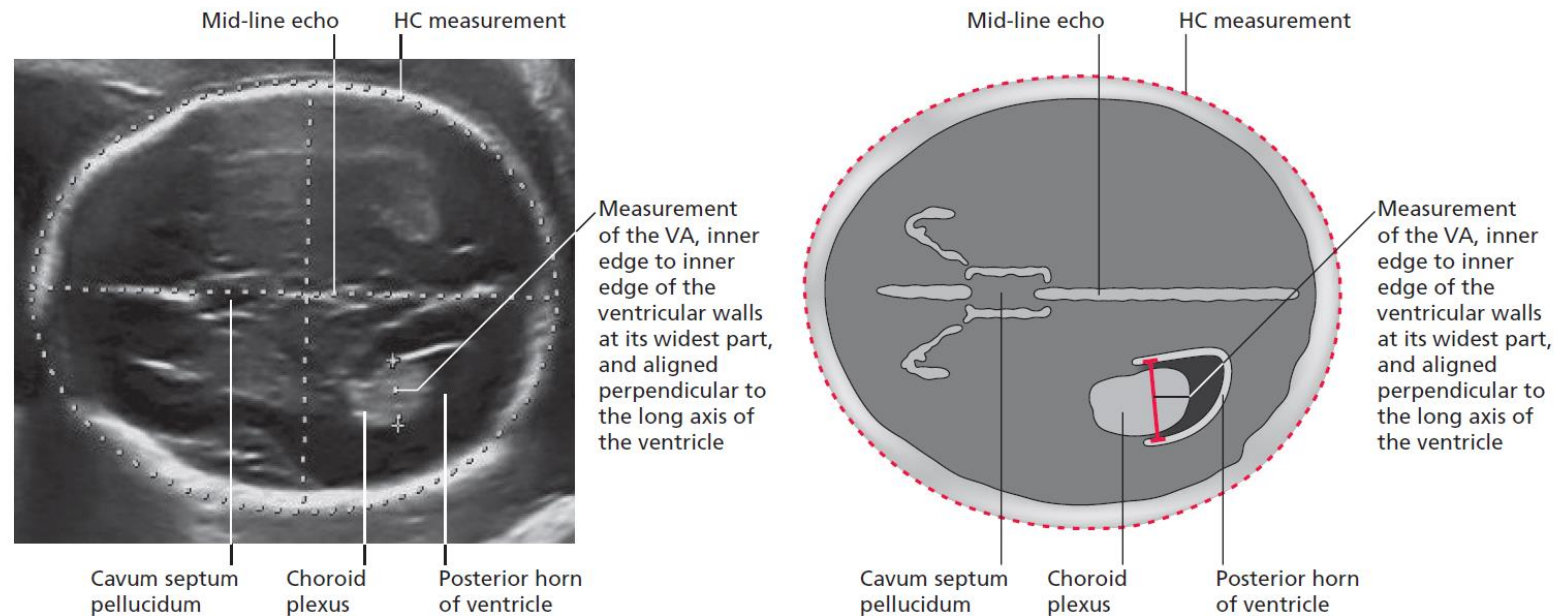
18⁺⁰ - 20⁺⁶ weeks – biometry, HC



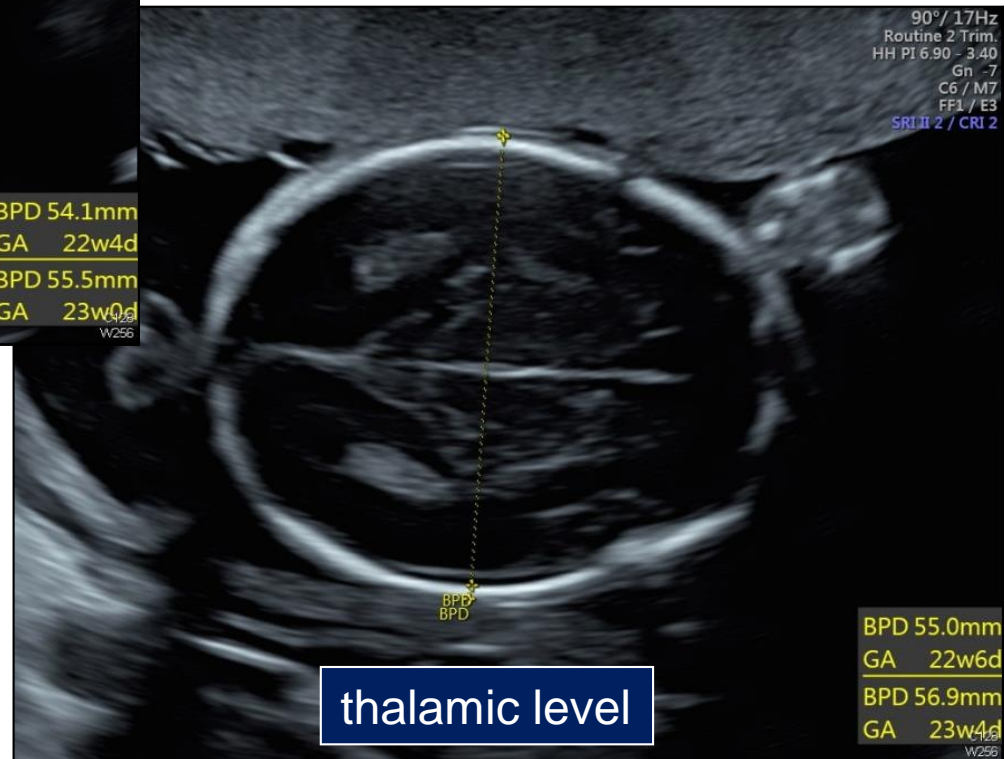
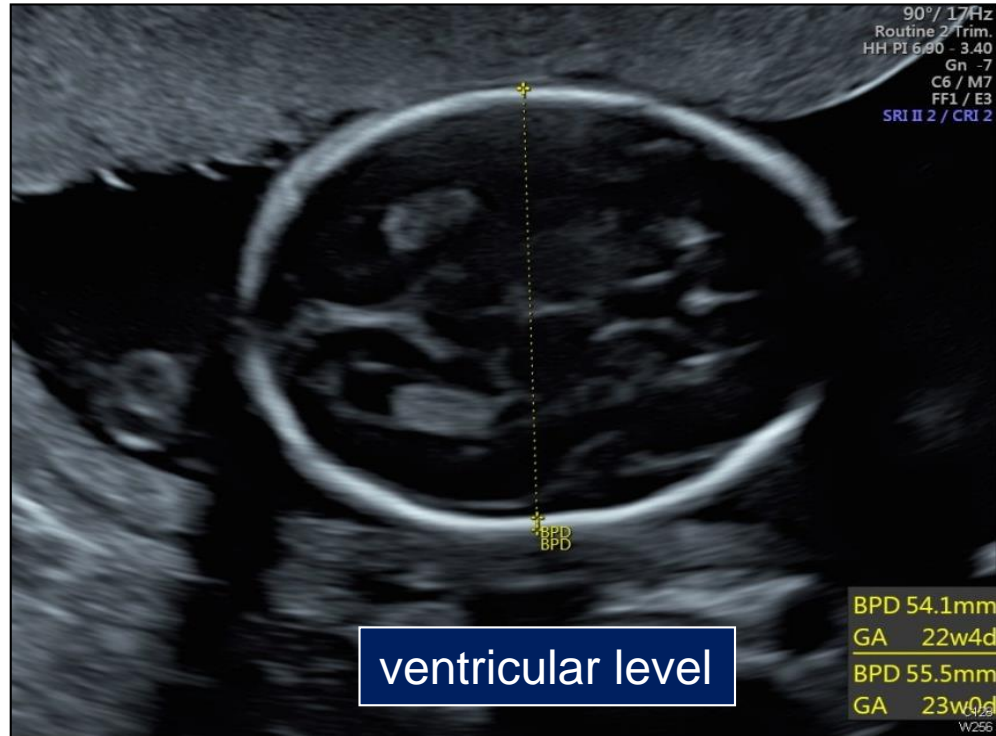
Assess fetal growth velocity, based on EDD assigned at dating/combined screening by measurement of:

