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Clinical interpretation of ultrasound biometry for dating and for assessment of fetal growth using a wheel and chart: is it sufficiently accurate?

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ABSTRACT

Objectives *To investigate how accurately practicing obstetricians (experts) can apply dating rules and compare the interpretation of gestation-sensitive ultrasound data with those of a computer system.*

Subjects *Seventeen practicing obstetricians, Members of the Royal College of Obstetricians and Gynaecologists, from 14 different units throughout the UK.*

Design *Six cases with menstrual and ultrasound data together with identical ultrasound charts and obstetric wheels.*

Main outcome measures *Concordance between the calculated estimated date of delivery (EDD) and growth assessment provided by the experts and the computer system.*

Results *The calculation of the EDD by the experts was imprecise (59% within 3 days overall). Concordance with the computer calculation was poorest when the ultrasound measurements lay close to the upper or lower centile lines (average 7% within 3 days of the computer). Interpretation of growth showed good concordance with the computer when gestation was not critical to the interpretation (94%), but very poor when gestation was critical (7%).*

Conclusions *Calculation of EDD by means of an obstetric wheel and charts is not precise. Compared with the computer system, these errors have a significant effect on the subsequent interpretation of growth scans when the data are borderline. A computer system provides the more accurate method for interpreting gestation-sensitive ultrasound biometry.*

INTRODUCTION

Despite the almost routine availability of ultrasound, the antenatal detection of fetuses that are small for gestational age has been disappointing and has not resulted in the substantial outcome benefit expected[1,2]. Failure to assess fetal growth adequately was highlighted in the *4th Annual Report* of the Confidential Enquiry into Stillbirths and Death in Infancy (CESDI)[3]. There are a number of reasons why this may be so. Some small babies may be constitutionally small but perfectly healthy, whereas others may be unable to meet their growth potential owing to hypoxia, which may result in permanent damage. Customized growth charts have been proposed to address this issue[4]. The interpretation of ultrasound measurements for growth depends on several criteria: the rate of growth, the ratio of growth to various parameters of size and the absolute measures of size according to the gestation[5].

The effectiveness of ultrasound scanning may be limited by the skill of clinical staff to interpret the data with precision. Relating size to gestation is the most commonly used method in clinical practice and in this situation it is essential that an appropriate gestation is applied. To measure rate of growth, it is necessary to measure between two known points and essential that the same method of assessing gestational age is used for both measurements.

It is common clinical practice for obstetricians to rely on a combination of menstrual and ultrasound data to determine the estimated date of delivery (EDD)[6,7]. A combination is also applied in epidemiological studies[8]. In women who are unsure of their menstrual dates, the EDD is calculated simply by ultrasound biometry (ideally measured

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before 20 weeks). In those women who are sure of their menstrual date, have a regular menstrual cycle and have not taken oral contraceptives within the previous 3 months, the menstrual date is accepted, provided ultrasound biometry falls within the expected 'normal' range for the menstrual gestation. When ultrasound biometry falls outside this normal range, ultrasound biometry alone is used. A similar approach for recording gestation is adopted by the CESDI, which recommends that the length of a regular menstrual cycle is also taken into account.

In clinical practice an obstetric wheel is usually needed in calculation of the gestation, to correlate the scan and menstrual data. It is well known that obstetric wheels can be inaccurate by up to 7 days[9].

METHODS

The computer system

We have developed a computer system for the interpretation of menstrual and ultrasound data. Menstrual details are recorded by the midwifery staff at the initial visit and entered into the system. The computer system follows a rule-based program for a combination of menstrual and ultrasound dating. The biparietal diameter (BPD) is compared with the normal range for the menstrual gestation by the computer program only in women who are certain of their last menstrual period, have a regular cycle of known length and have not been on an oral contraceptive in the previous 3 months. The system takes into account the length of a regular cycle according to the formula recommended by CESDI (EDD = LMP + 280 days + length of cycle – 28 days)[10], where LMP is the first day of the last menstrual period. The dating ultrasound scan is routinely carried out before 20 weeks. Ultrasound biometry (usually the BPD) is compared with the normal range described by Chitty and colleagues[11,12]. The system calculates a menstrual EDD and an ultrasound EDD and the menstrual EDD is selected by the system as the 'final EDD' if ultrasound biometry falls within the expected range for the menstrual date. The reason for selection is provided by the system, e.g. 'BPD used. Significant difference with LMP dates, therefore using scan date'. All subsequent ultrasound measurements for growth, together with amniotic fluid volume, are entered into the system and an interpretation is given by the system. In those women whose initial attendance is after 20 weeks, the system declines to provide a confident EDD.

