Articles

Ultrasonographic measurement of lower uterine segment to assess risk of defects of scarred uterus

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Summary

Background Ultrasonography has been used to examine the scarred uterus in women who have had previous caesarean sections in an attempt to assess the risk of rupture of the scar during subsequent labour. The predictive value of such measurements has not been adequately assessed, however. We aimed to evaluate the usefulness of sonographic measurement of the lower uterine segment before labour in predicting the risk of intrapartum uterine rupture.

Methods In this prospective observational study, the obstetricians were not told the ultrasonographic findings and did not use them to make decisions about type of delivery. Eligible patients were those with previous caesarean sections booked for delivery at our hospital. 642 patients underwent ultrasound examination at 36–38 weeks' gestation, and were allocated to four groups according to the thickness of the lower uterine segment. Ultrasonographic findings were compared with those of physical examination at delivery

Findings The overall frequency of defective scars was 4·0% (15 ruptures, 10 dehiscences). The frequency of defects rose as the thickness of the lower uterine segment decreased: there were no defects among 278 women with measurements greater than 4·5 mm, three (2%) among 177 women with values of 3·6–4·5 mm, 14 (10%) among 136 women with values of 2·6–3·5 mm, and eight (16%) among 51 women with values of 1·6–2·5 mm. With a cut-off value of 3·5 mm, the sensitivity of ultrasonographic measurement was 88·0%, the specificity 73·2%, positive predictive value 11·8%, and negative predictive value 99·3%.

Interpretation Our results show that the risk of a defective scar is directly related to the degree of thinning of the lower uterine segment at around 37 weeks of pregnancy. The high negative predictive value of the method may encourage obstetricians in hospitals where routine repeat elective caesarean is the norm to offer a trial of labour to patients with a thickness value of 3·5 mm or greater.

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Introduction

The rupture of a caesarean section scar is a potentially devastating complication of childbirth. The frequency of uterine rupture has been estimated at between 0·3% and 3·8%, and that of uterine dehiscence at between 0·6% and 4·0%.[1–6] Despite much evidence that a trial of labour is generally safer than a repeated caesarean,[1,7–9] the scarred uterus remains the commonest reason for caesarean deliveries in the USA.[10]

Hysterography of a healed scar has not proved useful for assessment of the safety of vaginal delivery; similarly, radiographic pelvimetry does not permit either the type of delivery or, more importantly, the risk of uterine rupture to be predicted.[11,12]

Only a few studies have examined the predictive value of ultrasonography in diagnosing a defective uterus before electing caesarean delivery,[13–15] and each included only a small number of cases. Our aim was to assess, among a large number of patients with uterine scarring, the usefulness of sonographic measurement of the lower uterine segment thickness at the beginning of the ninth month and, in particular, its predictive value for the risk of intrapartum uterine rupture.

Patients and methods

In this prospective study the referring obstetricians were not told the findings and thus did not use them in deciding the type of delivery to be used. The study took place at Poissy General Hospital between February, 1989, and October, 1994, and included all maternity patients who had a uterus scarred by one or more previous caesarean deliveries and who met the inclusion criteria of non-breech presentation of a singleton pregnancy, informed consent, and delivery in the Department of Obstetrics and Gynaecology of Poissy Hospital. Patients who delivered before 36 weeks' gestation were excluded from the study.

The obstetric staff decided on the type of delivery (trial of labour or elective caesarean section) for all study participants. In our institution, the standard indications for elective caesarean delivery were postoperative fever after a previous caesarean delivery, a pelvis incompatible with vaginal delivery as measured on radiography (sagittal inlet <11·0 cm, transverse inlet <11·5 cm, bispinous <9·0 cm), and a history of two previous caesarean sections, except when the patient requested that vaginal delivery be tried (and if the pelvis appeared normal on radiography).

The ultrasound examination was carried out transabdominally at between 36 and 38 weeks' gestation, with the bladder full. Good imaging was thus possible for the entire lower segment, from its upper limit (top of the bladder) to the cervix.

