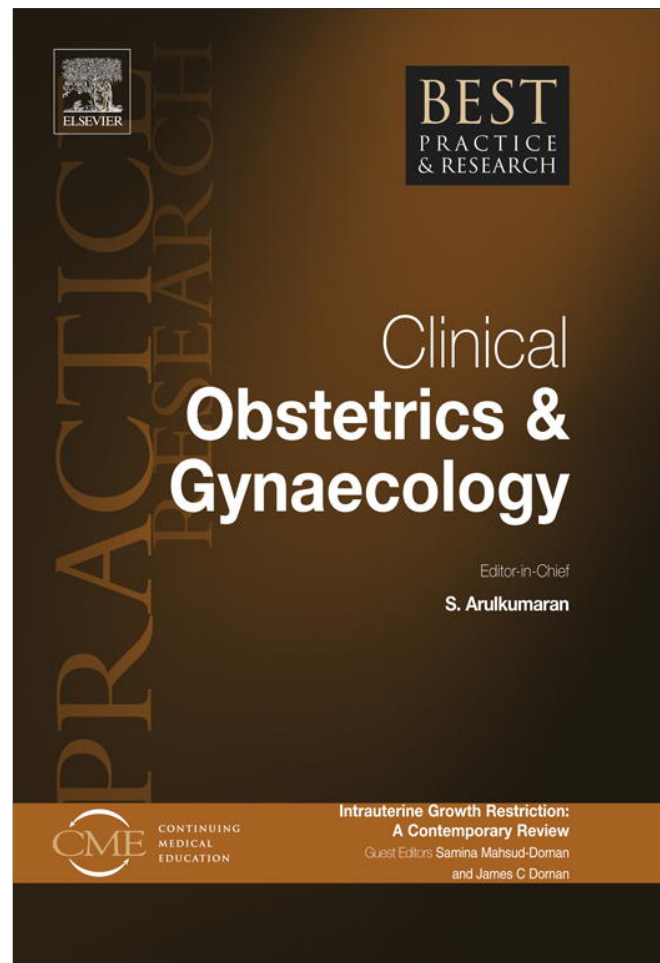


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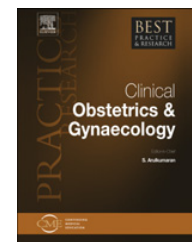
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Fetal growth screening by fundal height measurement

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Fundal height assessment is an inexpensive method for screening for fetal growth restriction. It has had mixed results in the literature, which is likely to be because of a wide variety of methods used. A standardised protocol of measurement by tape and plotting on customised charts is presented, which in routine practice has shown to be able to significantly increase detection rates, while reducing unnecessary referral for further investigation. Fundal height measurement needs to be part of a comprehensive protocol and care pathway, which includes serial assessment, referral for ultrasound biometry and additional investigation by Doppler as required.

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The urgency for improving antenatal detection of the small-for-gestation (SGA) or intrauterine growth-restricted (IUGR) baby increases with the awareness that fetal growth restriction is a common precursor of adverse outcome. While we have yet to establish reliable tests to *predict* which pregnancies are at risk of developing IUGR, surveillance of fetal growth in the third trimester of pregnancy continues to be the mainstay for the assessment of fetal well-being. Such surveillance is done by regular fundal height assessment, ultrasound biometry or a combination of both methods.

Where ultrasound is not available, fundal height measurement can be used as a proxy for estimating the gestational age of the pregnancy¹, or the weight of the fetus.² More commonly, it is used for fetal growth screening. Where scans *are* available, ultrasound biometry is used when fundal height is below expectation. Serial assessment of growth by ultrasound in *all* pregnancies is not feasible, even in

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developed countries. The cost-effectiveness of such a protocol has not been tested, nor whether this level of investigation would even be considered desirable by mothers.

If the scan findings confirm that the fetus is SGA, then further investigations by umbilical artery Doppler are recommended.³ In the presence of fetal growth restriction and/or maternal hypertension, the use of Doppler flow velocimetry has been shown to reduce mortality and morbidity, while for pregnancies without such complications, Doppler has not been found to be a useful investigation.⁴ The challenge therefore is to identify those pregnancies which require further investigation, for clinicians to be able to advise the mother with the best available information on whether it is safe to continue the pregnancy or to opt for a well-timed intervention to deliver the baby in the best possible condition.

