

Obstetric Ultrasound for Evaluation of Fetal Growth



22nd June 2014
Lorraine Walsh



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Aims

- Rationale
- Scanning protocol, HC, AC, FL
- Accuracy of measurements
- Audit
- Factors affecting quality of ultrasound
- Implications for workforce



Rationale

Not done routinely

Biometric tests (measuring fetal size) are designed to predict fetal size at a point in gestation. If performed periodically can indicate growth but **not** fetal well being.

Biophysical tests (Doppler / liquor assessment) can predict fetal well being but **not** growth



Why do we assess growth?

“Fetal growth restriction is the single largest category of conditions associated with stillbirth and is found in the majority of the cases previously considered unexplained”

Using Classification of stillbirth by relevant condition at death (ReCoDe). Gardosi et al 2005



Importance of Good Scanning

- Unexplained perinatal death may be regarded as unavoidable.
- However death after IUGR raises possibility of being avoided with better recognition, investigation and management.
- Affect management of future pregnancies. Past obstetric history of a SGA baby- at least a twofold risk increase of a subsequent SGA baby

RCOG Green-top Guideline 31 2013/14



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Role of Ultrasound in diagnosis of IUGR

Three important criteria needed;

1. Accurate gestational age
2. Estimated fetal weight – (HC, AC and FL or AC and FL Charts-Hadlock et al 1985)
3. A weight percentile calculated from the estimated weight and gestational age (CGC)



Third Trimester growth scan

- Fetal heart
- Presentation and fetal lie
- HC / AC / FL
- Estimated fetal weight
- Placenta
- Liquor volume (SDVP/AFI)
- Doppler
- Fetal movements and FBM
- Report





MEASUREMENTS HC , AC AND FL



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BPD

“BPD should not be used in routine clinical practice for the estimation of gestational age or the appropriateness of fetal size in later pregnancy”

Loughna et al 2009



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INTERGROWTH-21st

- The International Fetal and Newborn Growth Consortium for the 21st Century
- Large scale population based multicentre observational project of fetal and newborn growth across 8 countries
- Serial fetal growth scans every 5 +/- 1week from 14 to 42 weeks
- BPD OFD HC (ellipse) APAD TAD AC (ellipse) FL
- (Head measurements made at trans thalamic section
BPD – outer to outer)



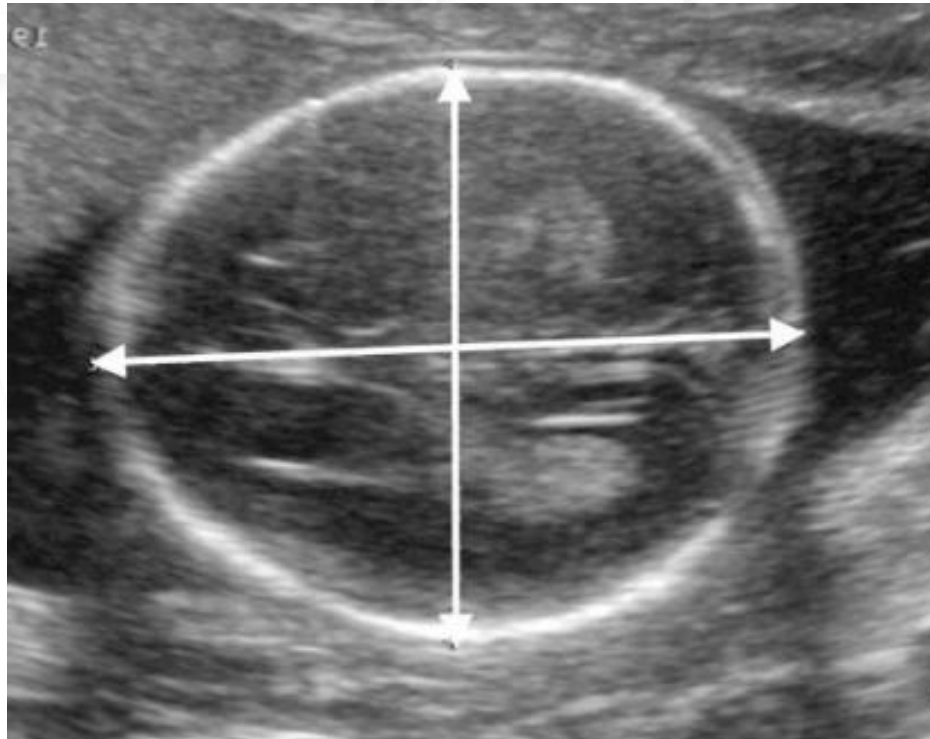
HC

- A cross-sectional view of the fetal head at the level of the ventricles should be obtained
- Rugby football shape; centrally positioned,
- Continuous midline echo broken at one third of its length by the cavum septum pellucidum
- Anterior walls of the lateral ventricles centrally placed around the midline
- Choroid plexus should be visible within the posterior horn of the ventricle in the distal hemisphere.

Loughna et al 2009



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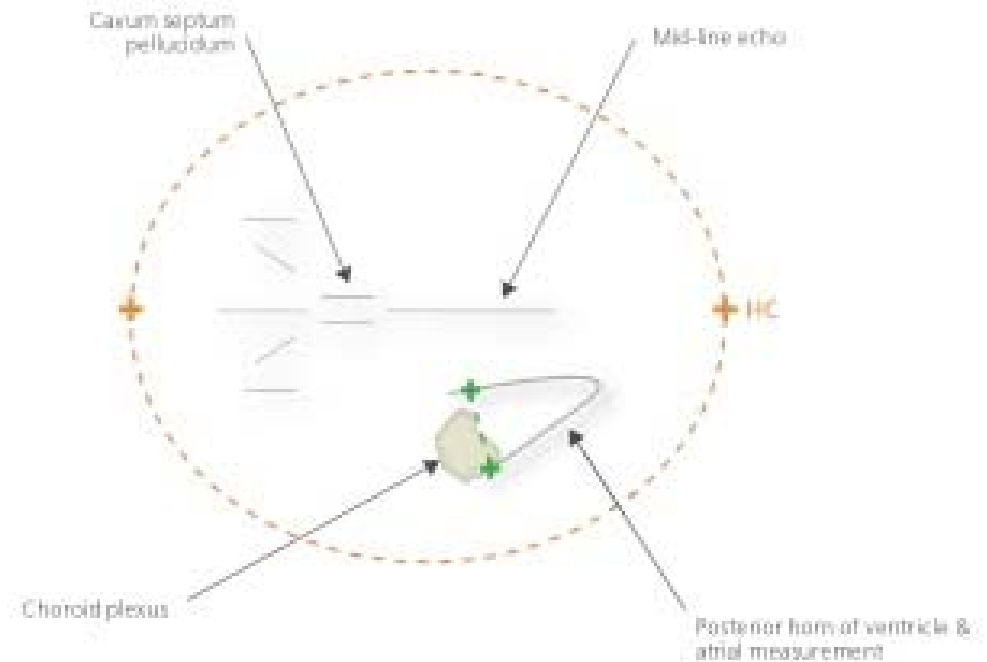
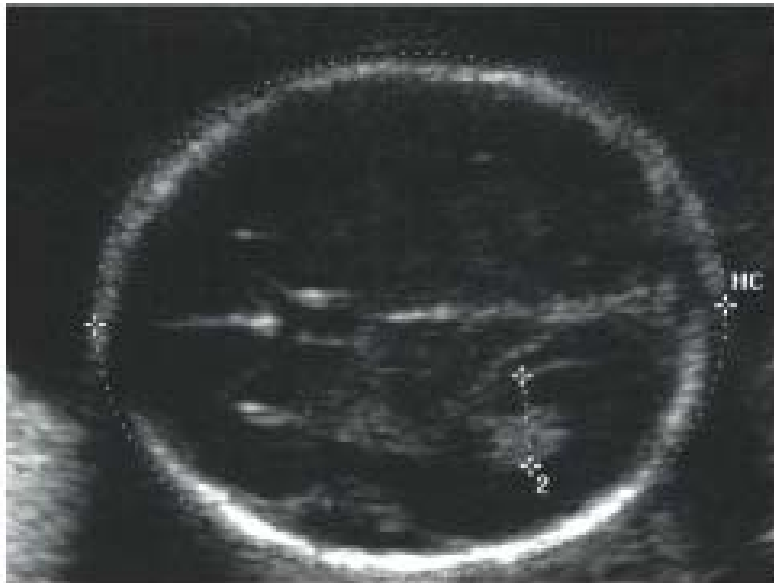


<http://www.maneyonline.com/doi/pdfplus/10.1179/174313409X448543>



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Head circumference and ventricular atrium



