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Antenatal screening by measurement of symphysis-fundus height

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Abstract

A study was undertaken to assess the value of symphysis-fundus measurement as a screening procedure for intrauterine growth retardation. The reproducibility of this measurement was investigated in two groups of six patients, each measured six times by six different observers. The intraobserver coefficient of variation was 4.6% and the interobserver coefficient of variation 6.4%. There was no evidence that experience aided consistency. A chart of symphysis-fundus measurements derived from Cardiff data was found to be similar to others previously published, and one measurement below the 10th centile identified 64% of pregnancies in which the eventual birth weight was below the 10th centile for gestational age.

Symphysis-fundus measurement is a useful screening test; one chart could be used for any Caucasian population and should be incorporated into the maternity services "co-operation card."

Introduction

In 1953 Rumbolz and McGoogan¹ showed the association between reduced growth of the uterine fundus and intrauterine

growth retardation. Beazley and Underhill in 1970² showed wide patient variation in the height of the uterine fundus above the symphysis pubis (the symphysis-fundus height) and questioned the value of such measurements. The technique, although simple and inexpensive, has never been widely accepted, and uterine size continues to be recorded in various ways such as centimetres or "finger breadths" from the umbilicus or xiphisternum, or, simply, equivalent to x weeks.

In the last decade the difficulty of diagnosing intrauterine growth retardation on abdominal palpation has been recognised. Even experienced obstetricians detect fewer than 50% of cases,³⁻⁵ and the diagnostic value of current hospital antenatal care has been questioned.⁶ In an attempt to facilitate the diagnosis of intrauterine growth retardation several charts of the symphysis-fundus measurement have been made.⁷⁻¹⁰ Despite this the technique is still not popular, probably because of the lack of agreed principles (table I), the suggested need for an individual curve for each maternity unit,¹⁰ and the anticipated problem of observer variation.

To assess the magnitude of these problems we undertook the two-part study reported here. In the first part we assessed the reproducibility of symphysis-fundus measurements made by the same observer and by different observers, and in the second part

TABLE I—Different principles used in three charts of symphysis-fundus measurements

Reference	Derivation of chart	Abnormal result
Westin*	Mean birth weight $\pm$ 1 SD	One value > 2 cm below mean or three consecutive static or declining values
Belizan <i>et al</i> ⁹	Birth weight between 10th and 90th centiles	One value < 10th centile
Quaranta <i>et al</i> ¹⁰	Birth weight between 25th and 90th centiles	Two consecutive or three isolated values < 10th centile

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we present a chart derived from Cardiff data and compare it with some of those previously published.

Reproducibility

We studied 12 patients at different stages of gestation in two groups of six. The symphysis-fundus height of each patient was measured by six observers in rotation until each observer had measured each of the six patients six times. The two groups of observers encompassed all grades of hospital staff, from a consultant who had been using symphysis-fundus measurements routinely for over a year to a medical student in the first week of his obstetric course.

All measurements were taken along the longitudinal axis of the uterus with the patient supine, her legs straight and her bladder empty. The measurements were made by lightly marking the position of the uterine fundus, then holding a piece of non-elastic string taut against the abdomen with a knot against the upper border of the symphysis pubis. The string was cut at the mark on the patient's skin, and this mark was then erased before the next observer made his measurement. The strings were labelled and subsequently measured to the nearest millimetre. All the strings from each session were measured by the same individual. Each patient was weighed and her height measured. Skinfold thickness was measured, using John Bull calipers (British Indicators Ltd), just below the inferior angle of the scapula, and the recorded measurement was the mean of two measurements taken vertically and two taken horizontally by the same observer.

RESULTS

Figure 1 shows the results for three patients. In case 1 there was little variation between observers (interobserver variation) compared

FIG 1—Examples of interobserver and intraobserver variation in measurements in three patients. Horizontal lines are overall mean measurements; horizontal bars are means for each observer.

C=Consultant. SR=Senior registrar. R=Registrar. S=Senior house officer. M=Midwife. MS=Medical student.