In this article, we review the evidence for fundal height as an antenatal screening tool, and describe a model by which its role can be optimised, as a key part of a cohesive fetal-growth-screening programme.

Evidence for fundal height measurement

The evidence on fundal height assessment is mixed, with some studies reporting that it is a good predictor for IUGR^{5–8}, while others failing to find much benefit.^{9–13} The literature is characterised by a heterogeneity of approaches, the outcomes used, the methods for assessment and the measurement and recording techniques applied.

- Most studies had detection of small babies as the endpoint, but with variable definitions, from -2 SD^{7,14} or -1 SD¹⁵, to 10th^{10,11,16–18} or 5th¹⁹ weight-for-gestational age centile. Clearly, the implication of a positive test depends on the cut-off limit used.
- The method of assessment of symphysis-fundal height (SFH) is also not standardised. It includes palpation to estimate the size of the uterus against some basic anatomical landmarks, or measurement by callipers or by centimetre tape.^{13,20} The measurement is done in the midline, or following the longitudinal axis of the uterus, with or without correction of the upper pole to the midline.⁵
- Frequency and timing of the measurements varied from one or two, at different gestational ages, to serial assessment. This also leads to a range of indications for referral, including a measure below a lower limit, or slow or static growth.
- Often the measurement is not plotted, but recorded as a number against the gestational age as the standard, on the (erroneous) assumption that 1 week gestation should be equivalent to a 1-cm increment in the symphysis-fundus height (SFH). SFH ± 2 cm or ± 3 cm of gestational age in weeks are taken as the limit of normal range.^{5,14,15}
- Different charts have been produced from a number of local populations,^{5,15,18,19,21} and it is evident that there is considerable variation in the standard they represent.^{16,22,23} Many fundal height charts show growth until about 36–38 weeks, after which the curve flattens. However, such charts are often based on menstrual dates, which can cause artificial flattening of the growth curve at term, as illustrated by birthweight charts such as those widely used in the US.²⁴ Menstrual dating error tends to overestimate the length of gestation, resulting in term weights being spread across a wider gestational age range. By contrast, routine ultrasound-dated birthweight charts demonstrate no such flattening at term.²⁵

In her comprehensive review of fundal height studies, McDermott²⁶ estimated the average sensitivity for detecting IUGR to be 65%, with a 50% false-positive rate. However, detection rates ranged widely between studies from 17%¹ to 93%.¹⁶ This was likely due to the various methodologies applied, and different definitions of the endpoint, that is, the level of SGA or IUGR to be detected. It is also possible that the detection rates presented an overtly optimistic picture, being mostly from small studies on selected populations carried out by motivated researchers. Audits in unselected maternity populations of the antenatal identification of SGA babies (<10 th centile birthweight) using conventional protocols suggest much lower detection rates of the order of 25%.²⁷ In pregnancies designated 'low risk', current protocols result in even lower detection rates of about 15%^{28,29}, presumably because of a reduced level of suspicion.

Table 1**Recommendations for fundal height measurement**

- Non-elastic tape measure, standardised technique performed by trained midwife/doctor
- Measurement/plotting on customised chart from 26–28 weeks
- Follow up measurements: every 2–3 weeks, preferably by same person

Referrals for further investigation

(ultrasound biometry, amniotic fluid assessment, +/- Doppler flow)

- If first fundal height measurement plots below 10th centile line on the customised chart
- If, based on consecutive measurements, growth is static (flat), or there is concern above it being slow because it does not follow the slope of the curves on the chart
- If, based on consecutive measurements, there is concern about excessive growth because of the steepness of the curve.
- A first measurement above the 90th centile line does not need referral for scan for? LGA, unless there are other clinical concerns – e.g. polyhydramnios.

Follow up: if ultrasound assessment is

- Normal: revert to serial fundal height measurement
- Abnormal: refer for urgent obstetric review

For further information and examples, please see <http://www.pi.nhs.uk/growth/example.htm>.