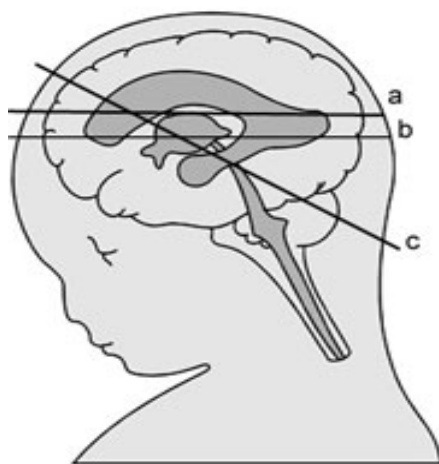
Head circumference denoted by orange dotted line and caliper markings (+)
Ventricular atrial measurement denoted by green dotted line and caliper markings (+)

http://fetalanomaly.screening.nhs.uk/fetalanomalyresource/images/stories/Downloads/2.4.1_Base_menu/base_menu1_head_circumference__ventricular_atrium.jpg

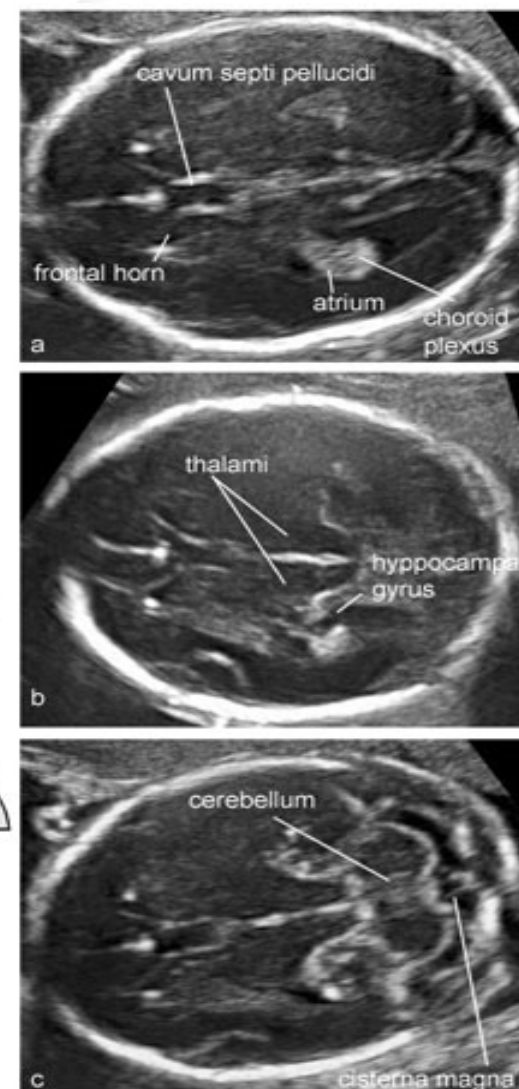


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Head Circumference HC

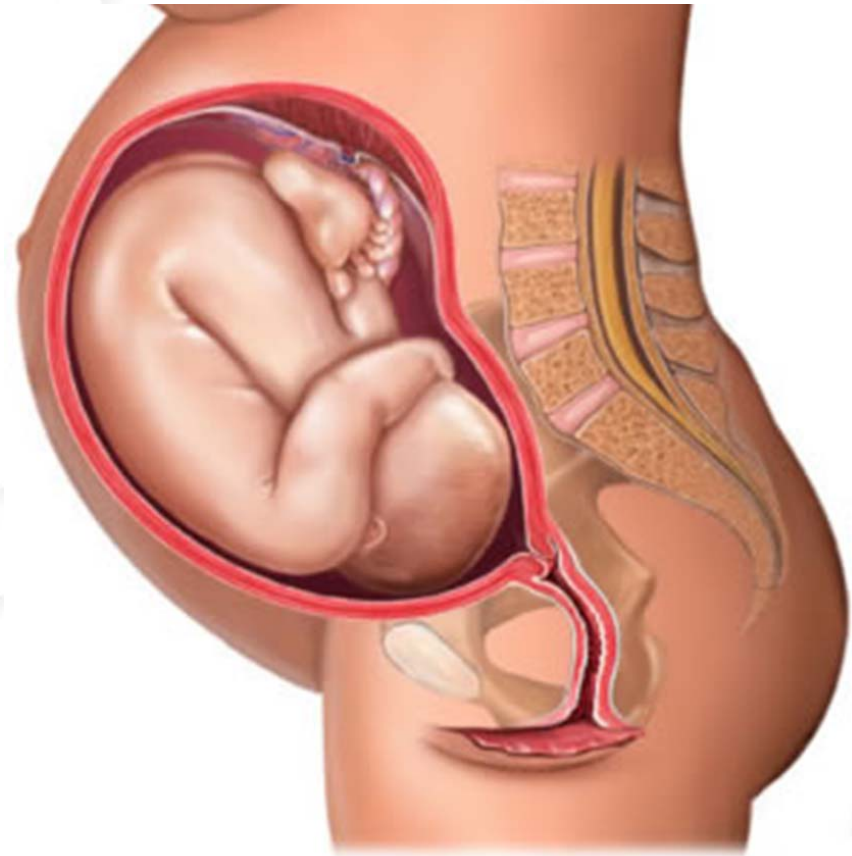
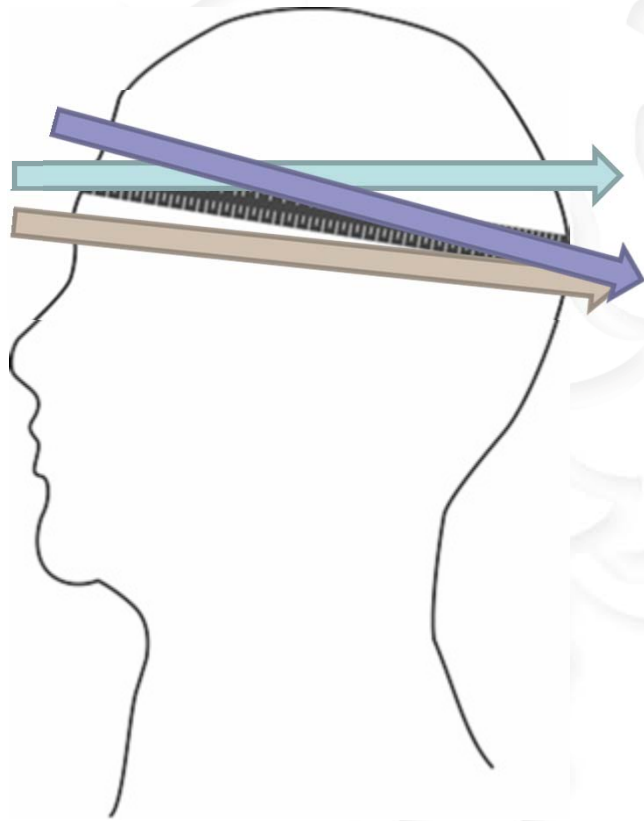


Glowm.com



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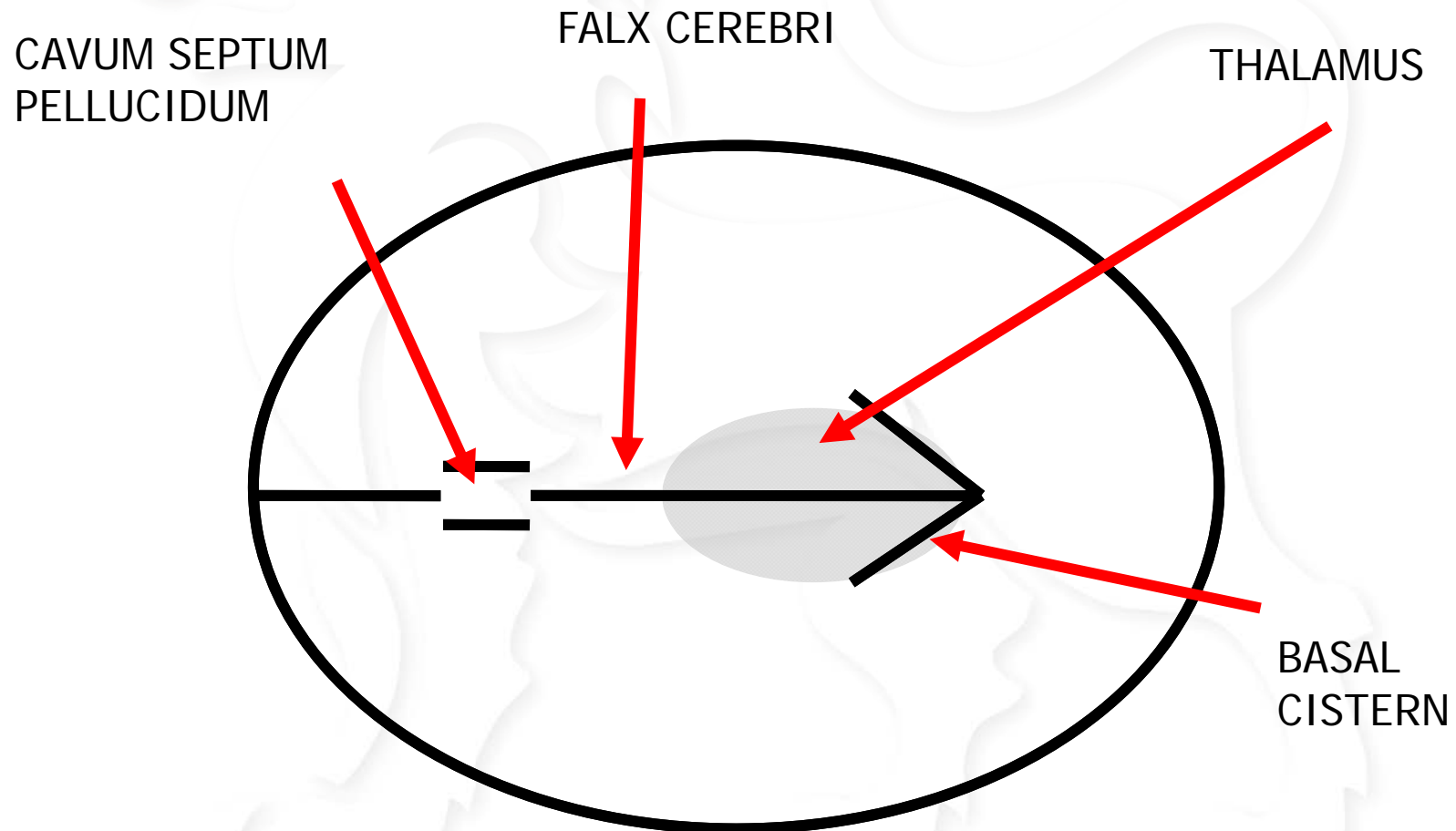
Head Circumference