The objectives of the study were to investigate whether clinicians could precisely apply the rules for dating and to compare the computer system's interpretation of third-trimester growth parameters with those of the experts.

Clinical experts

From within the database we selected four patients who had a range of dating and growth problems. Two additional *contrived* data sets were prepared. Twenty-four consultants were contacted and 17 agreed to participate themselves or nominate a member of their staff who was a Member of the Royal College of Obstetricians and Gynaecologists. A set of clinical details for each patient was printed directly from the computer database and provided to the experts together with charts of BPD[11], head circumference and abdominal circumference[12] and amniotic fluid volume[13] – the same charts as used by the system. An identical commercially sponsored obstetric wheel (provided by Schering) was given to each obstetrician to use in the assessment. The obstetricians were asked to deal with the data as they would in normal clinical practice using the information and equipment provided. They were asked to provide a clinical EDD and an ultrasound diagnosis of fetal growth. In addition, the contrived data sets were submitted to seven of the above participants. Six of the experts were consultants, eight were specialist registrars and two were senior house officers. One expert used his own charts and wheel and these results were not included in the analysis.

RESULTS

Estimated date of delivery

Clinical cases

Figure 1 shows that the concordance in the EDD calculated by the computer and the experts varied between nil in Case D and 38% in Case A. Concordance was within 3 days of the computer in 59% over all cases. The experts agreed with each other within 3 days in 63% of cases. The spread of delivery dates given by the experts varied from 10 days in Case A to 37 days in Case C. The commonest (modal) EDD given was the same as the computer date in Case A and 2 days different in Case D. In Case B, no menstrual dates were available and the only scan measurement (BPD) available was equivalent to a mean gestation of 36 weeks. Sixty-five per cent of the experts declined to give a confident EDD, as did the computer.

Contrived cases

In only one return (Case E) did the experts provide a date which lay within 3 days of the EDD given by the computer (Figure 1). The experts' modal EDD differed by 10 and 11 days from the computer-generated EDD. All but one of the experts agreed within 3 days of each other in the two cases (Case E and Case F) and the range between the earliest and the latest experts' EDD was 33 days in Case F.

Growth

Three of the four cases had third-trimester scan measurements. In Case C, all except one expert agreed with the system's analysis that there was intrauterine growth restriction (IUGR). In Cases A and D, 76% reported normal growth which was in line with the system's analysis. In Case D, two experts reported macrosomia. In Case A, 82% of the experts detected oligohydramnios which corresponded with the computer's report. In the two contrived Cases E and F, the abdominal circumference lay just below

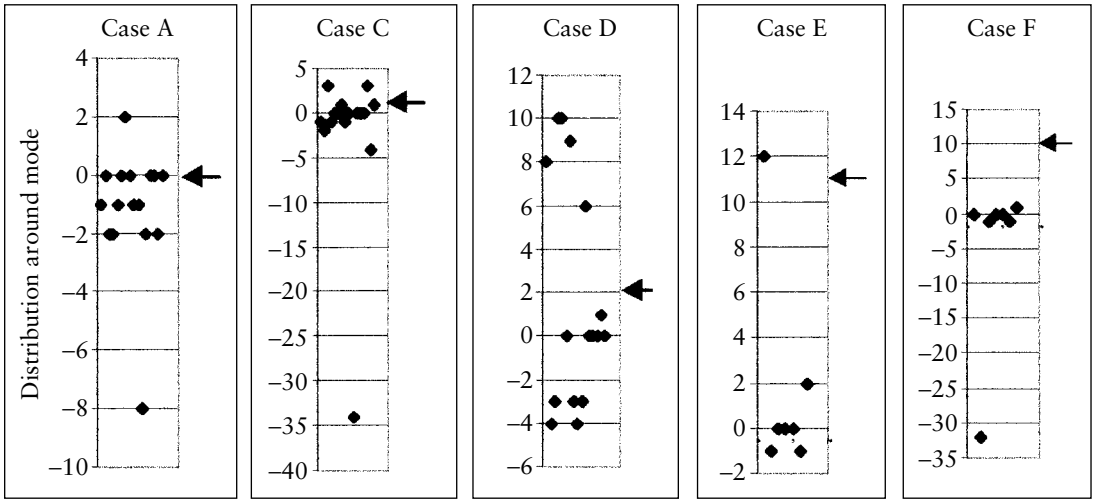

Figure 1 Distribution of estimated date of delivery (EDD) around the mode provided by the expert clinicians. The arrows show the EDD generated by the computer system