FIG 2—Chart of symphysis-fundus height based on Cardiff data.

with the variation in measurements by the same observer (intraobserver variation), but case 2 shows how different observers could form different assessments of the same patient. Experience did not reduce intraobserver variation: in case 3 the untrained student was the most consistent.

The pooled standard deviations of the measurements obtained by the two observers of each grade in both experimental sessions were: consultant 1.23 cm, lecturer 1.34 cm, registrar 1.35 cm, senior house officer 1.13 cm, midwife 1.20 cm, and medical student 1.18; the overall standard deviation was 1.24 cm. These results were not significantly different (Bartlett test: $\chi^2=2.85$, $df=5$). The average measurement for the whole series was 27.05 cm, giving an intraobserver coefficient of variation of 4.6%. The pooled interobserver standard deviation was 1.72 cm, giving an interobserver coefficient of variation of 6.4%.

Comparison of interobserver and intraobserver standard deviations in the 12 subjects showed no correlation (Spearman rank correlation coefficient +0.224); similarly, there was no correlation between either interobserver or intraobserver standard deviation for each patient and her mean symphysis-fundus height, skinfold thickness, or weight corrected for height.

The normal curve

PATIENTS AND METHODS

The symphysis-fundus height was measured as part of the routine antenatal examinations of all patients under the care of one of us (JFP). The measurements were made as described above, except that the distance between the mark on the fundus and the upper border of the symphysis pubis was measured direct with a tape measure held taut on the patient's skin. After delivery birthweight centiles were calculated from tables.¹¹

RESULTS

Data were available from 381 pregnancies in non-diabetic mothers with sure dates, confirmed by clinical examination and often ultrasonography, within the first 16 weeks. Twenty-five patients delivered babies weighing on or below the 5th centile (6.6%) and 20 babies were between the 5th and 10th centiles (5.2%). Only 23 babies had a birth weight above the 90th centile.

Figure 2 shows the normal curve derived from 1775 observations on the 313 patients for whom the birth weight was between the 10th and 90th centiles. To avoid possible bias because a different subset of the pregnancies yielded data at each week of gestation, adjusted weekly

means were obtained using the multiple classification option in the analysis of variance program of the Statistical Package for the Social Sciences.¹² These values were then smoothed by the use of a three-week moving average. The standard deviations of measurements at each week of gestation varied between 1.72 cm and 3.61 cm with no consistent trend and were pooled to give the value of 2.42 cm used to calculate the centile norms, assuming a normal distribution.

COMPARISON WITH OTHER CHARTS

Table II compares examples from the Cardiff data with the charts of Westin,⁸ Belizan *et al.*,⁹ and Quaranta *et al.*¹⁰ The Cardiff chart and the charts of Westin and Belizan *et al.* were all derived from pregnancies in which the birth weights were distributed symmetrically about the mean, and their mean values were very similar. The chart of Quaranta *et al.* was derived from an asymmetrical population (table I) and had, as expected, slightly higher values. The Cardiff chart and the chart of Belizan *et al.* were the only two to be derived from pregnancies in which the birth weight was between the 10th and 90th centiles for gestation, and the centile lines for measurements at each week of gestation were also similar. The centile lines for the chart of Quaranta *et al.* were slightly higher, as expected, but suggested approximately the same scatter of measurements at each week of gestation, even though the chart was derived from pregnancies with a narrower range of birth weights.

DIAGNOSTIC VALUE

Because the charts of Belizan *et al.*, Quaranta *et al.*, and Westin were derived and used in different ways, direct comparisons of their results with ours would be meaningless. We therefore tested the ability of our chart to detect those pregnancies with varying degrees of growth retardation using a variety of previously suggested criteria.⁸⁻¹⁰ Table III shows the results.

Discussion

The intraobserver and interobserver coefficients of variation of 4.6% and 6.4% show that measurements of the symphysis-

fundus height are not precise. In practice neither end point is easy to identify, and fetal movements change the apparent fundal height. The Cardiff chart was derived only from pregnancies in which the birth weight was between the 10th and 90th centiles, to ensure that it reflected only normal pregnancies, and the differences between this chart and others derived in the same way were much less than the observer variation. This suggests that one chart could be used for any Caucasian population.