Trans-thalamic plane



Trans-thalamic plane



Abdominal Circumference Guidelines

- RCOG Greentop Guideline No. 31
- Fetal Anomaly Screening Guidelines
- BMUS 2009

All refer back to original charts published in 1994 by Chitty et al

- AC guidelines by Chitty et al refer back to original guidelines by Campbell & Wilkin in 1975



Abdominal Circumference

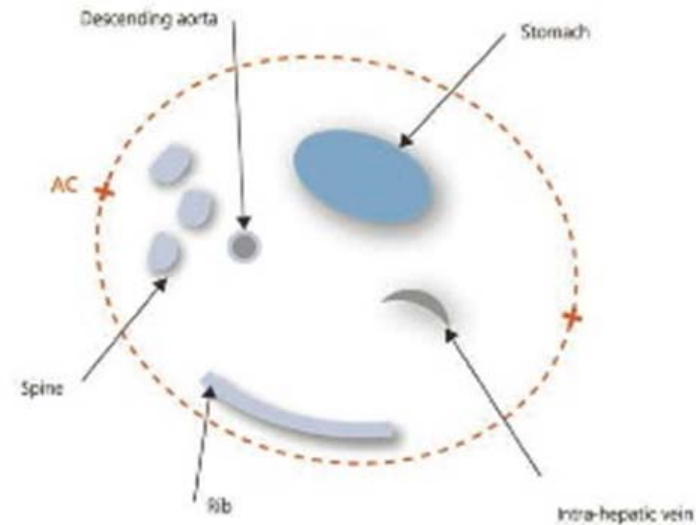
- Circular transverse section of the fetal abdomen at the level of the liver. Visualising the whole circumference without indentation.
- Short section of the of the intra hepatic umbilical vein - one third from the anterior abdominal wall
- Stomach
- Spine and descending Aorta

- Short 'unbroken' rib echo
- Ideally spine at 9 or 3 O'clock position



Abdominal Circumference AC

Abdominal circumference (AC)



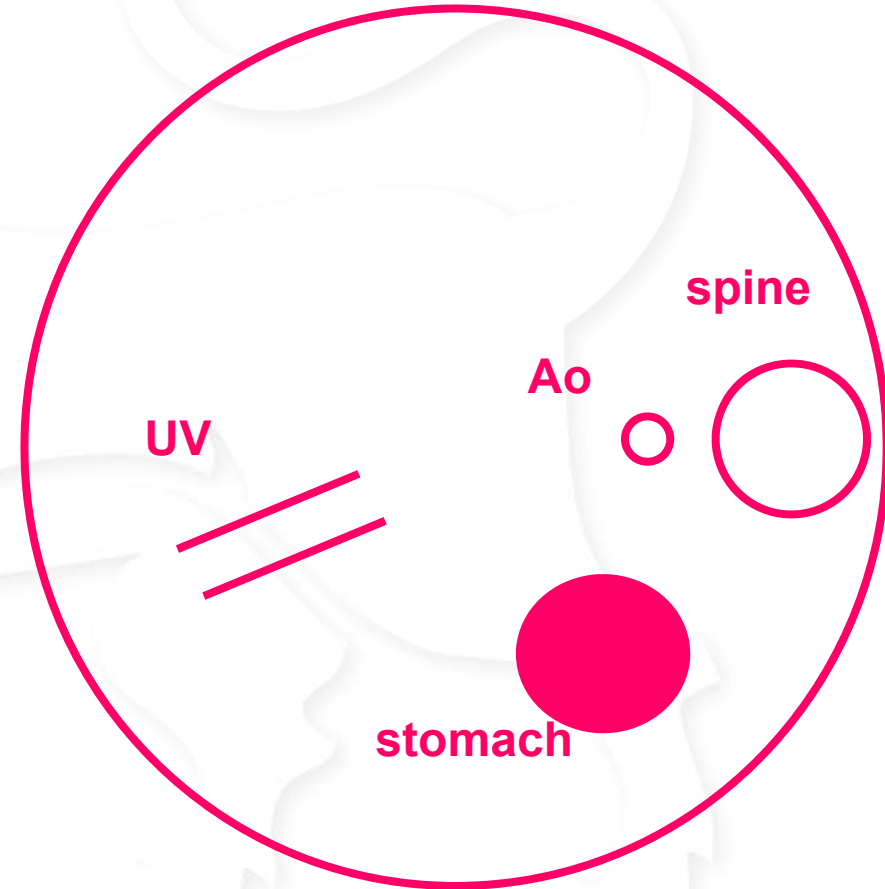
Abdominal circumference denoted by orange dotted line and caliper markings (+)

http://fetalanomaly.screening.nhs.uk/fetalanomalyresource/images/stories/Downloads/2.4.1_Base_menu/base_menu4_abdominal_circumference.jpg