Improving the tool

As with any investigation, there is a need to develop a systematic method based on the available evidence, to standardise the way it is applied, the way the measurement is recorded and the care pathway which is applied for further investigation and management. The basic principles of fundal height measurement are summarised in Table 1, and its clinical application can be set out as follows:

When to measure

Fundal height measurement should commence at 26–28 weeks, to monitor growth from soon after the fetus has reached viability. The UK National Institute of Clinical Excellence recommends measurement from 25 weeks for nulliparous women.³⁰ Examinations should be done at each antenatal visit to assess the wellbeing of the fetus alongside with that of the mother, that is, on average every 2–3 weeks. More frequent than fortnightly measurements are not recommended, as the increment in fetal growth is smaller than the measurement error.^{3,31}

Who to measure

Not all pregnancies are suitable for primary surveillance by fundal height measurement, and require ultrasound biometry instead. In most instances, these pregnancies fall into the following categories:

- A. Fundal height measurement unsuitable – for example, due to fibroids, high maternal body mass index
- B. Pregnancy considered high risk, requiring serial ultrasound – for example, due to previous history of SGA.

A third category could include pregnancies with positive screening tests, such as first-trimester serum markers or second-trimester uterine artery Doppler, when in established practice.

Table 2 lists the more common clinical conditions currently considered to be an indication for serial ultrasound. Increased risk based on past history usually ranges from odds ratio (OR) 1.5–2.³² The table gives the estimated prevalence of these conditions in our population. Smoking is also a strong and dose dependent factor on birthweight.²⁵ However because of its high prevalence, many clinicians are reluctant to include it as an indication for serial scans in the absence of other risk factors.

Table 2

Indications for serial ultrasound biometry.

	Approx prevalence of condition, %
A. Fundal height measurement is not possible/unreliable:	
Polyhydramnios (Idiopathic)	<1
High body mass index (BMI 35+) ^a	7
Large fibroids (e.g. >6 cm) or multiple fibroids	<1
B Increased risk of fetal growth restriction	
Multiple pregnancy	2
Previous history ^a of IUGR (birthweight <10th customised centile)	9
Unexplained stillbirth (excl congenital anomaly) 3.5/1000	<1
Hypertension/past history of PET ^b	3
Antiphospholipid syndrome, Lupus	<1
Thrombophylia	<1
Auto-immune disease	<1
Renal conditions	<1
Diabetes (pre-existing)	3
Maternal age 40+ ^a	3
Alcohol, Drug misuse	2

^a Approx cut-offs, to be used together with clinical assessment.

^b overall prevalence estimated (based on multipara only).

Because of overlap between categories, it is estimated that 20–25% of our maternity population have one or more indications for third-trimester surveillance by ultrasound. This means that fundal height measurement can be the primary method of surveillance of fetal growth in 75% of mothers in an unselected population.

The frequency of assessment of fetal growth by ultrasound should be 2–3 weekly, the same as the assessment by fundal height, as there is no evidence that the projected benefit of a scan is any longer than that of fundal height assessment.³

How to measure

Fundal height measurements should be undertaken using a non-elastic centimetre tape and a standardised technique to reduce the degree of error. The expectant mother should be in a semi-recumbent position on a firm surface, with an empty bladder (Fig. 1).

Contrary to the common reference to 'symphysio-fundal height', the measurement should start from the variable point, the fundus, while both hands are available for palpation. From there, the tape is run along the longitudinal axis of the uterus to the top of the symphysis – a fixed point, and the more easily identified landmark. The tape measure should be reversed to avoid the centimetre scale influencing the examiner. Preferably, the measurements should be undertaken by the same practitioner to aid continuity. Restricting assessments to one or two carers improves the accuracy significantly.³³

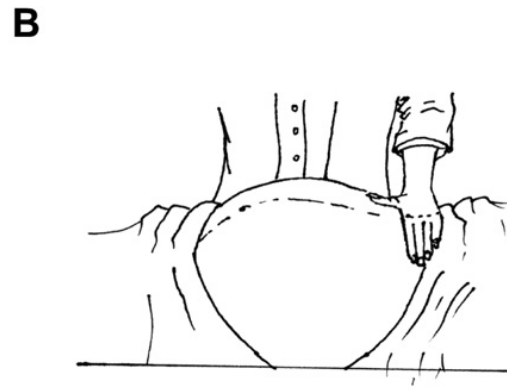
Where to record

There are several reasons for plotting in addition to recording fundal height as a number: first, the '1-week gestation = 1 cm fundal height' rule does not represent a reliable correlation and does not apply across the maternity population (see below). Second, the strength of fundal height assessment lies in the slope, the increment over multiple measurements over time, which requires graphical representation.