- HC (Chitty) - ventricular level, with image

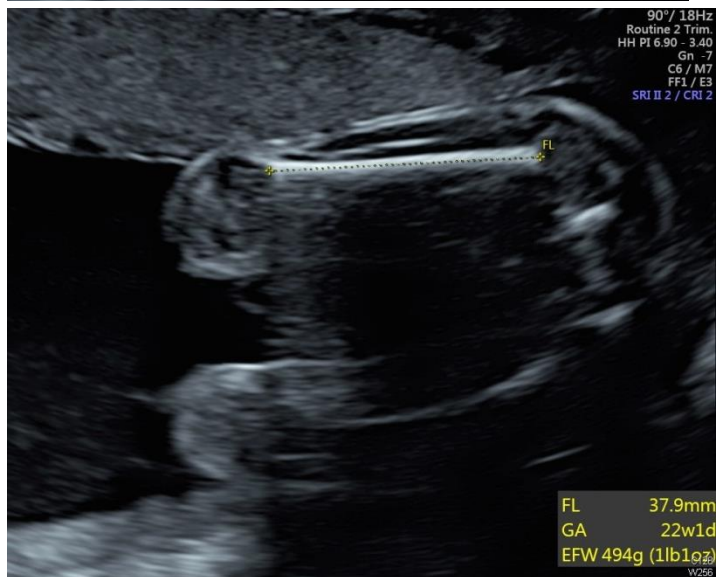
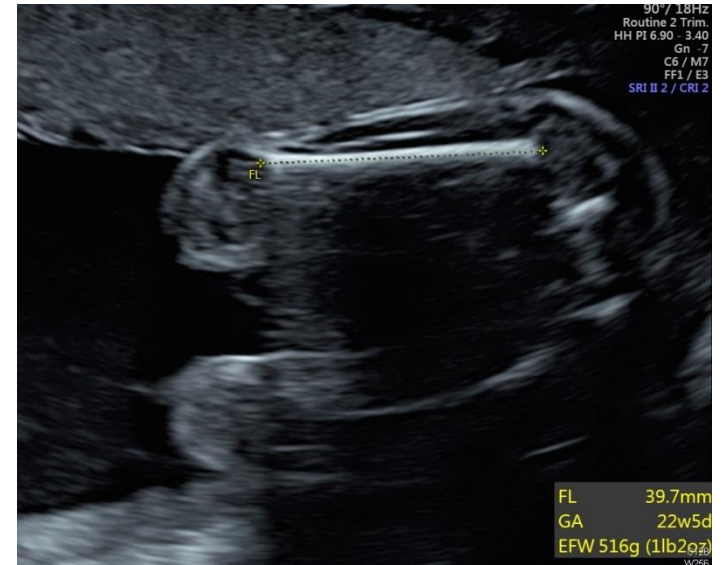
Head circumference (HC) and ventricular atrium (VA)



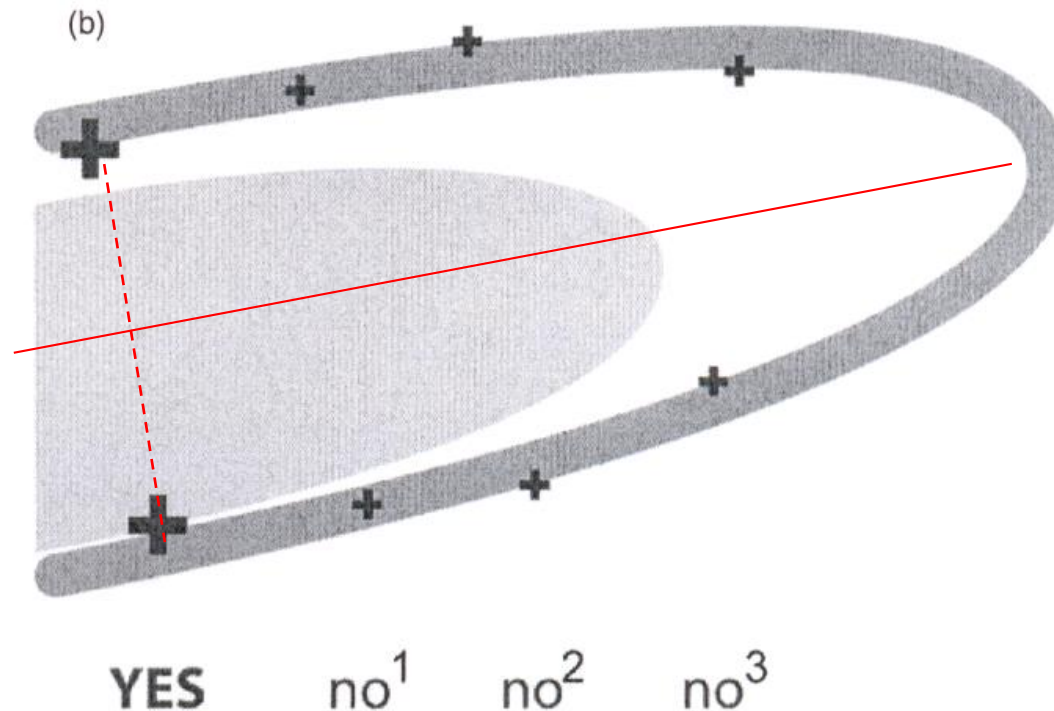
Head measurements – level & calliper placement



Femur length measurements- calliper placement



Measurement of the posterior horn - correct calliper placement

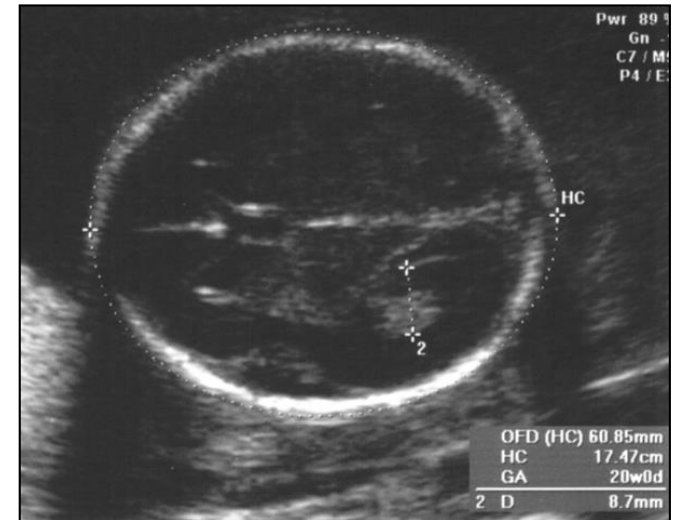
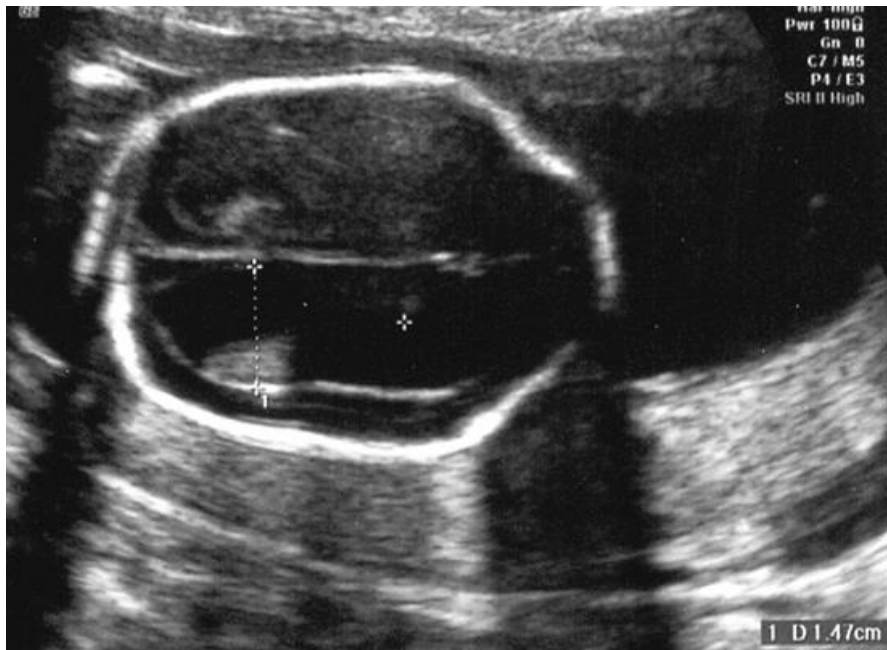