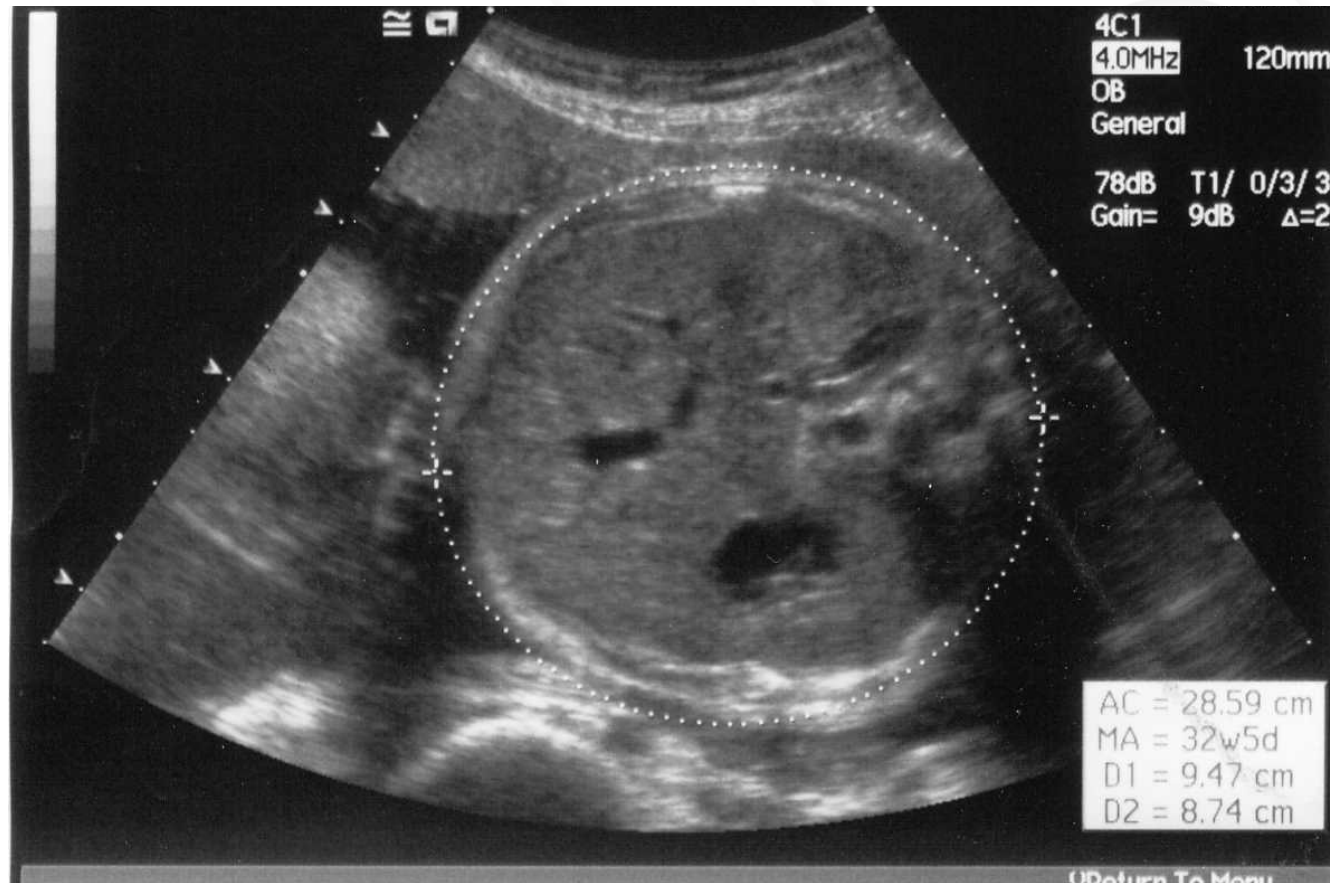


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Abdominal Circumference



AC

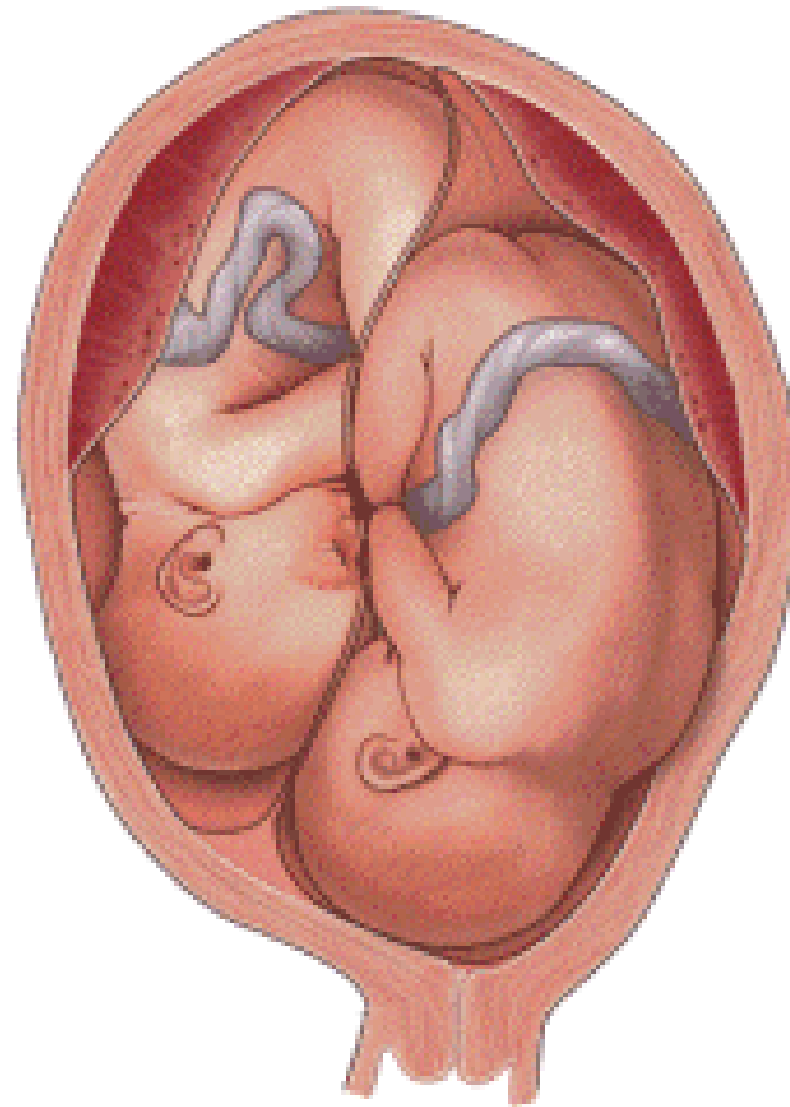


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Twins....



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Accuracy

“It has been shown that performance varies between centres and between individuals , especially for the AC measurement”

NJ Dudley 2013



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West Midlands Obstetric Ultrasound Biometry Audit 2003

AC Guidelines:

- Angle: A-P axis more than 30° from beam axis.
- Landmarks: Standard landmarks visible, i.e. short section of UV 1/3 in from anterior wall, lower pole of stomach, circular cross-section of spine.
- R-L alignment: Symmetry about A-P axis, symmetry of ribs (accounting for differing reflections due to convex arrays), small stomach.
- A-P alignment: Short UV, circular cross-section (allowing for effect of pressure in the third trimester, which may distort shape).
- Calliper placement: Follows abdominal skin outline.
- Magnification: Target >50% of image taken up by measured structure, pass criterion if >30%.



AC Best of 3??

- Chitty et al (1994) – “*Single measurement that fulfilled all criteria*”
- BMUS (2009) Loughna et al – “*Single measurement should be used provided it is of good technical quality and obtained using the techniques and planes described*”
- Sarris et al 2012 **used 2 measurements with 2 operators**
www.intergrowth2.org.uk
- Hargreaves et al 2011- no information on US sections or measurements at all
- RCOG Green top guideline no 31 2013/14 **“There is no evidence to recommend one specific method of measuring AC”**



How do you measure AC?

- Chitty et al (1994) observed derived values from 2 diameters **3.5% smaller across all gestations** compared to direct measurement
- Demonstrates need for separate centile charts
- Do you know what charts your machines calibrated to?
- Is everyone in department/community measuring with same method?



AC Measurement technique

Chitty et al 1994

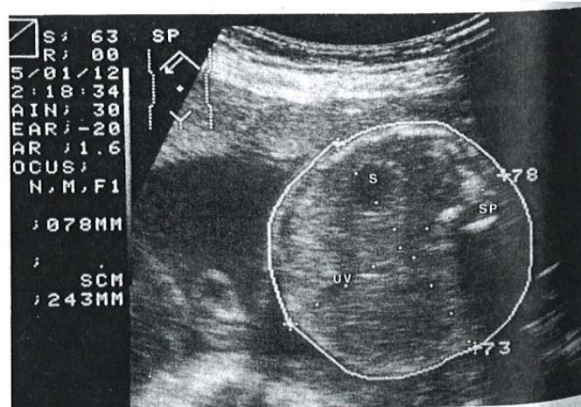


Fig. 1. Transverse section through the fetal abdomen at the level used for measuring the abdominal circumference, showing the spine (SP) posteriorly, the stomach (S), and the umbilical vein (UV). This image shows the directly plotted measurement (continuous line around circumference) and the measurement diameters as marked.

Loughna et al 2009

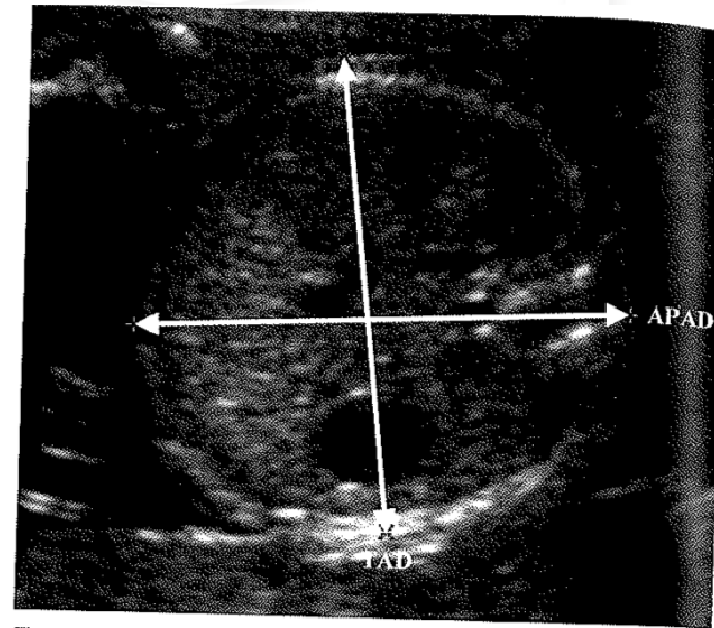


Figure 4. Measurement of AC using the abdominal diameters method.



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Pitfalls

The most common causes of failure West Midlands Obstetric Ultrasound Biometry Audit 2003 were:

- A-P & R-L alignment
- Landmarks
- Caliper placement
- Magnification



Best Section??

“Most difficult measurement is AC, which is probably the most important in the third trimester as it is most predictive of fetal weight”.