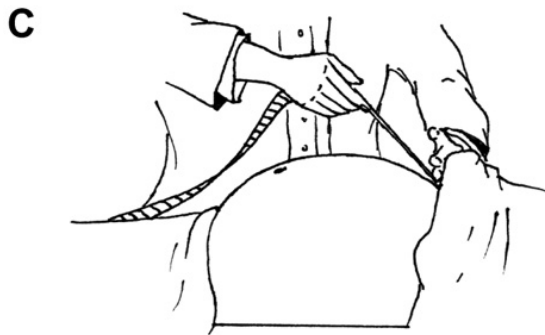
The choice of the chart for plotting is important. As is the case with birthweight, fundal height varies with constitutional variables such as maternal weight and parity.³⁴ This is likely to be a major reason why the values on fundal height charts vary – being derived not only by different methods, but also from populations with different maternal characteristics. However, there is also substantial variation *within* each of these populations, which need to be adjusted for when defining the standard. Customised charts³⁵ are able to adjust the normal curve according to maternal height, weight, parity and ethnic group, along with the variation which has been demonstrated for birthweight.^{36–38}



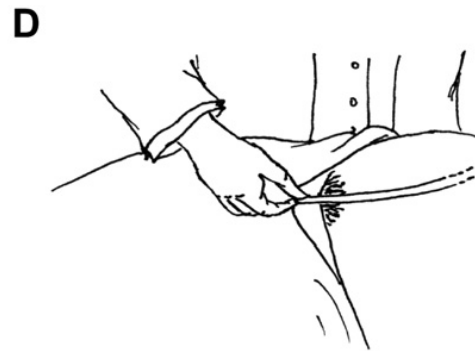
Mother semi-recumbent, with bladder empty.



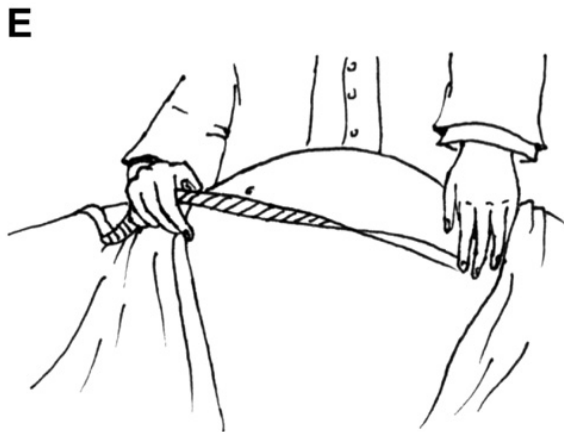
Palpate to determine fundus with two hands.



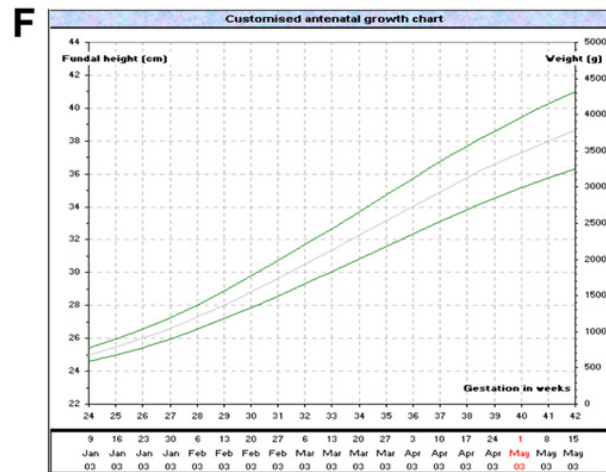
Secure tape with hand at top of fundus.



Measure to top of symphysis pubis.