the 3rd centile when accurately dated. IUGR was reported by the system in both cases but only in Case E by one expert.

DISCUSSION

The results show that in clinical practice it is very difficult to maintain precise and consistent assignment of EDD using charts and an obstetric wheel. The two contrived cases were given data points on the dating scan very close to the 3rd and 97th centile lines of the ultrasound charts. These cases demonstrate the inaccuracy that is possible when the scan measurement lies close to the lower or upper centile for the given menstrual date. When the length of the menstrual cycle is taken into account, as recommended by CESDI, there is the potential for a compounded error by subtracting rather than adding (or vice versa) the difference between the length of the regular cycle and 28 days.

We have demonstrated that the calculation of the EDD is often imprecise even by trained practicing obstetricians. The quality of obstetric wheels and ultrasound charts is likely to be a significant factor, and for the wheel used in this study there is a systematic error of 0.88 days and a random error of up to 3 days. The wheel is commonly used in clinical practice and, with identical charts and wheel, the experts' error range was up to 37 days. It is possible that they did not take as much care with the calculations as they would in normal clinical practice; however, this seems unlikely, as each expert was asked to look at only three or five cases. One expert probably made a transcription error in Case F, producing an EDD about 4 weeks different from that of all the others. Such an error would be unlikely to remain undetected in clinical practice.

The experts were asked to follow their normal clinical practice. No specific instructions about the CESDI recommendations were given; however, most obstetricians agree that a confident EDD cannot be obtained from a scan carried out after 24 weeks[7,14,15]. A first-trimester scan of crown–rump length may be the most accurate using transvaginal scanning[16], but a BPD is most commonly used. There are no intrinsic reasons why obstetric wheels should be inaccurate (other than by 1 day during a leap year), and they could be acceptably accurate if they were constructed carefully and of sufficient size.

The precise EDD is of great importance to the pregnant woman and her family, even when it is understood that it is only an approximate date around which she can expect to deliver her baby. Changing this date by even a few days may be upsetting, yet it is incumbent on the obstetrician to check that the EDD has been accurately calculated when interpreting growth scans or before induction of labor for post-maturity. A consistent EDD provides the basis for the assessment of growth and fetal health. An amended EDD can change the interpretation of scan growth measurements.

The interpretation of scan measurements is particularly amenable to computerization since it involves absolute measurements which are compared with a normal range. The rules are relatively simple. However, when scan measurements are plotted manually, there is a risk of error. When a dating policy is not completely consistent there is the opportunity for different interpretations of the same scan measurements.

No attempt was made to correlate the experts' or the computer's analysis with the actual outcome, since this was not the purpose of the study. The computer EDD, however, was validated in the five cases by manually counting on a calendar. Computation of the EDD is straightforward in mathematical and logical terms and the computer can be considered to provide the gold standard for this. Although the CESDI recommendation for estimating gestation has wide support, there are those who advocate a simple reliance on scan dates alone[17,18]. Adoption of ultrasonic biometry alone simplifies the calculation of the EDD which is carried out automatically on most modern ultrasound machines. However, such an approach is not accepted by everyone[19,20]. A wheel and chart are still necessary to interpret growth scans. Our results suggest that consistency and accuracy are difficult to obtain in clinical practice with the use of a wheel and chart.

None of the studies investigating the value of routine third-trimester biometry for growth[21,22] used a computer to calculate the gestation or assess the measurements in relation to the normal range. Most modern ultrasound machines already have built-in charts for both gestation and growth. It would take little more to incorporate a system such as this into the software to allow consistent generation of the EDD and decision support to interpret subsequent gestation-sensitive growth parameters. The system uses only 415 lines of code. The widespread use of such a system could have a significant impact on the detection of growth problems in pregnancy.