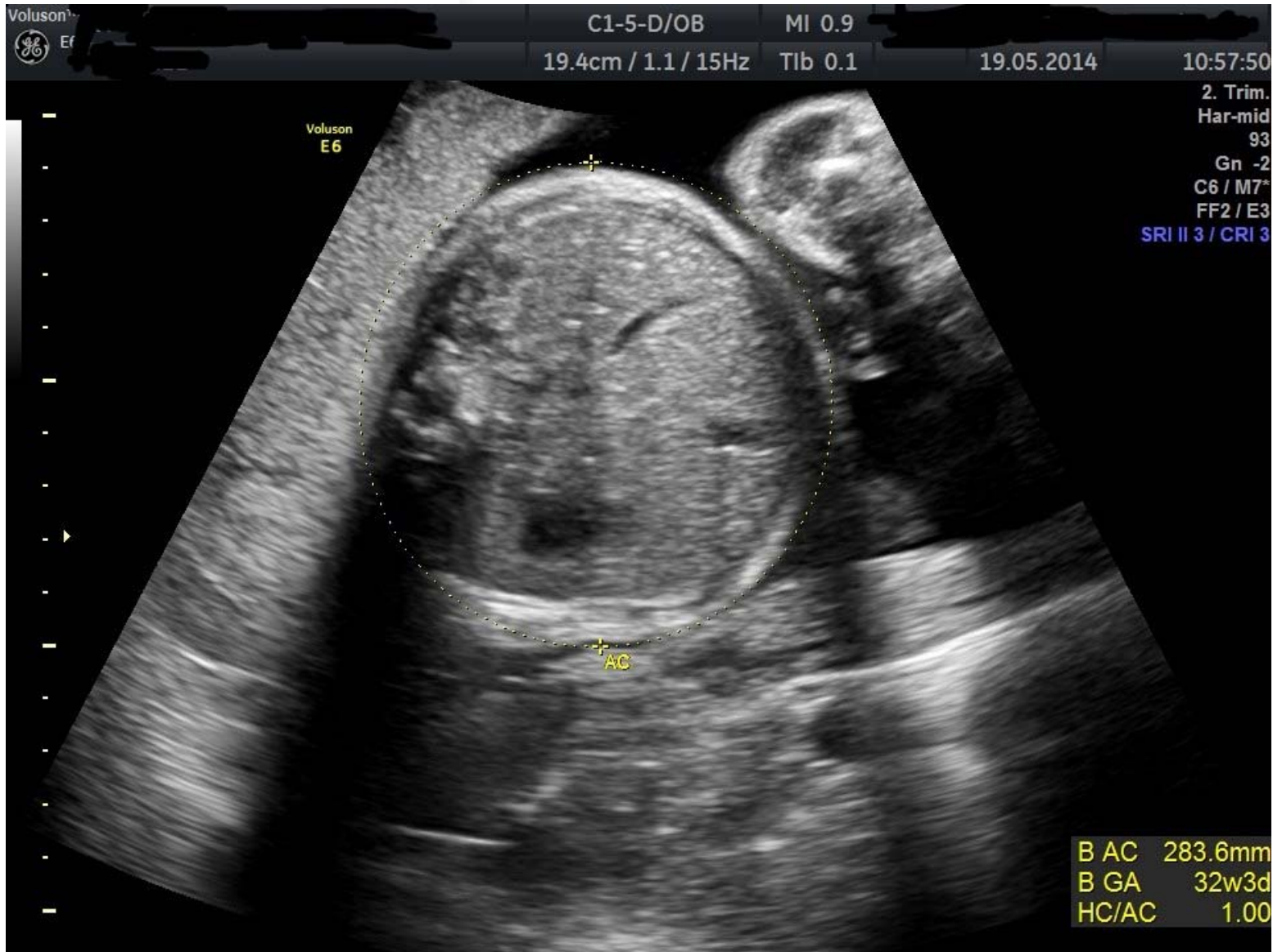
P. I. Audit 2003



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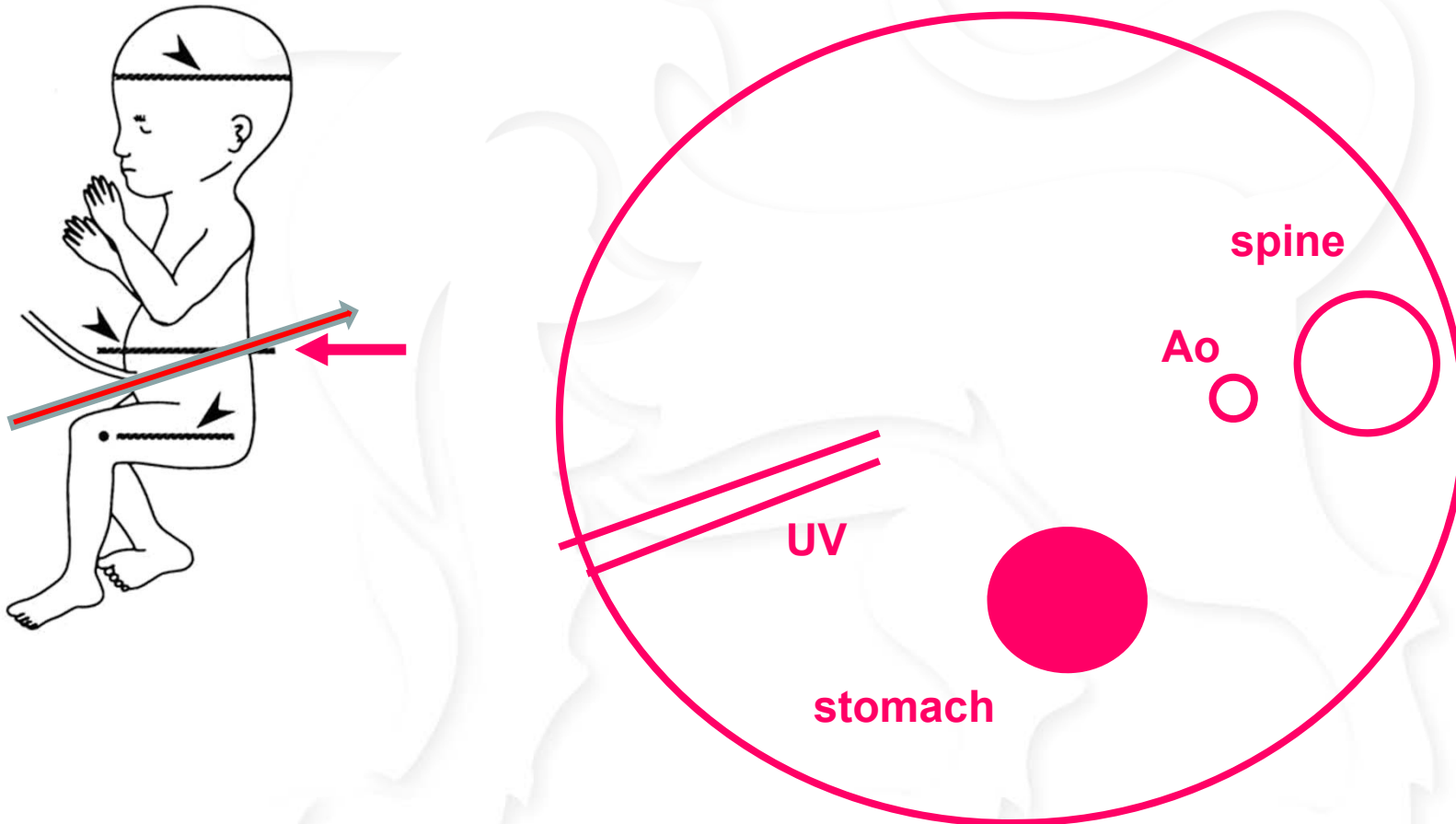
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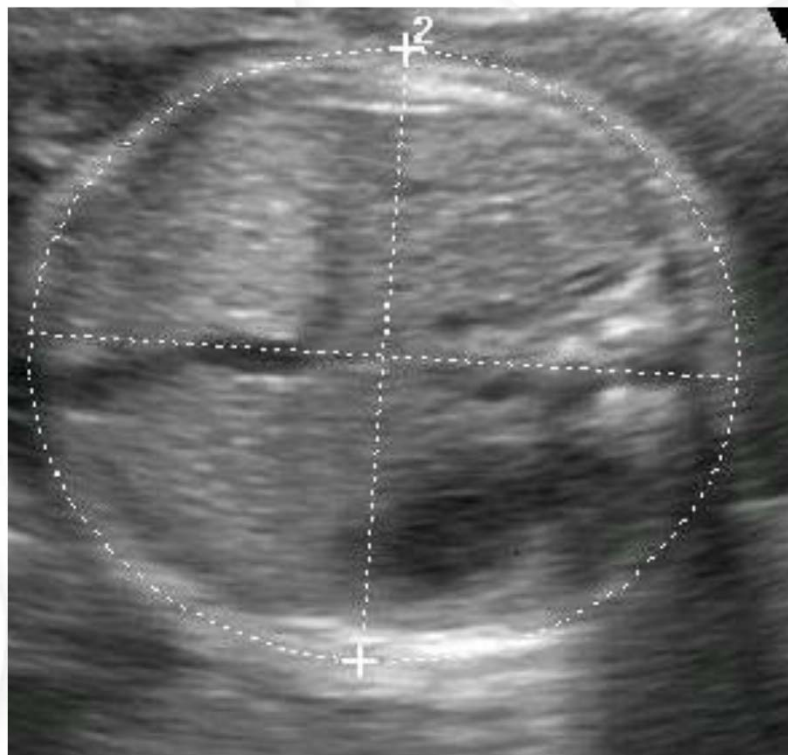


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Pitfalls: Abdominal Circumference



Pitfalls to beware.....