Ref: ISUOG (2007) Sonographic examination of the fetal central nervous system: guidelines for performing the 'basic examination' and 'fetal neurosonogram'. *The International Society of Ultrasound in Obstetrics & Gynaecology*. Vol 29; Pp 109 – 116.

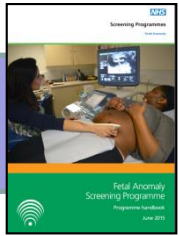
Size & abnormal findings

refer if:

- nuchal fold >6.0mm
- **ventriculomegaly (PH>10.0mm)**
- RPD (AP pelvis >7.0mm)
- significantly small (<< 5th centile)



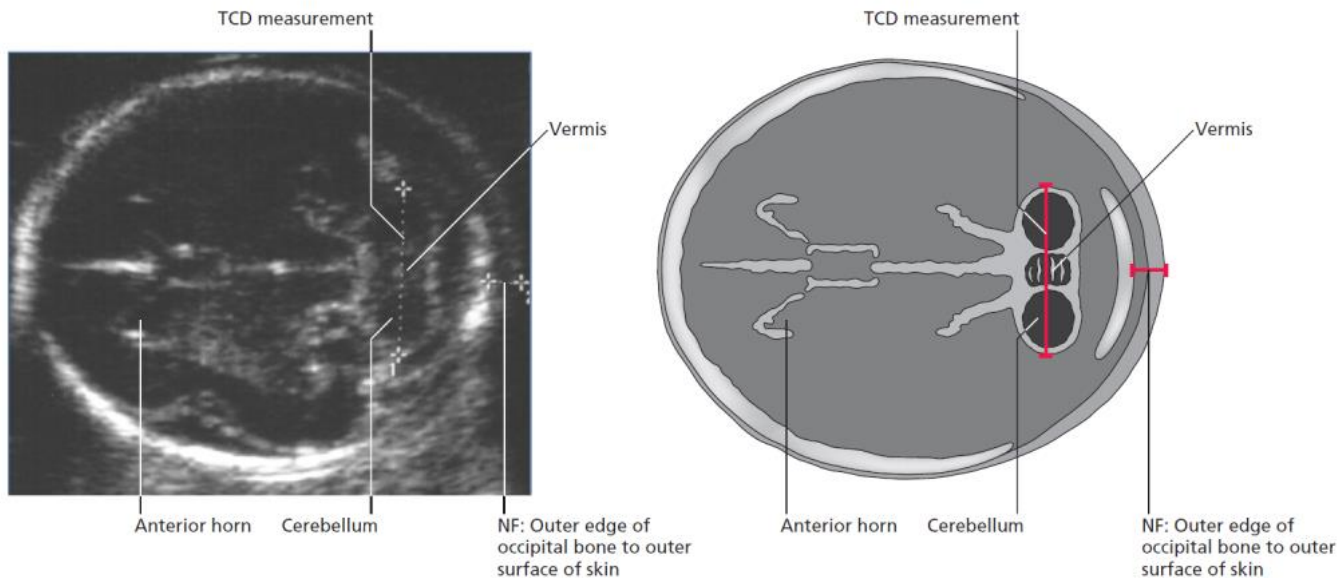
$18^{+0} - 20^{+6}$ weeks – biometry, TCD



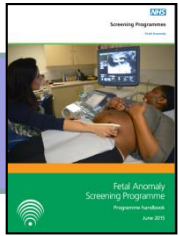
Assess skull, brain & neck

- measure TCD, with image
- assess nuchal fold (<6.0mm)

Transcerebellar diameter (TCD) and nuchal fold (NF)

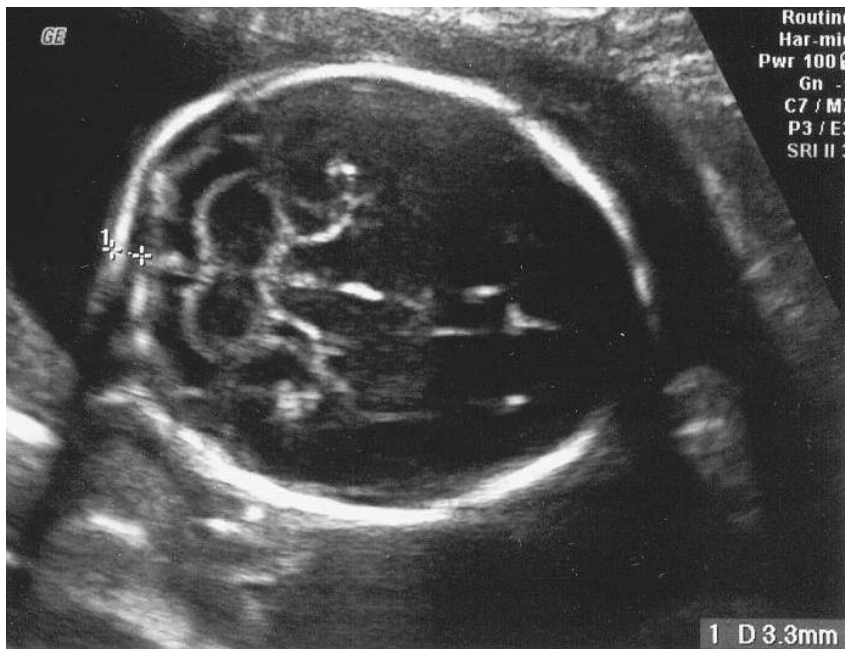


$18^{+0} - 20^{+6}$ weeks – biometry, nuchal fold

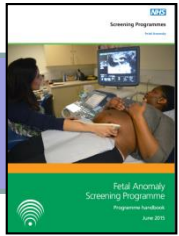


refer if:

- **nuchal fold >6.0mm**
- ventriculomegaly (PH>10.0mm)
- RPD (AP pelvis >7.0mm)
- significantly small (<< 5th centile)

