Estimated date of delivery from last menstrual period and ultrasound scan: which is more accurate?

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SUMMARY. The aim of this study was to determine which is the more accurate predictor of the date of delivery for pregnant women in a community-based population: a calculation based on the last menstrual period or a prediction based on the measurement by ultrasound scanning of well-recognized fetal characteristics. A prospective study was conducted of 225 consecutive women reporting their pregnancy in a semi-rural general practice; 106 women were included in the analysis. The results showed that in over 50% of cases the estimated date of delivery derived from the ultrasound scan was more accurate than that derived from the last menstrual period, whatever the discrepancy between the two predictions.

It can be concluded that all professionals involved with antenatal care should ignore the estimated date of delivery derived from the last menstrual period once a satisfactory scan has been obtained.

Keywords: gestational age; delivery [pregnancy]; ultrasound; menstrual cycle.

Introduction

THE estimated date of delivery has profound medical, social and personal implications for the pregnant woman and is a vital yardstick for the doctor who is responsible for the safe delivery of her child. Its accuracy is therefore of paramount importance. With the widespread availability of ultrasound scanning and the development of standard fetal measurement,[1,2] most women now have two independently derived estimates which may differ: a calculation based on the last menstrual period and a prediction based on the measurement by ultrasound scanning of well-recognized fetal characteristics.

General practitioners and midwives are often confused as to which date should be used. When the date of the last menstrual period is uncertain, the date of delivery is derived solely from the ultrasound scan and there is no conflict. However, when a definite and accurate last menstrual period date and details of usual cycle length are available, these can be used to calculate a valid estimated date of delivery. The aim of this study was to determine which method is the more accurate predictor of the date of delivery.

Method

All patients presenting for antenatal booking at a semi-rural four-partner practice in Bedfordshire, England from April 1988 to July 1989 were enrolled in the study. During the initial consultation, index pregnancy data were entered on record sheets for each patient by the doctor they had consulted. The estimated date of delivery was calculated from a specially-prepared table based on 279 days from the first day of the last menstrual period.

Ultrasound scanning was performed during a hospital appointment at around 17–18 weeks' gestation in the usual manner as part of routine antenatal care. The radiographers performing the scans either held the Diploma of Medical Ultrasound or were students studying for the diploma under supervision during their 18 month course. After the ultrasound scan had been performed the measurements of biparietal diameter and femur length were recorded. The radiographers in the two main hospitals used by the practice had agreed in advance to use standard graphs.[3,4] The gestational age was determined from both the graph of biparietal diameter and of femur length, and if there was a small discrepancy between the two the mean was taken (if the discrepancy was greater than one week the scan was repeated as such a discrepancy could suggest a fetal abnormality). The estimated date of delivery was then determined from a gestation calculating wheel. If the fetal head appeared elongated (dolichocephalic) the head circumference was measured and used instead of the biparietal diameter, and the relevant graph consulted.

After delivery, details of the pregnancy outcome were recorded. Patients whose pregnancy terminated at 24 weeks' gestation or less, those with multiple pregnancy, those whose labour was induced, those who delivered an abnormal baby, those for whom the hospital did not provide an estimated date of delivery based on an ultrasound scan, those who moved away during the pregnancy and could not be traced, those without a last menstrual period date accurate to plus or minus two days, those who had been on the contraceptive pill during the three months prior to conception and those who reported that the length of their menstrual cycle was most commonly greater than 40 days were excluded from the analysis.

Data were entered onto a microcomputer using the statistics package for personal computers *SPP* (Royston P, 1988). Data analysis was performed by P R.

Statistical analysis

Accuracy rates for ultrasound scan and menstrual period estimates of date of delivery were calculated as the percentage of estimates accurate to within a given number of days. Significance tests and confidence intervals for differences in these paired rates were calculated using the exact (binomial) method[5] (Appendix 1). The choice of sample size was guided by the finding of Campbell and colleagues that the date of delivery, estimated from measurement of biparietal diameter at 12–18 weeks' gestation, was not accurate to plus or minus 14 days of the actual date in 10.6% of 1678 patients.[6] Using the method of Schork and Williams[7] it was determined that, for a sample of 120 women, the binomial test at the 5% significance level would have a power of 90% to detect a ratio of 2.6:1 (in fact 27.6%:10.6%) in the inaccuracy rates of the two methods. To compensate for expected exclusions it was hoped to recruit about double this number of women.