Femur Length

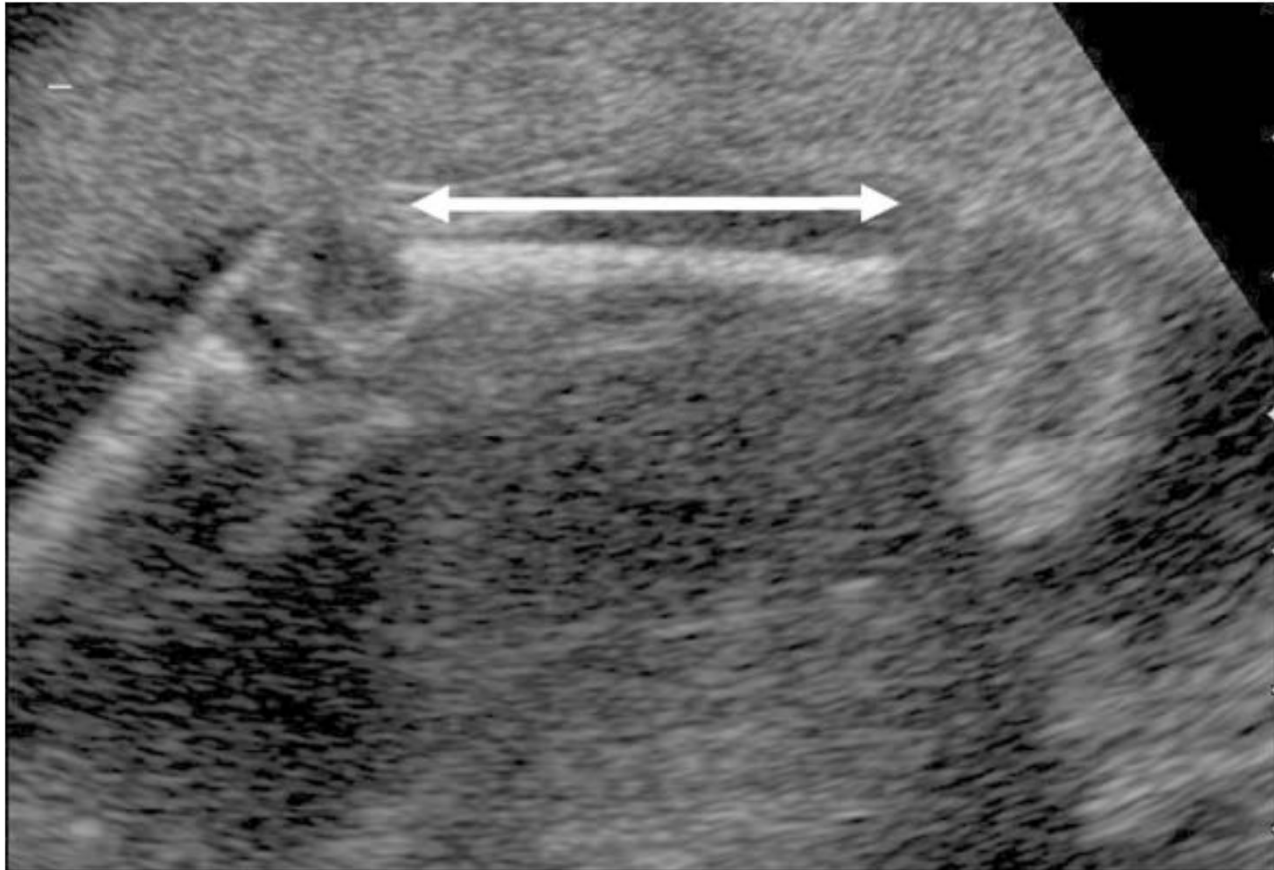
- The femur should be imaged lying as close as possible to the horizontal plane, angle of insonation of the ultrasound beam is 90°
- Care should be taken to ensure that the full length of the bone is visualised and the view is not obscured by shadowing from adjacent bony parts.
- Provided a technically good image is obtained, a single measurement is adequate

Loughna et al 2009



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Femur Length



Loughna et al 2009



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Femur Length FL

Variations of the breech presentation



Complete
breech



Incomplete
breech



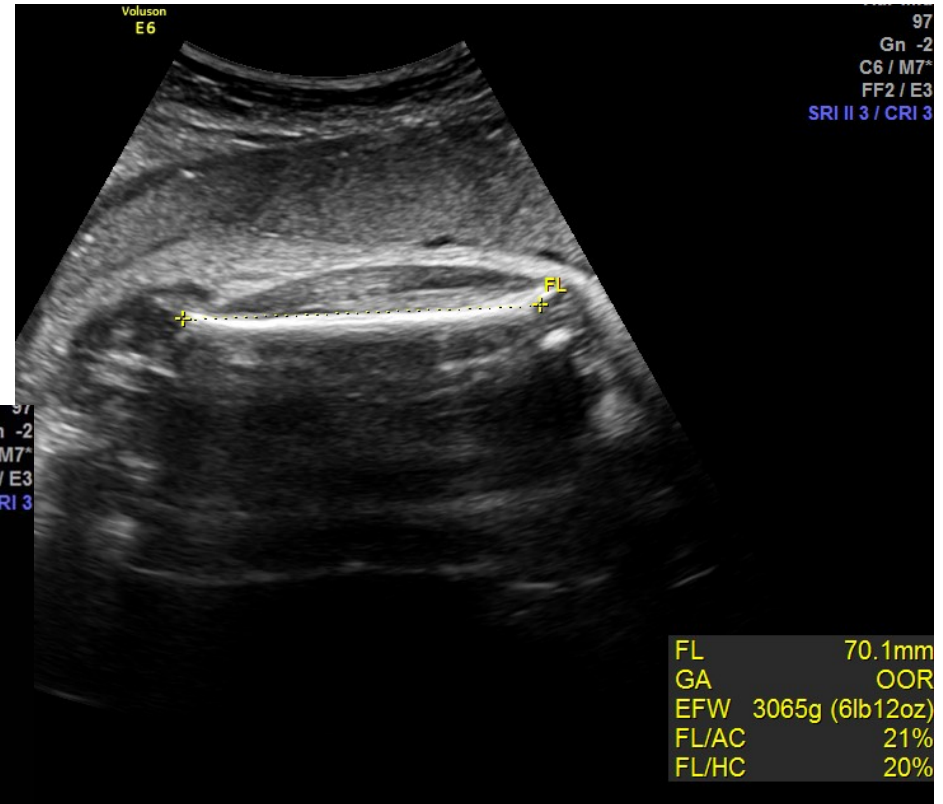
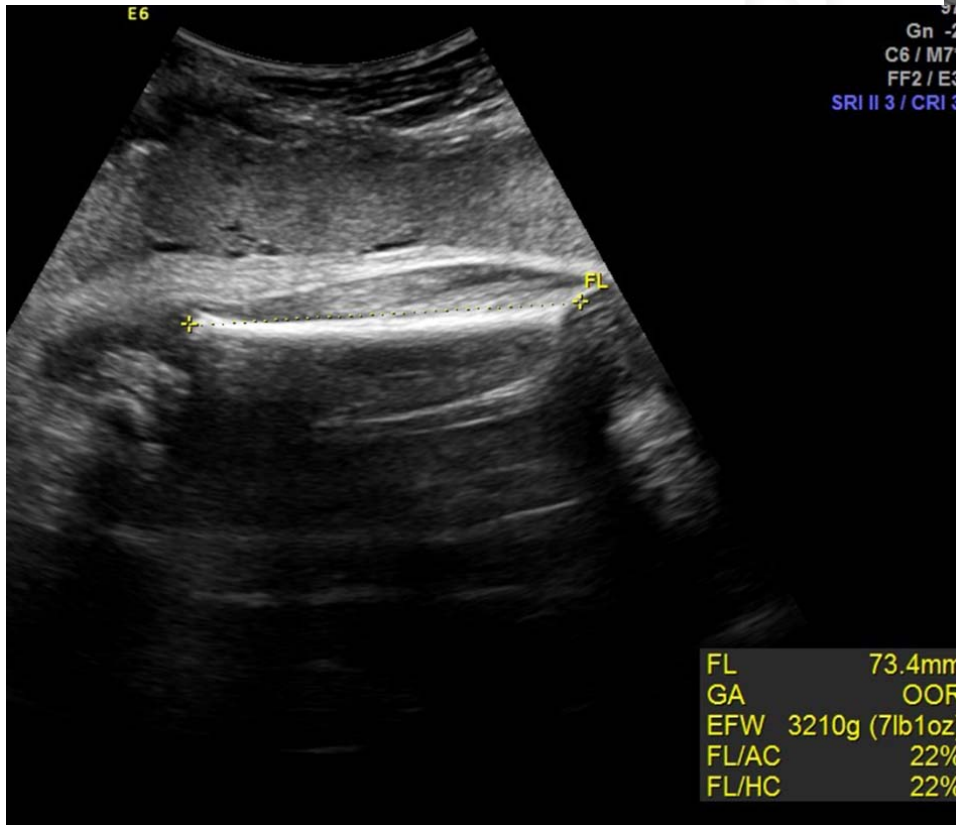
Frank
breech

ADAM.