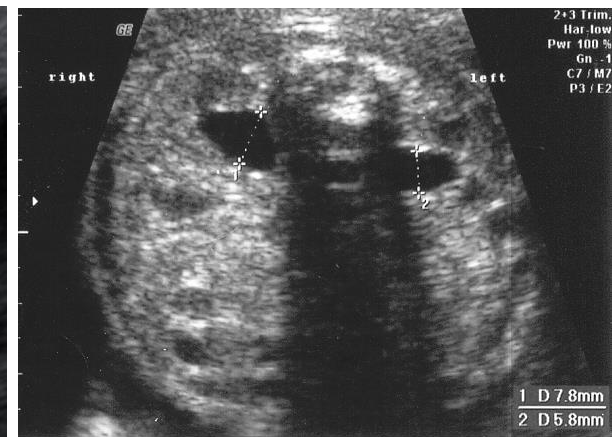
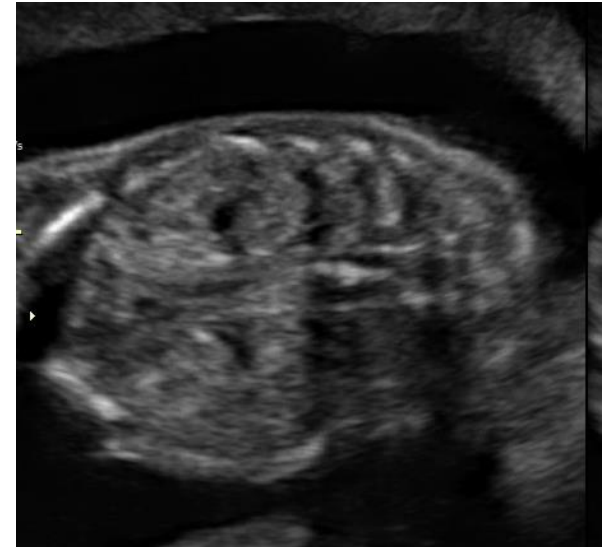


$18^{+0} - 20^{+6}$ weeks – biometry, renal pelvis



refer if:

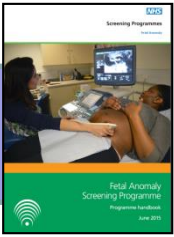
- nuchal fold $>6.0\text{mm}$
- ventriculomegaly ($\text{PH} > 10.0\text{mm}$)
- **RPD (AP pelvis $>7.0\text{mm}$)**
- significantly small ($<< 5^{\text{th}}$ centile)



3rd trimester

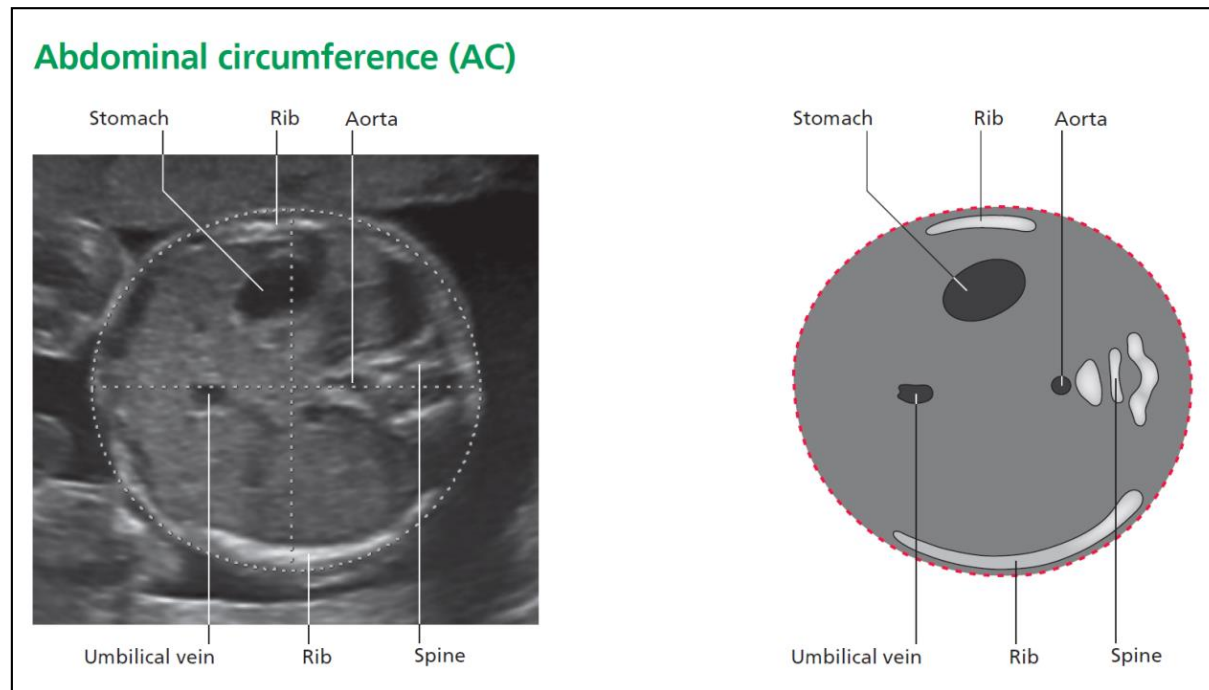


Fetal biometry – abdominal circumference (AC)

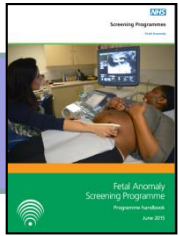


Assess fetal growth velocity, based on EDD assigned at dating/combined screening by measurement of:

- AC (Chitty) with image



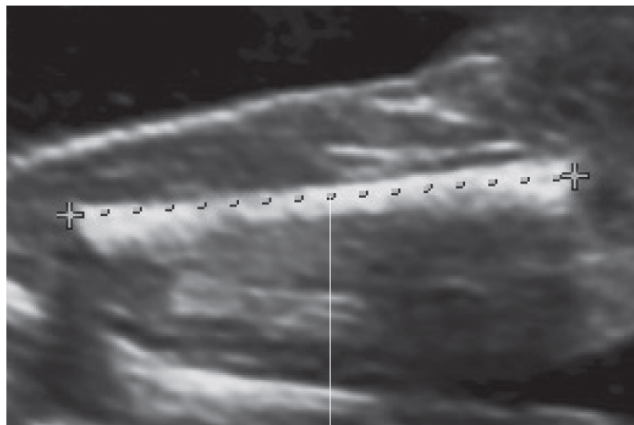
Fetal biometry – femur length (FL)



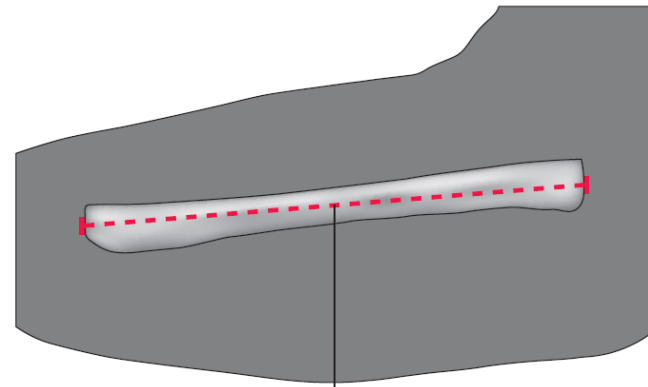
Assess fetal growth velocity, based on EDD assigned at dating/combined screening by measurement of:

- FL (Chitty), with image

Femur length (FL)