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Results

A total of 225 women presented for antenatal booking during the 16-month period; all but two were white. One hundred and nineteen women were excluded from the analysis for the following principal reasons (some women were excluded for more than one reason): on the contraceptive pill during the three months prior to conception (21 women), uncertain date of last menstrual period (20), usual menstrual cycle longer than 40 days (three), no estimated date of delivery by ultrasound scan (14), miscarriage (28), induced labour (29) and abnormal baby (one). The remaining 106 women were included in the analysis. They had a mean age of 28 years (range 20–41 years) and were scanned at a mean gestation of 19 weeks (17–24 weeks) — 79 women attended Lister Hospital, Stevenage and 27 Bedford General hospital. Fifty women were nulliparous.

Figure 1 shows the accuracy rates of the last menstrual period and scan dates as estimates of the actual date of delivery. An error of zero days means that the scan or the last menstrual period predicted the actual date of delivery exactly and an error of 14 days means that the scan or the last menstrual period estimate is 14 days earlier or later than the actual date of delivery. The accuracy rate of the scan was greater than that of the menstrual period method for errors of 12 days or less, the same for 13 day error and similar for 14 day error.

Figure 2 has the same horizontal axis as Figure 1, but with a direct comparison of accuracy rates on the vertical axis. The difference in accuracy has been calculated by subtracting the percentage of cases in which the last menstrual period was accurate to within a given number of days from the percentage of cases in which the scan was similarly accurate. The horizontal line at zero corresponds to equal accuracy. The scan accuracy is significantly better than the last menstrual period accuracy ($P<0.05$) when the lower dashed line is above the zero line, that is for an error of between five and seven days, inclusive. At its best, at an error of plus or minus five days, the scan prediction is accurate in 52% of cases and last menstrual period in 37%, a difference of 15% (95% confidence interval 4% to 23%).

The cases where the estimated dates of delivery disagree are termed 'discrepant'. For 11 patients the estimated dates of delivery from the two methods were identical and in nine of these cases they were exactly correct. The percentages of the 95 discrepant cases in which the scan gave a closer prediction of the date of delivery than the last menstrual period are shown in Table 1. The proportion of cases where the scan was the better predictor was never less than 50% and became significantly greater than 50% ($P<0.05$) for discrepancies of five days or more.

Discussion

It has been argued that much anxiety would be alleviated if a range of dates were substituted for a specific date of delivery.[8] However, we feel that a single estimated date of delivery using the most accurate method of prediction is useful for a pregnant woman and her medical advisers.

A study from a London hospital accepting many tertiary referrals from district general hospital obstetric units and serving a multiracial local population showed that biparietal diameter measurements performed at between 12 and 18 weeks' gestation were significantly more accurate predictors of the actual date of delivery than last menstrual period for all 4527 women examined, including those who were sure of the date of their last menstrual period.[6] As a result of this work many obstetricians now prefer the scan estimated date of delivery in all cases, but some still take the last menstrual period estimated date of delivery if the two predictors differ by only a few days.[9] A recent study from Edinburgh analysed the certainty of last menstrual period