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Automated Measurements





FL 66.2mm
GA 34w5d

Par-110
97
Gn -2
C6 / M7*
FF2 / E3
SRI II 3 / CRI 3

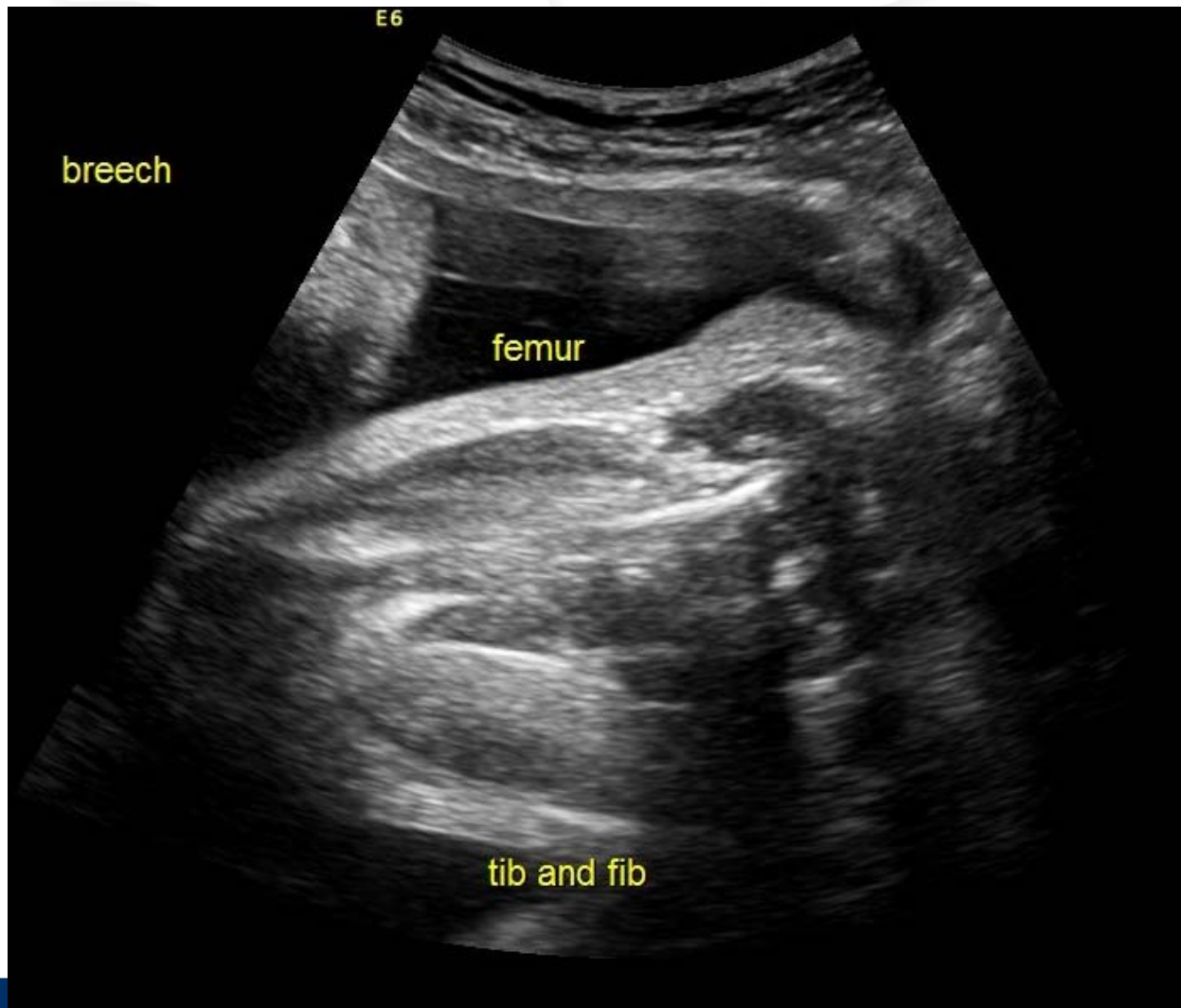
automatic measurement vol E6



FL 62.5mm
GA 32w6d

AM
sity

Pitfalls



Measurements used to provide EFW

“The quality of ultrasound measurements must be measured, improved and maintained in all centres for their full potential to be achieved and recognised”

Dudley and Chapman 2002



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AUDIT



**YOUR
ULTRASOUND DEPARTMENT
NEEDS**

YOU

*“The time has come for everyone in the
NHS to take clinical audit very
seriously.”*

Nice 2002



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Society of Radiographers

Section 4: Practice guidelines

4.1 Clinical Effectiveness:

- Taking part in personal, departmental and **wider audit programmes** to evaluate clinical practice and service to patients/patients including the reporting of ultrasound examinations

4.2 Acquisition, Archiving And Use Of Ultrasound Data

Image Recording

- support for the written report
- a second opinion to be given on those parts of the examination that have been imaged
- **contribution to clinical governance through audit and quality control**
- a teaching tool
- evidence that the examination was carried out to a competent standard
- evidence that the local guidelines were followed

BMUS: Diagnostic Accuracy and Quality Control

- A mechanism of **audit/quality** control to ensure patients continue to receive the expected level of diagnostic accuracy should be in place, with regular checks on the service quality.
- It is important to validate the diagnostic accuracy of ultrasound in the Primary Care setting, and this is likely to require the involvement of hospital departments.
- An independent operator routinely working in isolation, **without the benefit of audit, feedback or the ability to discuss cases and technological advances with colleagues**, may not be able to sustain an adequate standard of good practice.



UKAS Guidelines

- **Clinical Effectiveness** Taking part in personal, departmental and wider **audit programmes** to evaluate clinical practice and service to patients/patients including the reporting of ultrasound examinations



The Code: Standards of conduct, performance and ethics for nurses and midwives 2008

- You must deliver care based on the best available evidence or best practice
- You must keep your knowledge and skills up to date throughout your working life
- You must take part in appropriate learning and practice activities that maintain and develop your competence and performance

NICE Principles for Best Practice in Clinical Audit 2002

- Clinical audit should be **compulsory** for all healthcare professionals providing clinical care and the requirement to participate in it should be included as part of the contract of employment.
- Clinical audit must be fully supported by trusts. They should ensure that healthcare professionals have access to the **necessary time, facilities, advice, and expertise** in order to conduct audit effectively.



*“Even for **experienced sonographers**, a standardization exercise before starting a study of fetal biometry can improve consistence of measurements”*

Sarris et al 2011

Dudley and Chapman 2002 suggest overconfidence by some experienced sonographers



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Audit Improves Quality?

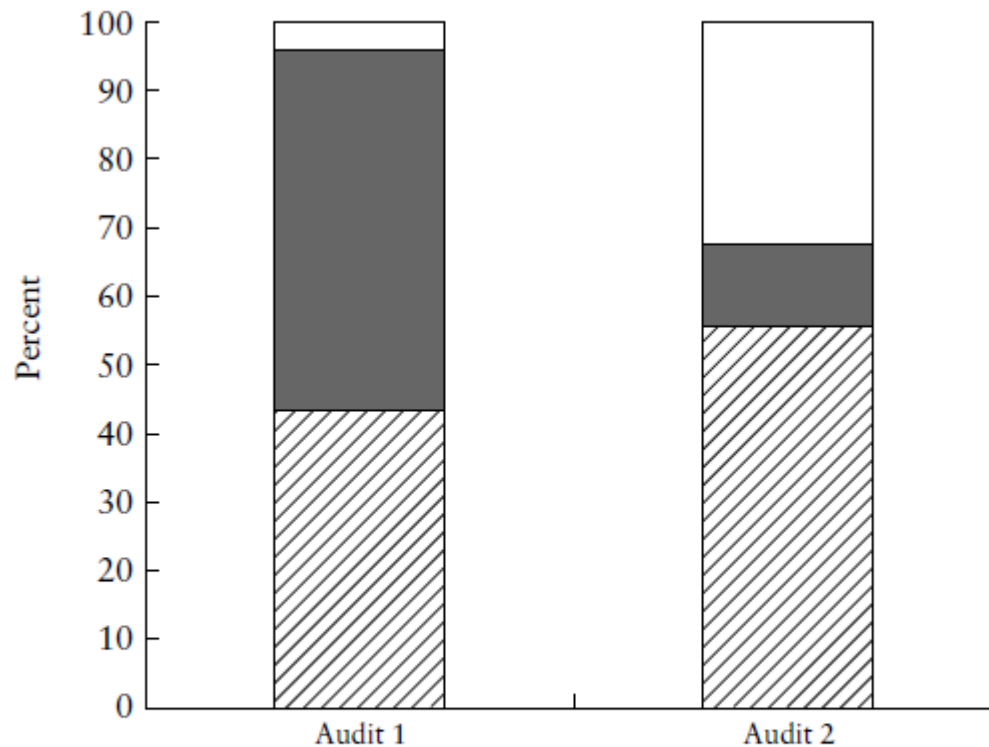


Figure 1 Results of initial and repeat audits of AC in hospital D following a discussion of their original results, quality criteria and means for improvement. □, Sonographer rejects; ■, technically unsatisfactory; ▨, meets quality criteria.