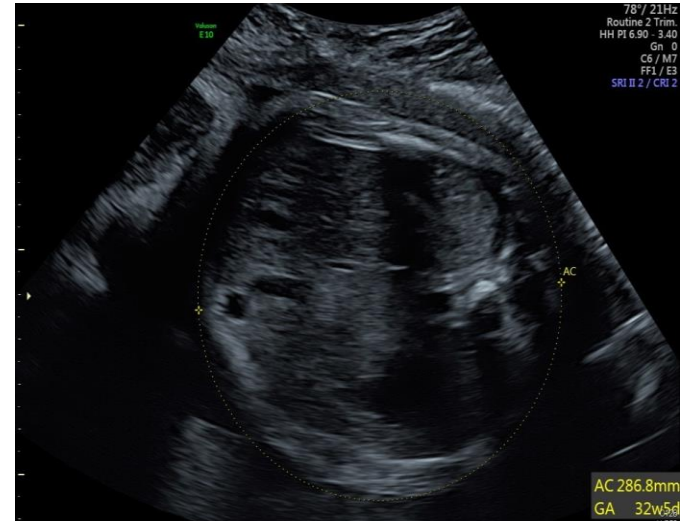
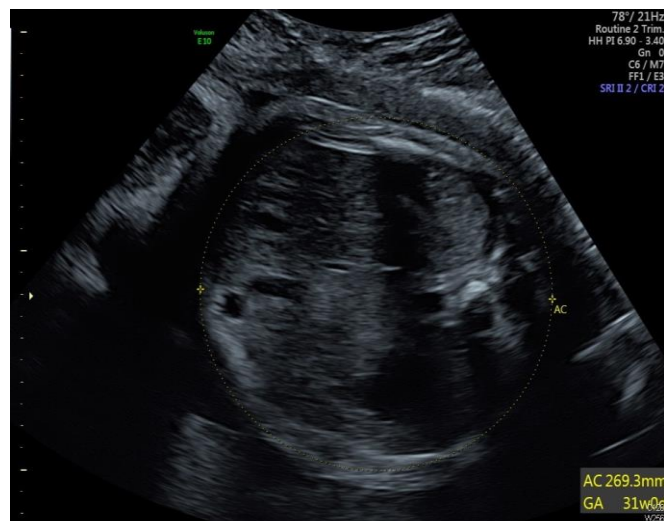
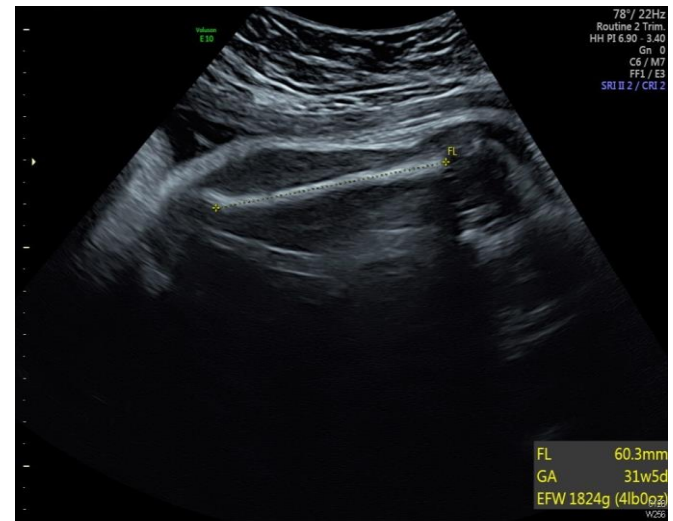
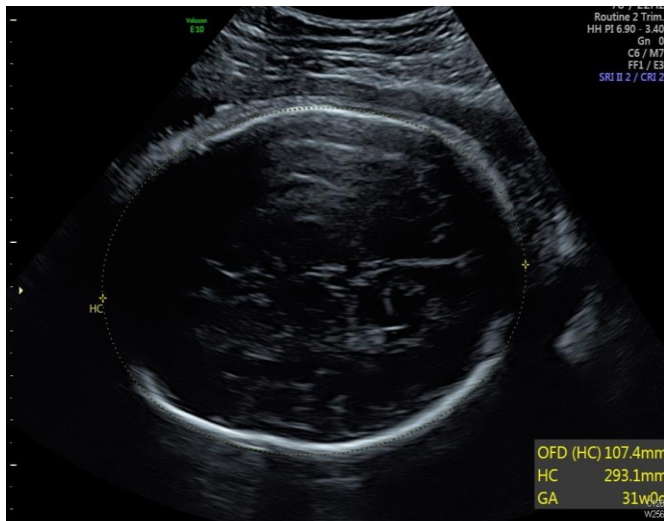