Perhaps more pertinent was the finding that, when measurements were made in a manner that avoided the effects of memory, anticipated result, or terminal digit preference, experience did not aid consistency. The implication of this is that the technique may be used by medical and paramedical staff without loss of accuracy, which would not only free senior medical staff to fulfill other functions but also be of particular value in underdeveloped societies. Similarly, neither the gestational age nor the patient's physique affected the accuracy of measurement.

The choice of the lower limit of normal values of symphysis-fundus height is arbitrary and allows the sensitivity of the test to be varied, depending on acceptable levels of false-positive results and the facilities for more detailed investigation of positive results. In our series one measurement of symphysis-fundus height below the 10th centile (3.1 cm below the mean) selected out 100 (26%) patients as having growth-retarded babies, and at delivery this group contained 29 (64%) of the babies weighing below the 10th centile, with a false-positive rate of 71%. We found no evidence that pregnancies with static or declining symphysis-fundus heights⁸ were likely to suffer intrauterine growth retardation, although they might be at risk in some other way.

We believe that measurement of the symphysis-fundus height provides a communicable way of expressing fundal height and an easy and inexpensive screening test for intrauterine growth retardation. As no special skill is necessary it may be used with equal accuracy by all who care for pregnant women. A chart of symphysis-fundus heights would be a useful addition to the standard "co-operation card" and would enhance communication between midwife, general practitioner, and hospital obstetrician.

TABLE II—Comparison of values obtained from chart of symphysis-fundus height based on Cardiff data with values obtained from three other charts

Gestational age (weeks)	Mean				10th centile			90th centile		
	Cardiff	Westin**	Belizan <i>et al.</i> ⁹	Quaranta <i>et al.</i> ^{10*}	Cardiff	Belizan <i>et al.</i> ⁹	Quaranta <i>et al.</i> ^{10*}	Cardiff	Belizan <i>et al.</i> ⁹	Quaranta <i>et al.</i> ^{10*}
16	12.8				9.7			15.9		
20	18.8	18.0	18.5	20.2	15.7	16.0	16.7	21.9	23.0	23.8
24	22.9	22.0	22.5	24.1	19.8	20.0	21.0	26.0	25.3	27.4
28	26.8	26.0	26.5	28.1	23.7	23.5	25.1	29.9	29.3	31.2
32	30.2	29.6	30.5	31.8	27.1	27.3	28.7	33.3	33.3	34.8
36	33.7	33.0	33.5	34.7	30.6	30.5	31.6	36.8	36.8	38.0
40	36.2	35.5	34.5	36.3	33.1	32.0	33.6	39.3	38.5	39.7

*From published graph.

TABLE III—Results obtained from Cardiff chart when different criteria indicating growth retardation were applied

Criteria used to indicate growth retardation	Results				Predictive performance			
	Birth weight	No predicted as:			Birth weight	Sensitivity*	Specificity†	False-positive rate
		Retarded	Not retarded					
One value > 2 cm below mean, or three consecutive static or declining values (Westin ⁸)	< 5th centile (n = 25)	18	7		< 5th centile	72%	58%	89%
	5th–10th centile (n = 20)	16	4		< 10th centile	76%	60%	80%
	> 10th centile (n = 336)	133	203					
	All patients	167 (44%)	214 (56%)					
One value < 10th centile (Belizan <i>et al.</i> ⁹)	< 5th centile	15	10		< 5th centile	60%	76%	85%
	5th–10th centile	14	6		< 10th centile	64%	79%	71%
	> 10th centile	71	265					
	All patients	100 (26%)	281 (74%)					
Two consecutive or three isolated values < 10th centile (Quaranta <i>et al.</i> ¹⁰)	< 5th centile	9	16		< 5th centile	36%	92%	76%
	5th–10th centile	7	13		< 10th centile	36%	94%	57%
	> 10th centile	21	315					
	All patients	37 (10%)	344 (90%)					

*Sensitivity = Proportion of low birthweight babies predicted as being retarded.