Other factors affecting image quality

- Fibroids, Scar tissue
- Reduced Liquor associated in the third trimester or oligohydramniotic
- Fetal position
- HC- fetal head low in maternal pelvis and increased acoustic shadowing due to increased mineralisation
- AC-Fetal breathing movements



The Independent Thursday 29th May 2014



Life > Health & Families > Health News

UK women are fattest in western Europe: 1 in 12 are clinically obese



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Obesity Rates in UK

- Worldwide, prevalence of overweight and obesity combined rose by **27.5%** for adults and **47.1%** for children between 1980 and 2013.
- 57.2 % women over 20 yrs in UK have BMI \geq 25
- 25.4 % women over 20 yrs in UK have BMI \geq 30

Global, regional, and national prevalence of overweight and obesity in children and adults during 1980—2013: a systematic analysis for the Global Burden of Disease Study 2013

Gakidou et al 2014



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Implications

“Mothers with a high body mass index are known to have an increased risk of perinatal mortality”

Gardosi J 2009

“Women in whom measurement of SFH is inaccurate e.g. BMI \geq 35 should be referred for serial assessment of fetal size using ultrasound”

RCOG Green-top Guideline No 31



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“Scanning obese pregnant women is difficult, and on some occasions it may become a real challenge”

Paladini D 2009

“Adipose tissue makes ultrasound imaging especially challenging”

Benacerraf B 2013



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Technical Issues with scanning obese patients

Reduced image quality due to

- Increased depth of insonation
- Absorption and dispersion of ultrasound energy

Not feasible to refer to tertiary centres due to high numbers

- **57.2 %** women over 20 yrs in UK have BMI \geq 25
- **25.4 %** women over 20 yrs in UK have BMI \geq 30



Obesity- High Risk Pregnancies

- Increased infertility leads to assisted reproduction techniques
- ❖ Greater no multiple pregnancies
- ❖ Increased miscarriage rate
- ❖ Increased maternal age
- Maternal obesity associated with increased risk of fetal anomalies
- Increased caesarean sections with associated scarring
- Hypertension
- Diabetes
- Thromboembolism
- Postpartum haemorrhage



*“Maternal **obesity**, smoking and **fetal growth restriction**, potentially modifiable risk factors, together account for the majority of normally formed stillbirths”*

Gardosi et al 2013



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Improving Image quality

- Need good quality contemporary ultrasound machines
- Manufacturers have reduced the mean array emission frequency to warrant better penetration
- Sonographer need to use all possible pre and post processing filters to increase the signal-to-background noise ratio
 - Harmonic imaging
 - Compound imaging
 - Spatial compounding
 - Speckle reduction filters



Safety of Ultrasound

- Operators advised re ALARA principle
- Dwell time over particular area kept to limit

“Evidence that operator knowledge about safety may not be accurate”

Bricker et al 2009



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Ultrasound Tips?

- Fill maternal bladder to push fetus higher up abdomen
- Use umbilicus as acoustic window
- Periumbilical area
- Suprapubic area
- Roll patient into decubitus position and scan from flank or groin

- Sit Pt up and scan above panniculus
- Transvaginal scan with external manipulation of fetus



Risks to sonographers

- The higher the degree of obesity the greater the pressure applied to reduce the insonation depth to obtain an acceptable image
- As a **direct** result of scanning obese obstetric patients...
“an increase in orthopaedic illness is therefore predictable in..... the near to mid term future”

Paladini D 2009



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Financial Implications

- Good quality ultrasound machines
- More time required to scan difficult cases
- Fewer examinations
- Higher costs- staffing rates

“There is an urgent need for increased resources and staffing to deliver a third trimester ultrasound service which is able to improve the detection of FGR babies.”

Reducing Perinatal Mortality Project
Birmingham Fetal Growth Audit 2009



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Limiting Liability

- Educate and Inform locally and nationally
- Sensitively inform patients and partners the direct relationship between maternal BMI , poorer image quality and increased risk of missing fetal abnormalities
- Produce an information leaflet with detailed information that obesity, scars from previous c sections, multiple pregnancy and fibroids all impair image quality
- Include in report BMI of patient (at booking)



Accuracy of Ultrasound

- *“Ultrasound fetal weight estimation is currently the most accurate method available in clinical practice for the obese and non-obese pregnant women.*
- *Despite this, errors in weight estimation of $\pm 20\%$ are possible and must be borne in mind when decisions regarding obstetric management are formulated”*

Farrell et al 2002



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BMFMS Fetal Medicine Posters

Accuracy of ultrasound estimation of fetal weight at term

Abstract PFM.24 Table 1

Accuracy of ultrasound scan at preterm vs term gestational age

| Proportion of error within | +/-10% | +/-15% | +/-20% |
|----------------------------|--------|--------|--------|
| Gestational age at scan | | | |
| <37 weeks | 69.6% | 85.6% | 91.9% |
| 37+ weeks | 72.8% | 89.6% | 95.9% |



West Midlands Regional Ultrasound Workforce Report 2013

- Shortage of sonographers
- Aging workforce
- Increasing demands
- 7 day working
- Affecting training of future staff
- Increased birth-rate



Young Population and Increasing Birth-rate

| Demographics | West Midlands Region | | England | | Period |
|-------------------------------------|----------------------|---|------------|---|---------|
| Population and Age | | | | | |
| Total population | 5,455,200 | | 52,234,000 | | 2010 |
| Average age (all residents) | 39.9 | ▼ | 39.5 | ▼ | 2010 |
| % aged 0 -15 | 18.7 | ▲ | 19.3 | ▼ | 2010 |
| % aged 16-17 | 2.4 | • | 2.6 | ▲ | 2010 |
| % aged 18-24 | 9.5 | ▲ | 9.6 | ▲ | 2010 |
| % aged 25-29 | 6.9 | ▲ | 6.5 | ▲ | 2010 |
| % aged 30-44 | 20.6 | ▼ | 19.5 | ▲ | 2010 |
| % aged 45-64 | 25.3 | ▼ | 25.4 | ▼ | 2010 |
| % aged 65+ | 16.5 | ▼ | 17.2 | ▼ | 2010 |
| % aged 16 -64 (working age) | 64.8 | ▲ | 63.5 | ▲ | 2010 |
| Birth rates | | | | | |
| Number of births | 72,090 | | 687,007 | | 2010 |
| Birth rate increase over five years | 6% | ▲ | 8% | ▲ | 2005-10 |
| Fertility rate* (15-44) | 67.5 | • | 65.5 | ▲ | 2010 |



SGA fetus should be examined closely

- Structural abnormalities may not develop until later pregnancy
 - Craniospinal abnormalities
 - Intestinal obstruction/atresia
 - Urinary tract abnormalities
 - Skeletal abnormalities
- Chromosomal abnormalities

“The recognition of IUGR in late pregnancy must always trigger a re-evaluation of the apparent normality of the foetus” Bricker et al 2009



Why don't we scan all babies?

Sensitivity

- The ability to identify those subjects who **have** the disease
- High sensitivity means that the test 'catches' as many people with the condition as possible.
- It is measured as the proportion of those with the condition, who have a positive test result.

Specificity

- The ability to identify those subjects who **do not have** the disease
- High specificity means the test has as few false positives as possible



RCOG Green Top Guideline No 31

US to assess growth Low risk population

- Sensitivity varies from 0-10%
- Specificity 66-99%

US to assess growth High risk population

Fetal AC < 10th Centile

- Sensitivity ranging 72.9 - 94.5%
- Specificity 50.6-83.6%

EFW < 10th Centile

- Sensitivity ranging 33.3 – 89.2%
- Specificity 52.7 – 90.7%



How can we improve Accuracy of Ultrasound

- Audit US to confirm best practise:
 - ❖ Standardisation of measurements
 - ❖ Quality of sections used for measurements
 - ❖ Accuracy of ultrasound in EFW
- Quality of Equipment
 - ❖ Use all pre and post processing facilities
 - ❖ Application specialist



Summary

- Rationale
- Scanning protocol, HC, AC, FL
- Accuracy of measurements
- Audit
- Factors affecting quality of ultrasound
- Implications for workforce



Conclusion

“With well designed modern equipment, standardised methods and well trained, experienced and conscientious sonographers, it may be possible to eliminate systematic error and reduce random errors to less than 5%.....for EFW”

Dudley 2013



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