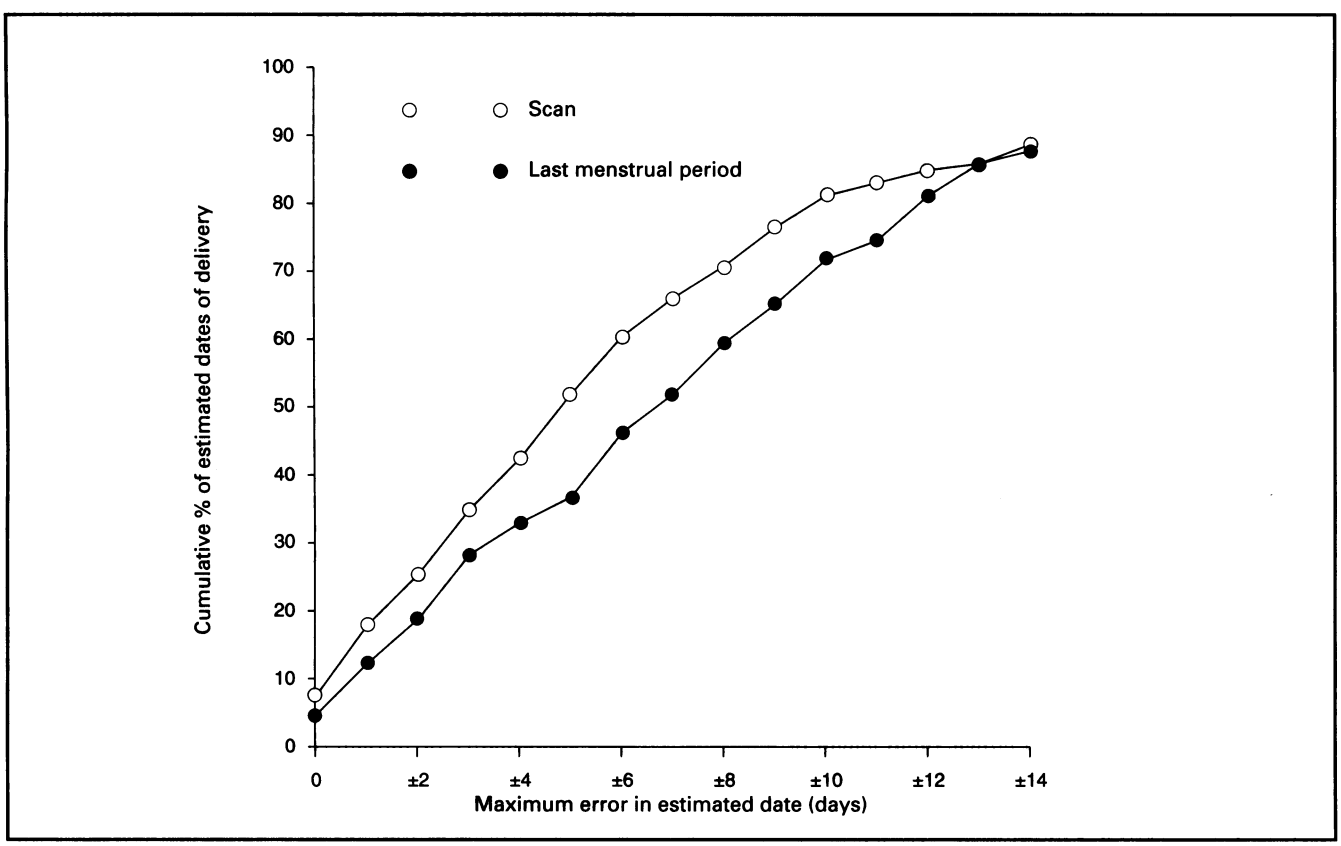

Figure 1. *Accuracy of estimated date of delivery for differing errors from the actual date of delivery for the 106 women.*