Femur length



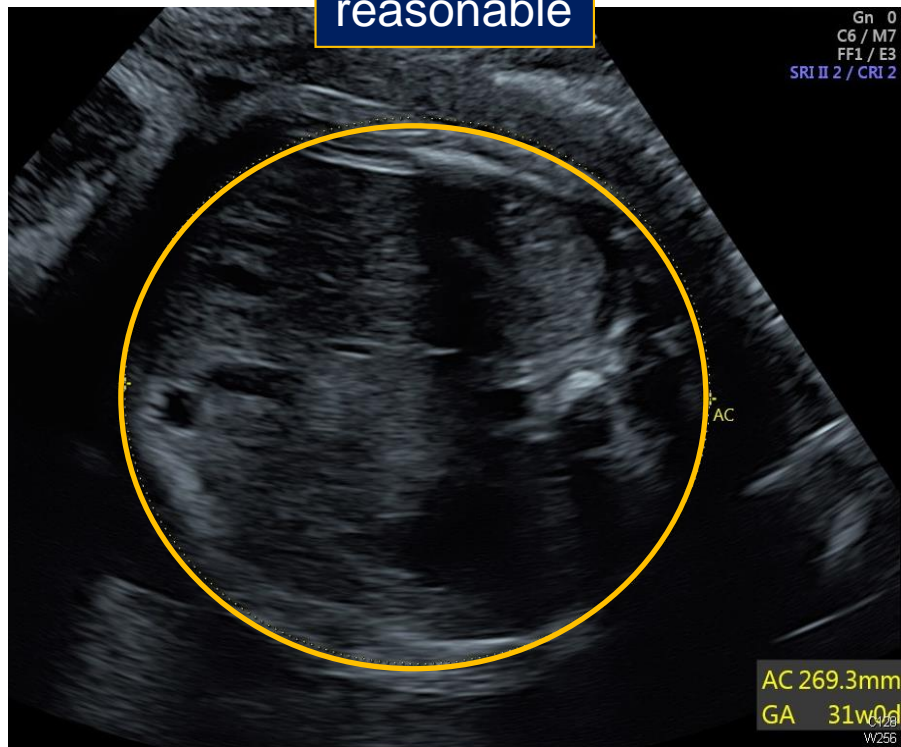
Femur length

31+ weeks - growth

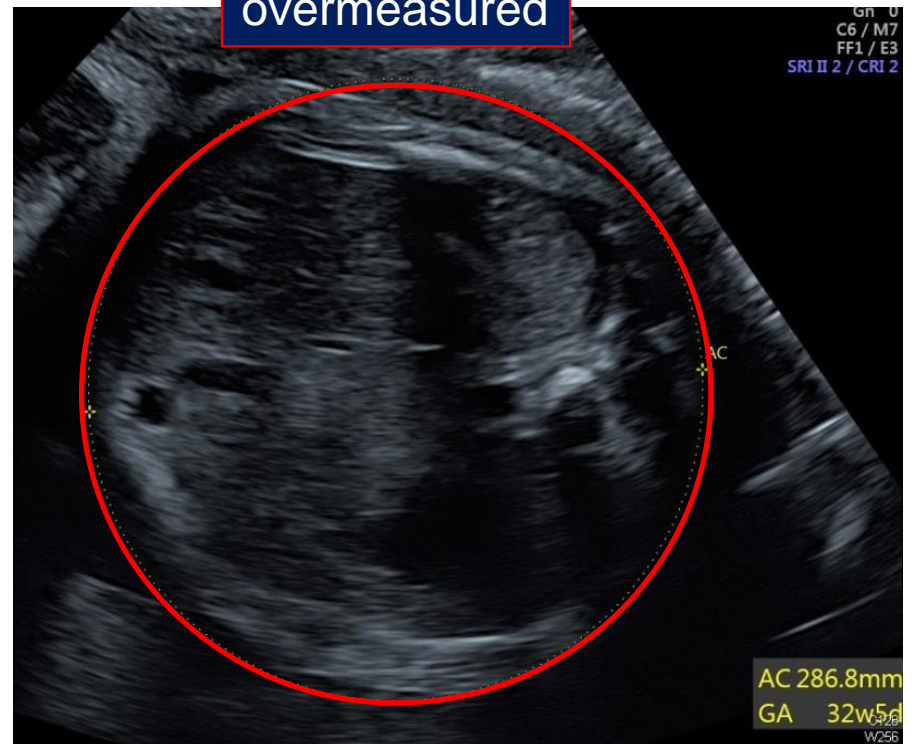


AC measurements

reasonable

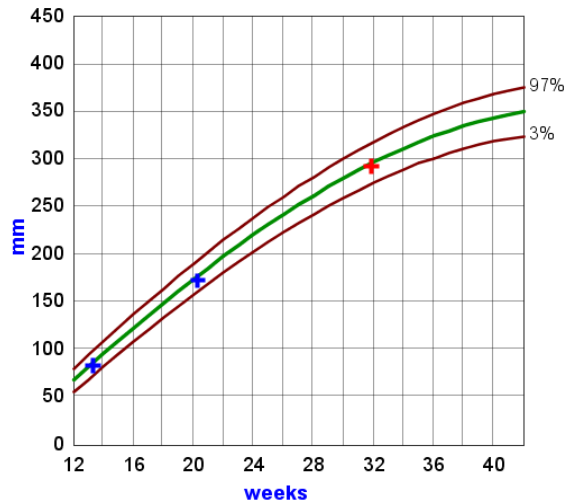


overmeasured

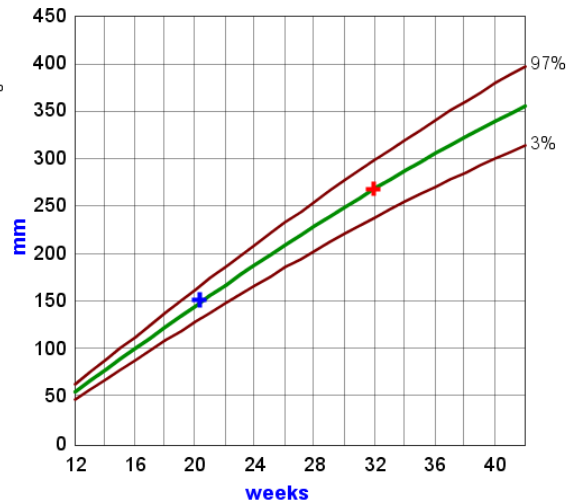


Acceptable measurements including AC

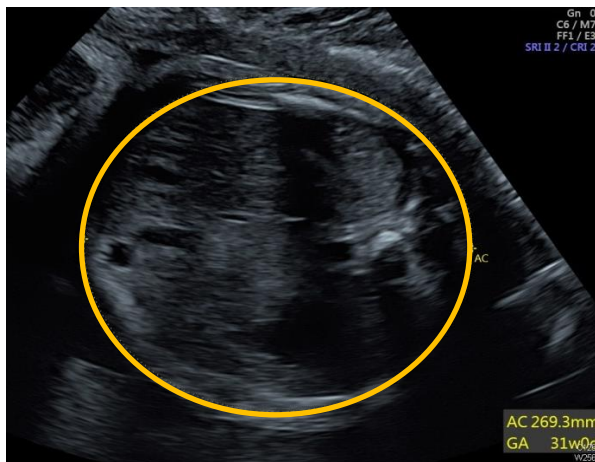
Head circumference



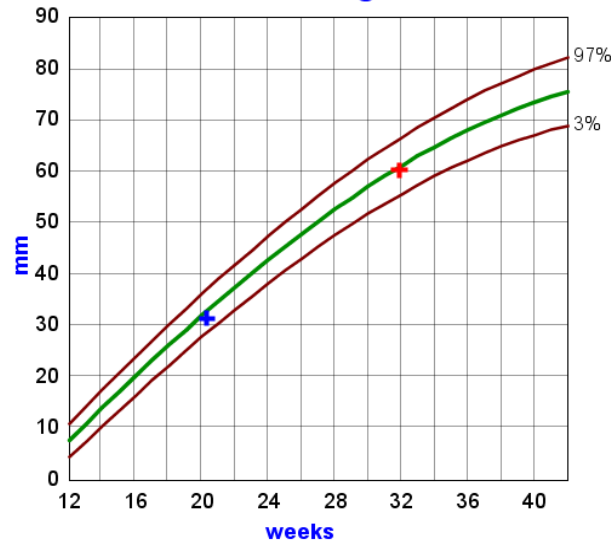
Abdominal circumference



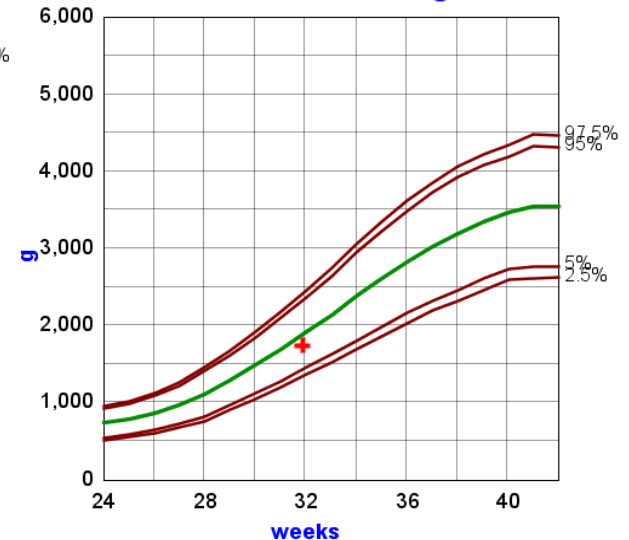
Gest age 31+6 wks
 HC 293.1mm
 AC 269.3mm
 FL 60.3mm
 EFW 1748g