Measure along longitudinal axis of uterus,



Plot on customised chart, record in notes.

Fig. 1. Method of fundal height measurement.

In addition to weight, the charts have an additional axis for fundal height, based on formulae of the association between fundal height and estimated fetal weight, which are well correlated ($r = 0.85$).² Thus, fundal height and estimated fetal weight (EFW) can be plotted together on the same chart. This method also avoids the need for separate plots of individual biometric variables, such as head and abdominal circumference and femur length, which have little additional benefit³¹ and which, unlike EFW, have no customised limits. The three lines on the chart are the 90th, 50th and 10th centile limits,

representing not only the normal range of measurement but also the range of normal slopes/velocities of fundal height or fetal weight gain.

What next: referral and care pathways

The first fundal height plot represents the initial assessment as well as the baseline for subsequent measurements, which are interpreted on the basis of the slope or velocity of growth. Indications for referral for further investigation are represented in Fig. 2, and include cases where

Fig. 2A: the first fundal height measurement is below the 10th centile

Fig. 2B: consecutive measurements suggest static growth

Fig. 2C: consecutive measurements suggest slow growth

Fig. 2D: consecutive measurements suggest excessive growth

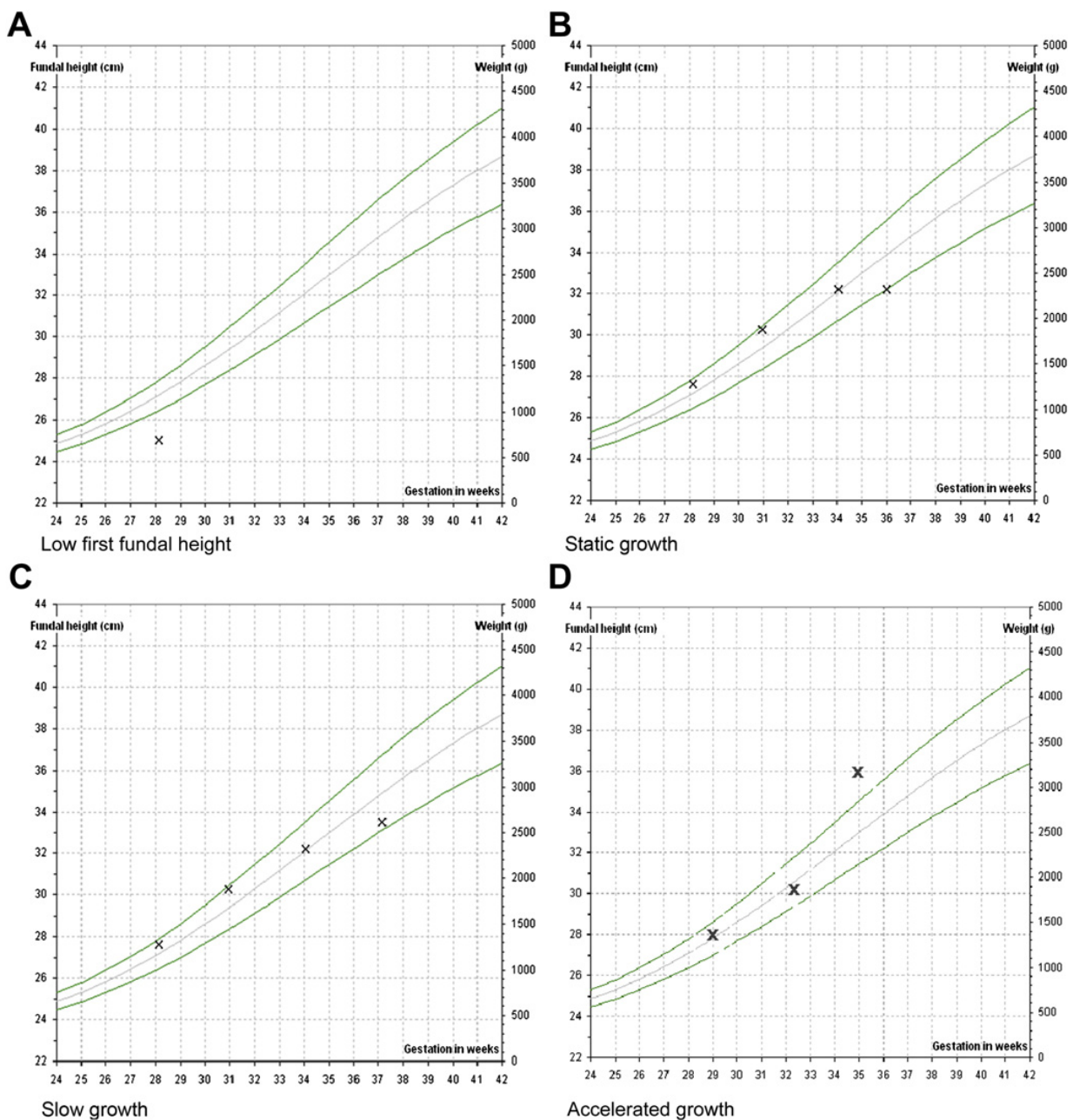


Fig. 2. Examples of abnormal growth.

If the first plot is *above* the 90th centile, referral is not indicated unless there are clinical concerns, for example polyhydramnios, or unless subsequent measurements do not follow the slope of the curve.