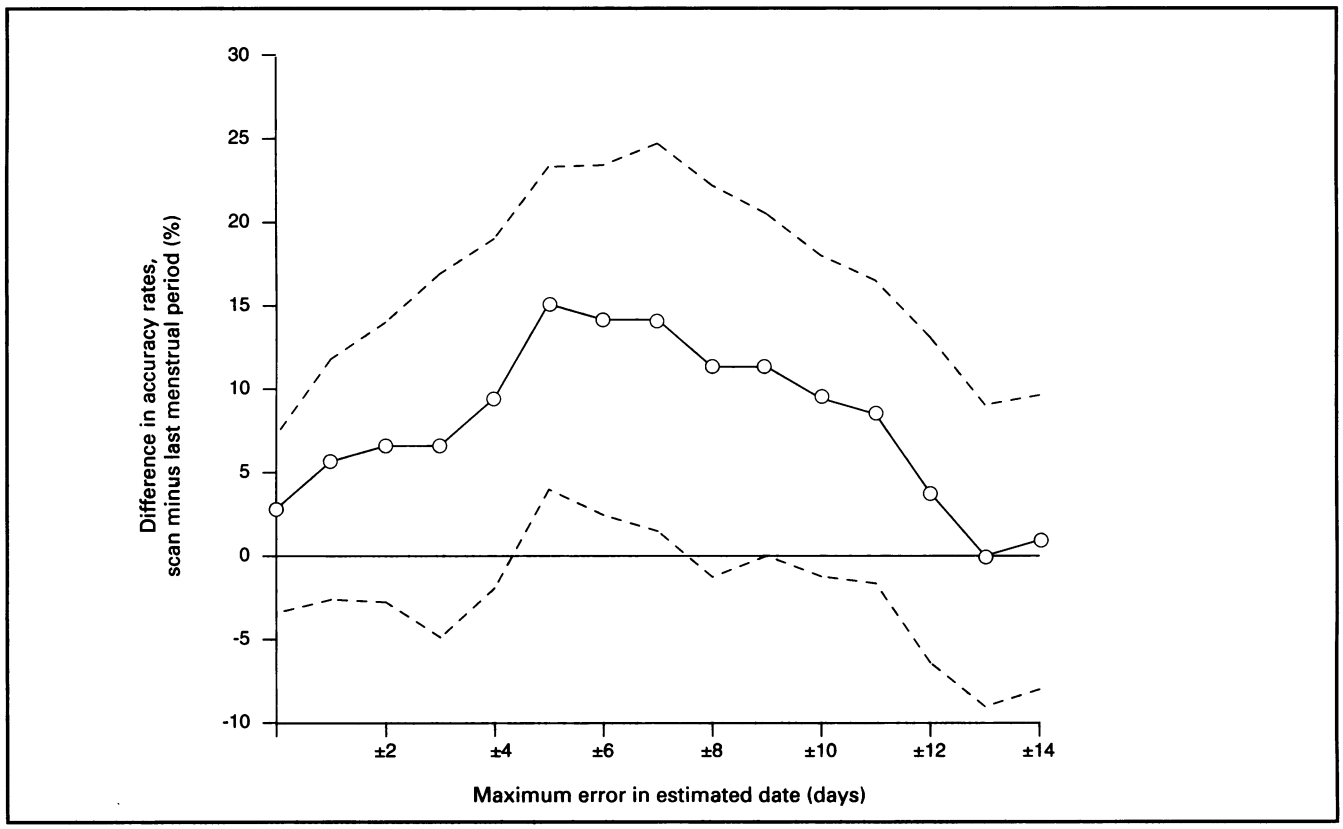

Figure 2. *Difference in accuracy rates between last menstrual period and scan estimated date of delivery for differing errors from the actual date of delivery. The dashed lines represent the 95% confidence interval.*

Table 1. Percentage of 'discrepant' cases where the scan gave a closer prediction of the date of delivery than the last menstrual period.

Discrepancy in estimated date of delivery (days)	% of discrepant cases where scan more accurate than last menstrual period (95% confidence interval)
⩾1 (*n* = 95)	*56* (*45* to *66*)
⩾2 (*n* = 82)	*56* (*39* to *61*)
⩾3 (*n* = 69)	*58* (*46* to *70*)
⩾4 (*n* = 60)	*60* (*47* to *72*)
⩾5 (*n* = 53)	*66* (*52* to *79*)
⩾6 (*n* = 45)	*67* (*51* to *80*)
⩾7 (*n* = 39)	*69* (*52* to *83*)
⩾8 (*n* = 29)	*76* (*57* to *90*)
⩾9 (*n* = 25)	*76* (*55* to *91*)
⩾10 (*n* = 23)	*78* (*56* to *93*)
⩾11 (*n* = 20)	*75* (*51* to *91*)
⩾12 (*n* = 18)	*78* (*52* to *94*)
⩾13 (*n* = 14)	*86* (*57* to *98*)
⩾14 (*n* = 10)	*90* (*56* to *100*)
⩾15 (*n* = 10)	*90* (*56* to *100*)

n = number of cases where the estimated dates of delivery disagree, that is that are 'discrepant'.

dates in detail.[10] Even for those with the greatest certainty of menstrual history from three groups of women, a scan estimated date of delivery derived from crown–rump length or biparietal diameter was more accurate than last menstrual period estimated date of delivery.