Femur length

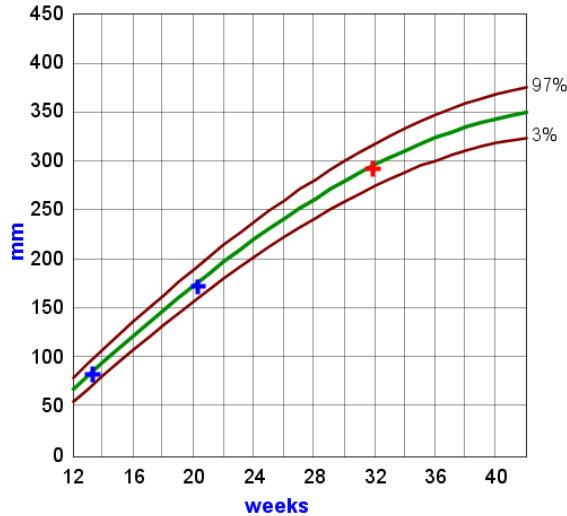


Estimated Fetal Weight



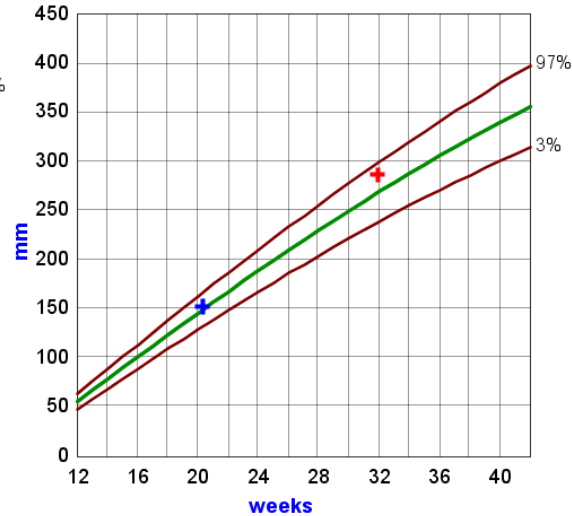
AC overmeasured

Head circumference



Chitty et al. BJOG 1994; 101: 35-43

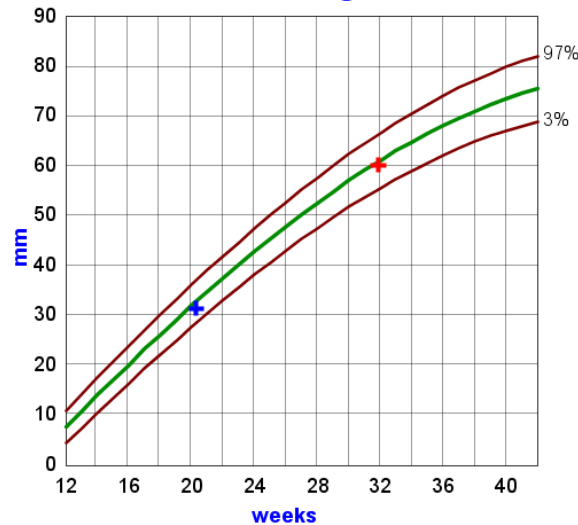
Abdominal circumference



Chitty et al. BJOG 1994; 101: 125-131

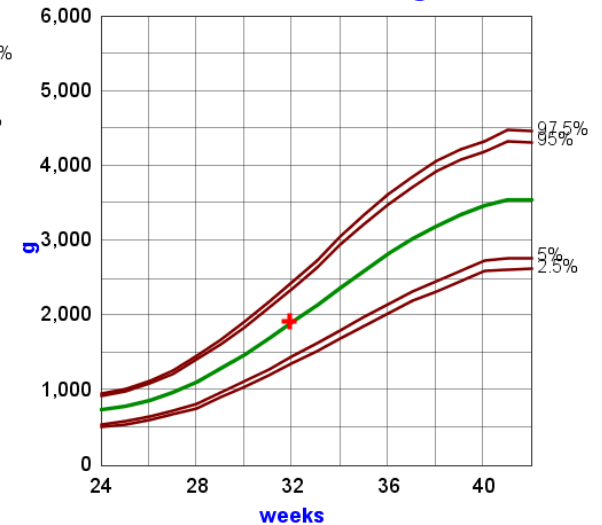
Gest age 31+6 wks
HC 293.1
AC 286.8
FL 60.3
EFW 1929gm

Femur length

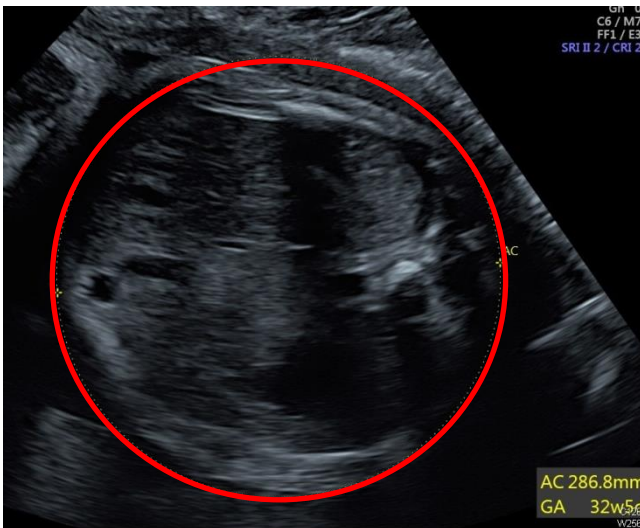


Chitty et al. BJOG 1994; 101: 132-135

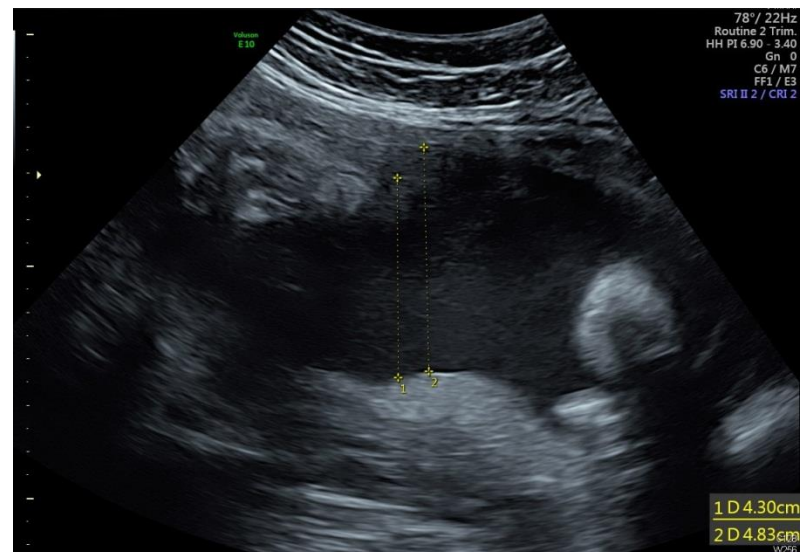
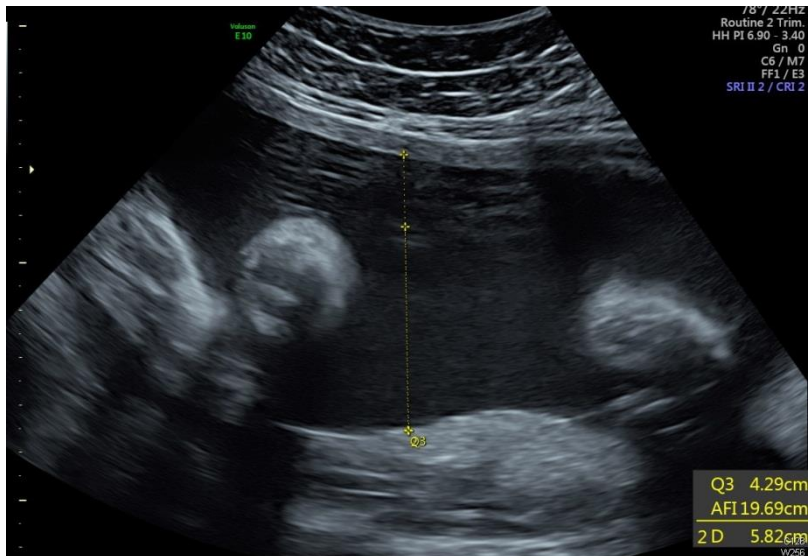
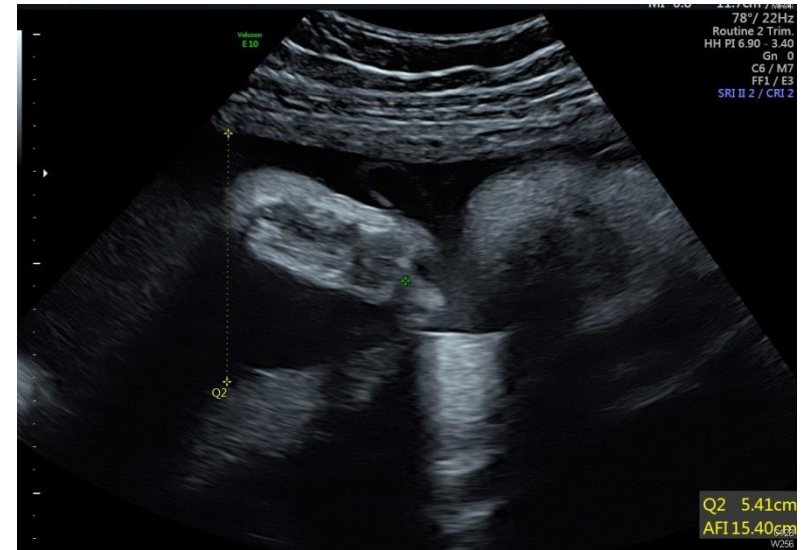
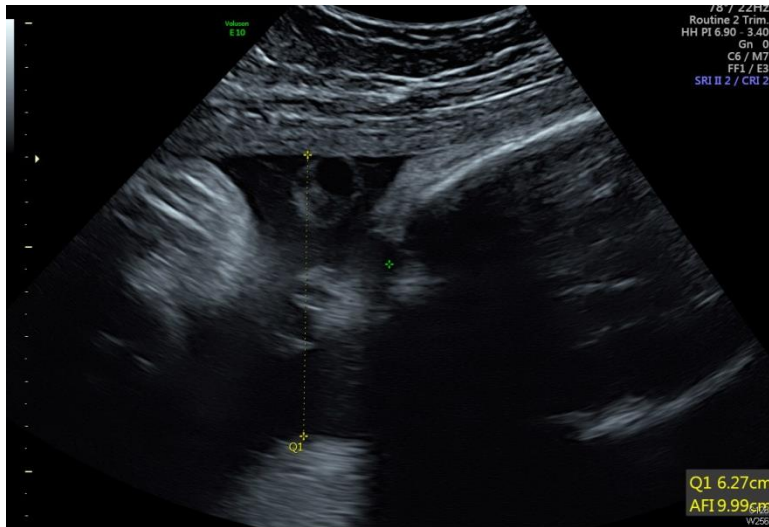
Estimated Fetal Weight