If fundal height measurement suggests growth restriction, the recommended follow- up investigations are ultrasound biometry for calculating and plotting estimated fetal weight and assessment of amniotic fluid volume. If IUGR is suspected, the next step of the investigation is Doppler flow and referral for obstetric review. If the ultrasound assessment indicates normal growth, surveillance can revert to serial measurements of fundal height. Figure 3 represent a flow chart for the recommended care pathway.

Evaluation in practice

Application of the above standardised method of fundal height measurement and plotting on customised charts has demonstrated a significant increase in detection rates of babies born SGA, when introduced into routine maternity service as part of a controlled study with over 600 pregnancies in each arm.³⁹ The endpoint was birthweight below the 10th customised percentile; thus, the same standard was applied for antenatal assessment and for defining adverse outcome. Despite the increased detection, there was no difference in clinical outcome. However, the study was not powered to investigate outcome, but the detection of the at-risk fetus (in this case, SGA).

Despite the increased detection rates, the study³⁹ also showed a reduction in referrals for further investigation, suggesting that midwives were more likely to be reassured by the plots of fundal height measurement staying within normal, customised limits on the growth charts.³⁹ This finding corresponds to the reduction of false-positive diagnoses of IUGR based on EFW growth curves plotted on customised charts.^{40,41} The dual findings of increased detection and reduced false-positive assessments have since been reproduced in a different setting.⁴²

Fundal height measurements plotted on customised growth charts are recommended by the RCOG Green Top Guidelines.³ The method has been introduced recently in the NHS, to date in over 100