A hospital-based study from Oklahoma reached a conflicting conclusion.[11] The authors suggested that gestational age based on good menstrual records supported by a pelvic examination in the first trimester may be more reliable than even the best ultrasound method for dating. They stated that if a pregnant woman has fairly regular periods and knows the date of her last menstrual period within a time-frame of plus or minus one week, the last menstrual period estimated date of delivery should not be changed unless the discrepancy between last menstrual period and scan estimated date of delivery is 14 days or more.

The British Medical Ultrasound Society's view is that if the scan estimated date of delivery differs from the clinical, including last menstrual period, assessment by more than one week, then the ultrasonic assessment should be the working gestational age and the clinical assessment should be discarded.[12]

This study was community based and updates the previous studies to include femur length, as used in current practice in the United Kingdom. It confirms the findings of Campbell and colleagues[6] and Geirsson and Busby-Earle[10] and refutes the conclusions of Rossavik and Fishburne[11] and the British Medical Ultrasound Society (for discrepancies between the predictions of one week or less).[12] Once a woman has had a scan at hospital with a reliable biparietal diameter and/or femur length measurement, the estimated date of delivery calculated by the radiographer should always be taken in preference to the last menstrual period prediction, even when the woman is absolutely sure of her dates and however little the discrepancy between the two predictions. It remains good practice to re-scan those with a large discrepancy (say more than two weeks) between predictions so that fetal abnormality or intrauterine growth retardation are not missed.

Some general practitioners and midwives advise patients to ignore the scan estimated date of delivery. This study suggests that this is not only confusing for the pregnant woman, but may

lead to unnecessary complaint and possibly litigation in cases where the last menstrual period estimated date of delivery is earlier than the scan estimated date of delivery. For example, if the last menstrual period estimated date of delivery is one month earlier than the scan estimated date of delivery, the occurrence of an intrauterine death at around the time of the scan estimated date of delivery, either in the final days of pregnancy or in labour, could be construed as negligence if the patient has been led to believe that she is a month past her 'true' date. Our conclusion is in line with that of Campbell and colleagues based on their much larger hospital series.[6] It is recommended that general practitioners and midwives fall into line with obstetricians and ignore the last menstrual period estimated date of delivery once the scan estimated date of delivery has been ascertained.

Appendix 1. Comparison of accuracy rates.

As an example, consider the following 2 x 2 table, which gives a breakdown of the accuracy (to within seven days or less) of the estimated date of delivery according to the two methods:

	% of women (n = 106)		
	LMP estimate accurate	LMP estimate inaccurate	Total
Scan estimate accurate	*39.6*	*26.4*	*66.0*
Scan estimate inaccurate	*12.3*	*21.7*	*34.0*
Total	*51.9*	*48.1*	*100.0*

n = total number of women. LMP = last menstrual period.

The difference in accuracy rates (scan minus last menstrual period) is 66.0% minus 51.9% which equals 14.1%. However, each of these rates includes the 42 patients (39.6%) for whom both methods were accurate. The rates are therefore correlated and the standard test of difference between independent proportions is inapplicable. Instead, the difference may be seen to be mathematically identical to the difference between rate A (scan accurate, last menstrual period inaccurate, 26.4%) and rate B (scan inaccurate, last menstrual period accurate, 12.3%). Rates A and B are calculated from non-overlapping subsets of patients and so may be presumed to be statistically independent. If rate A equals rate B, both estimates are equally accurate. A test of rate A equals rate B is the same as a test of rate A/(A + B) = ½ and may be based on the binomial distribution with proportion ½. Similarly, confidence intervals for rate A minus rate B (and by implication for the difference in accuracy rates, which is identical to rate A minus rate B) may be found using the binomial distribution. In the above example, rate A minus rate B (14.1%) is significantly different from zero ($P<0.05$), so the scan is significantly better than the last menstrual period method for predicting the date of delivery to within one week of the actual date. The confidence interval for rate A minus rate B is 1.5% to 24.7%.

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Corrigendum – nausea and vomiting in pregnancy

In the paper by Gadsby and colleagues (A prospective study of nausea and vomiting during pregnancy, *Br J Gen Pract* 1993; **43:** 245-248) the sentence in the summary 'Cessation of symptoms occurred at approximately the same day from the last menstrual period whether they had begun earlier or later or whether they had been severe or mild' should have read 'Cessation of symptoms occurred at approximately the same day from the last menstrual period whether they began early or later, severely or mildly'.