†Specificity = Proportion of appropriately grown (or large) babies predicted as being not retarded.

Supplies of the Cardiff symphysis-fundus chart may be obtained from Titan Press Ltd, Wroughton Place, Fairwater, Cardiff (tel: 0222-569321).

Requests for reprints should be sent to Dr J P Calvert, lecturer in obstetrics and gynaecology, Welsh National School of Medicine, Heath Park, Cardiff CF4 4XN.

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SHORT REPORTS

Terbutaline aerosol given through pear spacer in acute severe asthma

Pressurised aerosols are an ineffective way of giving bronchodilators in acute severe asthma. Less than 10% of a correctly administered dose from a standard pressurised aerosol reaches the bronchial tree,¹ and this may be reduced in acute severe asthma. Even under normal circumstances not more than 75% of patients are able to use pressurised aerosols efficiently.² Those who are unable to co-ordinate aerosol actuation with inhalation obtain benefit from the addition of an extension tube or spacer to the mouthpiece of the aerosol.³ The pear spacer (Nebuhaler) is a plastic tube (750 ml volume) with a one-way valve that obviates the need for co-ordination. It is designed to contain the shape of the aerosol cloud when it leaves the actuator and increase the availability of the drug for inhalation. Newman *et al*⁴ showed that the deposition of radio aerosol in the whole lung is improved from 7.8% to 11.5% with a tube spacer and to 13% with a pear spacer.⁴

We used a pear spacer to deliver an aerosol bronchodilator (terbutaline) to patients with acute severe asthma and compared it with an electric nebuliser.

Patients, methods, and results

We studied 18 patients (11 women, seven men; age 15-67 years). All gave informed consent and satisfied the following: pulse rate 110/min or greater; forced expiratory volume in one second 25% predicted or less; arterial oxygen pressure 9.3 kPa (70 mm Hg) or less; and forced expiratory volume in one second and forced vital capacity (best of three) measured on admission and 10 minutes later not varying by more than 10%. Patients who had received treatment with a bronchodilator within the previous two hours were excluded. Intravenous hydrocortisone 200 mg was given at the start of the study and oxygen administered throughout.

Patients were randomly allocated into two groups: one group received terbutaline 4 mg via an electric nebuliser (RTU 4; Medic Aid Ltd) followed after 30 and 60 minutes by two doses of terbutaline 2 mg (eight puffs) via a Nebuhaler; the second group received terbutaline 4 mg (16 puffs) via a Nebuhaler followed by two doses of 2 mg via a nebuliser 30 and 60 minutes later.

Forced expiratory volume in one second, forced vital capacity (Vitalograph dry spirometer), pulse, and blood pressure were measured on admission and 10 minutes later immediately before the first administration. Forced expiratory volume in one second, forced vital capacity, and pulse were recorded immediately after each administration and at 10-minute intervals until a plateau was reached. The blood pressure was recorded after 30 minutes and at the end of the study. The figure shows the mean baseline values after each administration of terbutaline.

The data were subjected to analysis of variance. Each treatment produced a significant rise in forced expiratory volume in one second and forced vital capacity ($p < 0.01$), but there was no significant difference between the two

modes of administration. Pulse rate and blood pressure tended to fall throughout the study, and no adverse side effects were noted despite a total of 8 mg inhaled terbutaline being given.

Mean baseline values and mean maximum values of heart rate, forced expiratory volume in one second (FEV₁), and forced vital capacity (FVC) after each administration of terbutaline.

Comment

In severe asthma a bronchodilator given by any route may produce a fall in arterial oxygen partial pressure. Oxygen should be given before, during, and after its administration, as it was in this study.

Nebulised terbutaline produces just as effective bronchodilation as the intravenous drug in acute severe asthma.⁵ In our patients terbutaline administered via a conventional pressurised aerosol with a Nebuhaler attached was as effective as wet nebulisation of the drug. The Nebuhaler requires no power supply and is smaller, less complicated, easier to assemble, and vastly less expensive than a nebuliser. We recommend its use in the treatment of acute severe asthma both in the home and in hospital.

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