APPENDIX

The computer system is Smartware II database and project language. The source code is available on request from the authors.

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REFERENCES

1. Neilson JP. Routine fetal anthropometry in late pregnancy. In Enkin MW, Keirse MJNC, Renfrew MJ, Neilson JP, eds. *Pregnancy and Childbirth Database*. Pre-Cochrane reviews. 12 May 1994. Oxford: Update Software, Cochrane Updates on Disk, Disk Issue 2, 1993
2. Leeson S, Aziz N. Customised fetal growth assessment. *Br J Obstet Gynaecol* 1997;104:648–51
3. Confidential Enquiry into Stillbirths and Death in Infancy. *4th Annual Report*. London: Maternal and Child Health Consortium, 1997
4. Gardosi J, Chang A, Kalyan B, Sahota D, Symonds EM. Customised antenatal growth charts. *Lancet* 1992;339:283–7
5. Chang TC, Robson SC, Spencer JAD, Gallivan S. Identification of fetal growth retardation: comparison of Doppler waveform indices and serial ultrasound measurements of abdominal circumference and fetal weight. *Obstet Gynecol* 1993;82:230–6
6. Hutchon DJR. Menstrual and ultrsaound data – which EDD? *Darlington Post-grad J* 1996;15:5–9
7. Geirsson RT. Ultrasound: the rational way to determine gestational age. *Fetal Matern Med Rev* 1997;9:133–46
8. Williams LA, Evans SF, Newnham JP. Prospective cohort study of factors influencing the relative weights of placenta and the newborn infant. *Br Med J* 1997;314:1864–8
9. Fogarty P, Fogarty B. Time to reinvent the wheel [Letter]. *Br J Obstet Gynaecol* 1994;101:737
10. NAB Secretariat. *Guidance For All Questions. Confidential Enquiry into Still Births and Deaths in Infancy (CESDI)*. Rapid Report Forms. London: Maternal and Child Health Research Consortium, 1997
11. Chitty LS, Altman DG, Henderson A, Campbell S. Charts of fetal size: 2. Head measurements. *Br J Obstet Gynaecol* 1994;101:35–43
12. Chitty LS, Altman DG, Henderson A, Campbell S. Charts of fetal size: 4. Femur length. *Br J Obstet Gynaecol* 1994;101:132–5
13. Nwosu EC, Welch CR, Walkinshaw SA. Measurement of amniotic fluid volume using maximum pool depth. *Contemp Rev Obstet Gynaecol* 1994;6:25–8
14. Waldenstrom U, Axelsson O, Nilsson S. A comparison of the ability of ultrasonographically measured biparietal diameter and the last menstrual period to predict the onset of labor. *Obstet Gynecol* 1990;76:336–8
15. RCOG. *Ultrasound Screening for Fetal Abnormalities*. Royal College of Obstetricians and Gynaecologists working party report. London: RCOG, 1997
16. Lasser DM, Peisner DB, Vollebergh J, Timor-Tritsch I. First trimester fetal biometry using transvaginal sonography. *Ultrasound Obstet Gynecol* 1993;98:48–51
17. Geirsson RT. Ultrasound instead of last menstrual period as the basis of gestational age assignment. *Ultrasound Obstet Gynecol* 1991;1:212–19
18. Mongelli M, Wilcox M, Gardosi J. Estimating the date of confinement: ultrasonographic biometry versus certain menstrual date. *Am J Obstet Gynecol* 1996;174:278–81
19. Olsen O, Clausen JA. Routine ultrasound dating has not been shown to be more accurate than the calendar method. *Br J Obstet Gynaecol* 1997;104:1221–2
20. Hutchon DJR. Estimating the date of confinement: ultrasonic biometry versus certain menstrual dates [Letter]. *Am J Obstet Gynecol* 1996;175:510–11
21. Secher NJ, Hansen PK, Lenstrup C, Eriksen PS, Morsing G. A randomized study of fetal abdominal diameter and fetal weight estimation for the detection of light-for-gestation infants in low-risk pregnancies. *Br J Obstet Gynaecol* 1987;94:105–9
22. Larsen T, Larsen JK, Petersen S, Greisen G. Detection of small-for-gestational-age fetuses by ultrasound screening in a high risk population: a randomized controlled study. *Br J Obstet Gynaecol* 1992;99:469–74