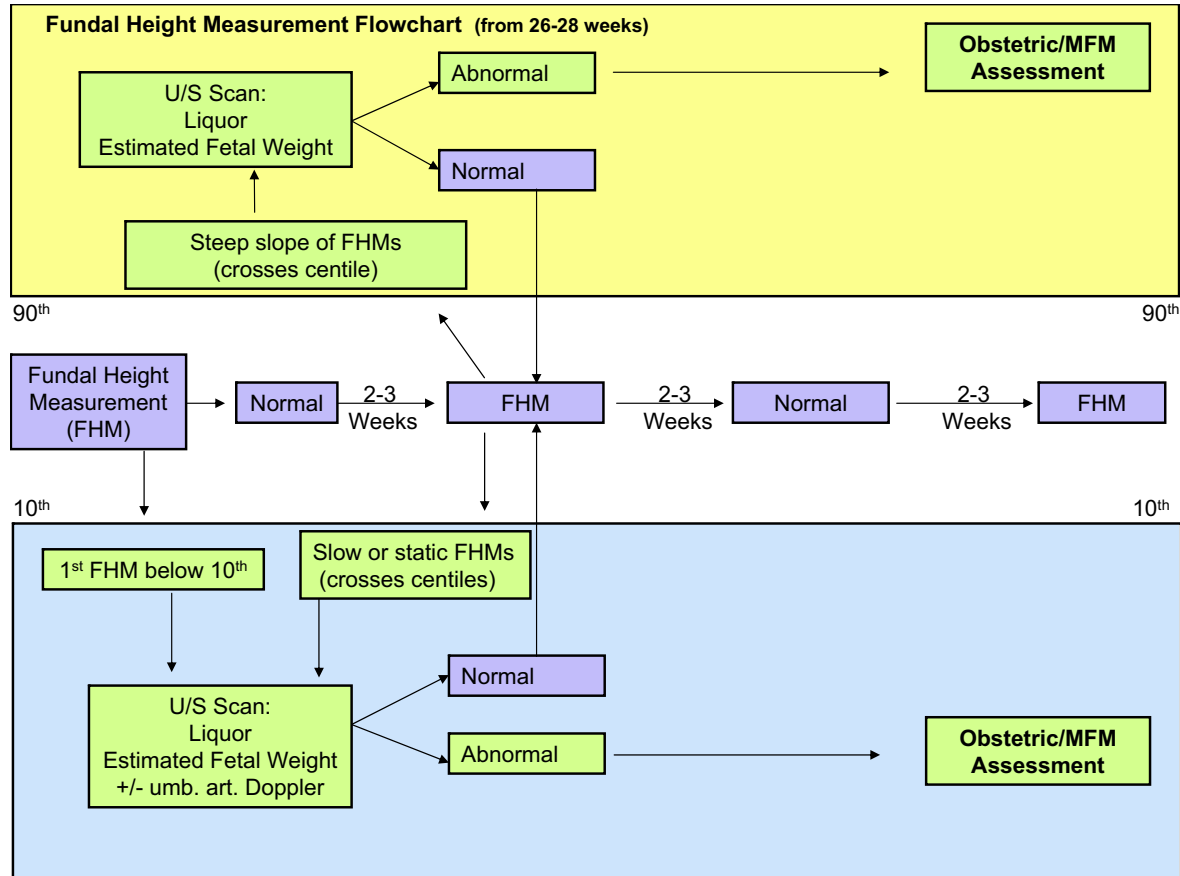


Fig. 3. Flow chart for fundal height measurement.

maternity units with a total annual delivery rate of 200 000, as well in centres in Australia and New Zealand. Implementation of fundal height assessment as a screening tool requires intensive training, which the Perinatal Institute delivers through multidisciplinary workshops leading to assessment and accreditation.

Integration of model for growth screening

To reach its full potential as a screening tool for intrauterine growth restriction, fundal height assessment needs to be established as part of a fully integrated system. It requires clearly defined methods and standards for measurement and plotting, and care pathways for further investigation and management. The test must complement ultrasound biometry for assessing mothers for whom fundal height is not suitable, or who have an elevated risk of fetal growth restriction, or in pregnancies which are already recognised as of increased risk because of suspected abnormal growth.

Thus, the overall performance of a growth-screening programme, in terms of the proportion of SGA babies who are detected antenatally, depends on adequate resources for third-trimester ultrasound which are not always available. In the West Midlands, a two-pronged approach is being adopted, with intensive fundal height training workshops and a parallel programme of community growth scanning service delivered by midwives trained in special, short ultrasound courses.

A vital component of the service is ongoing audit. Antenatal detection of fetal growth restriction has recently been accepted by health service commissioners as a key quality indicator in the West Midlands, and information about its performance is being audited through routine electronic data collection. This provides an ongoing focus on the importance of growth restriction, and has in turn already led to demonstrable local improvements in maternity services.

Practice points

- The literature on effectiveness of fetal growth screening with fundal height measurement is mainly due to a wide variety of methods used.
- Standardised training and protocols are required, as with any clinical investigation.
- Measurements need to be done serially, preferably by the same care provider to reduce inter-observer variation.
- Measurements should be plotted on customised charts.
- Clear care pathways are required for further investigation, including ultrasound biometry, which should be plotted as estimated fetal weight on the same chart.
- Antenatal detection rates and referral rates should be recorded as part of routine monitoring of the service.

Research point

- Large prospective studies are needed to quantify the clinical effect of fundal height measurement on hard outcome (perinatal mortality) in units with fully trained staff and well-established protocols and care pathways.

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