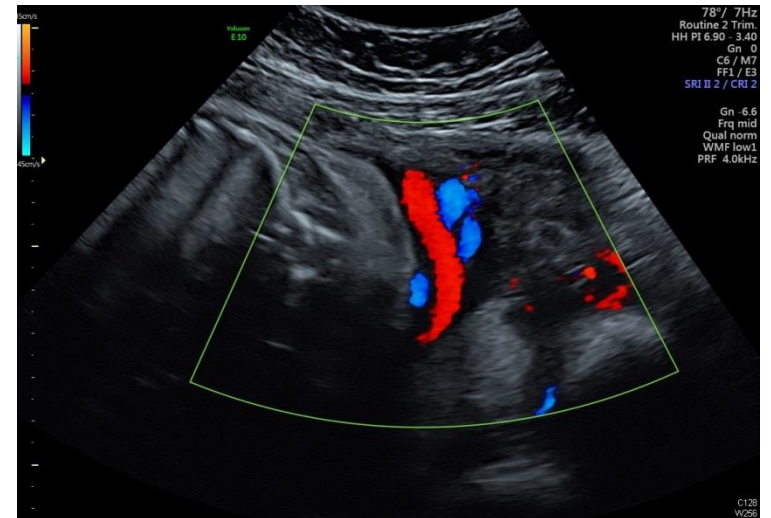
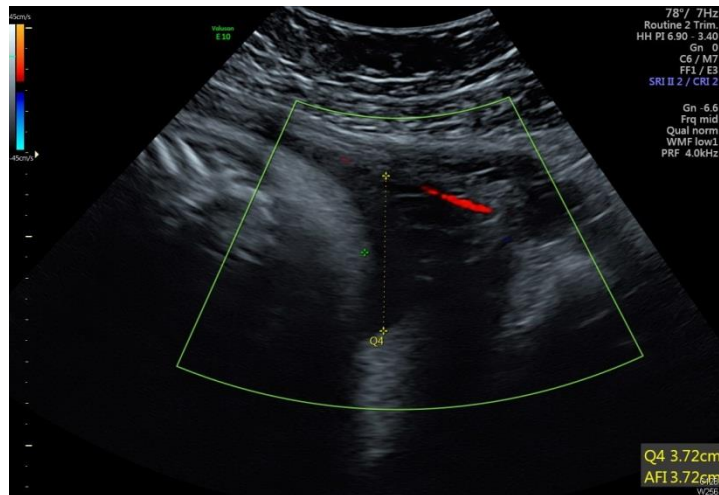
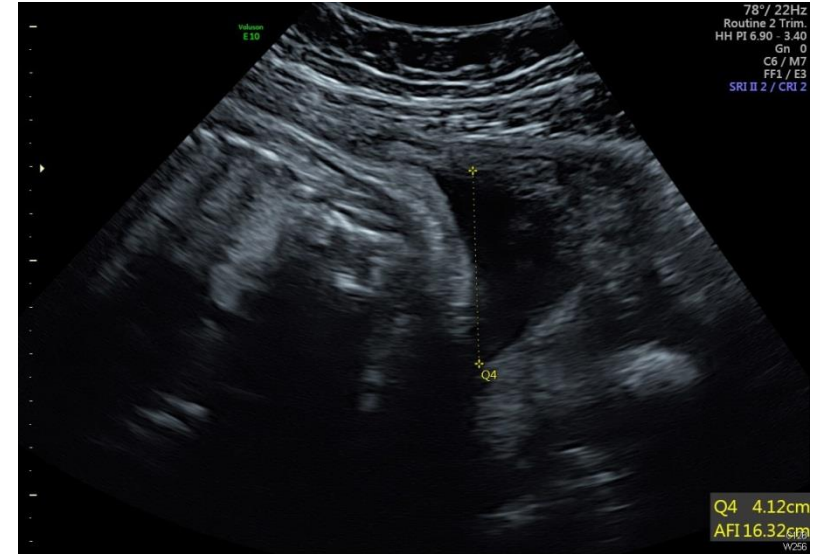
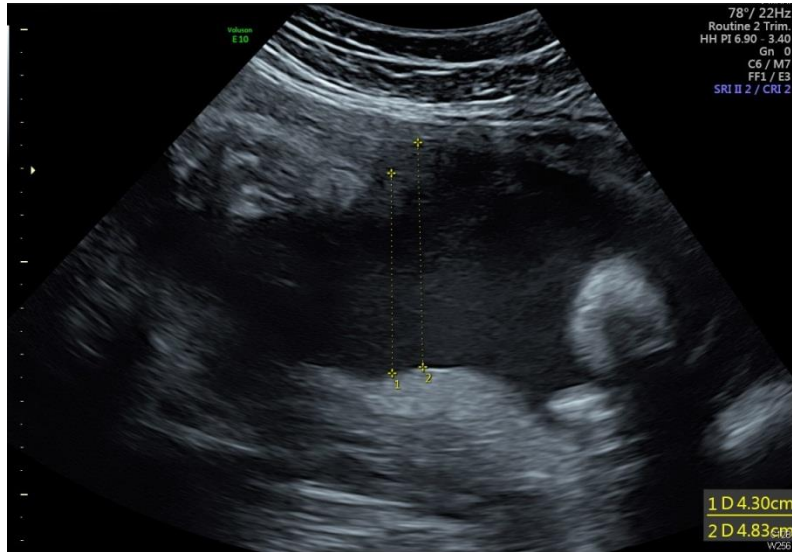
Yudkin et al. Early Hum Dev 1987; 15: 45-52 (extended)



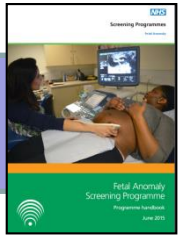
AFI measurements – pool or reverberation



AFI measurements - cord & reverberation



Take home messages



- Accurate fetal biometry is a vital component of every fetal examination
- It is as easy to perform biometry badly as well.
- Selecting the correct section for measurement, & placing the callipers correctly, is as important as other methods of fetal screening
- Be aware of the clinical implications of selecting incorrect sections &/or measuring them incorrectly

*Thank you
for your attention*