On ultrasound, the normal lower uterine segment is a two-layered structure that consists of a superficial, very echogenic layer (the outer myometrium, juxtaposed to the bladder), and a deep, less echogenic layer (the inner myometrium and the decidualised endometrium). A longitudinal transverse scan first searched for any symptomless dehiscence of the lower segment. Sagittal sections were then measured successively (four to five measures, on average) to search for the thinnest zone of the lower segment. The measurement was done with the cursors at the

	Number of women	Number with caesarean delivery		Median thickness of lower uterine segment in mm (10th–90th centile range)	Number with defects
		Elective	Emergency		
Previous caesareans					
1	539 (83·9%)	34 (6·3%)	126 (23·4%)	4·05 (2·7–6·0)	12 (2·2%)
2	75 (11·7%)	64 (85·3%)	5 (6·7%)	3·05 (2·3–4·7)	10 (13·3%)
≥3	28 (4·4%)	27 (96·4%)	0	3·50 (2·9–4·8)	3 (10·7%)
Total	642 (100%)	125 (19·5%)	131 (20·4%)	3·95 (2·6–6·0)	25 (3·89%)

Table 1: **Numbers of caesareans and of lower uterine segment defects by number of previous caesareans**

interface of the urine and bladder and the amniotic fluid and decidua. We used the lowest value measured to describe the thickness of the lower segment. All the examinations were done and interpreted by one investigator (PR). We used the Kretz Combison 330 with a probe of 5 MHz.

Sonographic results were compared with assessments of the uterine scar by the physician at delivery. This assessment was straightforward after caesarean delivery. A rupture was defined as a complete separation of the uterine scar (of any length) resulting in communication between the uterine and peritoneal cavities. Dehiscence was defined as a subperitoneal separation of the uterine scar, with chorioamniotic membrane visible through the peritoneum of the lower uterine segment. After vaginal delivery, the obstetrician systematically examined the uterine scar. Uterine examination after vaginal delivery sought only ruptures (proved by the hand passing into the peritoneal cavity through the incision); the notion of extreme thinning of the scar suggesting dehiscence is too subjective as is the anatomical thickness of the lower segment (during caesarean or vaginal delivery).

The association between a uterine scar defect and the thickness, as measured by ultrasound, of the lower uterine segment was assessed, and the sensitivity, specificity, positive predictive value, and negative predictive value were calculated for every 1 mm from 2·5 mm. This study interval was chosen because the axial resolution of the probe was 0·5 mm. We then quantified the risk of uterine rupture according to the thickness of the lower uterine segment.

Results

During the study, 12 270 patients gave birth in our department. 817 (6·6%) had a scarred uterus and 642 of these (78·6%) were included in the study. The remaining 175 patients were not included, either because they did not meet the criteria or because the attending obstetrician, apparently through forgetfulness, did not propose participation in the study to them.

Of these 642 patients, 386 (60·1%) gave birth vaginally and 256 (39·9%) by caesarean section. 125 (48·8%) of the operative deliveries were elective and 131 (51·2%) emergencies. There were 15 (2·5%) uterine ruptures and 10 (1·5%) uterine dehiscences. The overall frequency of lower uterine segment defects was therefore 4·0%. There were no maternal deaths. Two infants died: in one case of uterine rupture at home, the fetus was dead on arrival at hospital; and one fetus had distress resulting in hypoxic convulsions then death, despite an emergency caesarean.

The mean age of the participating women was 31·7 (SD 4·1) years, the mean parity 2·8 (1·1), and the mean duration of gestation at delivery 38·9 (1·2) weeks. 86·3% of women received epidural anaesthesia and 19·4% (of those with trial of labour) oxytocin augmentation of labour. The mean birthweight of the infants was 3370 (592) g.

	Thickness of lower uterine segment							
	>4·5 mm		3·6–4·5 mm		2·6–3·5 mm		1·6–2·5 mm	
	Number of patients	Number with defect	Number of patients	Number with defect	Number of patients	Number with defect	Number of patients	Number with defect
Delivery								
Vaginal*	203	0	108	1 (1%)	61	3 (5%)	14	0
Emergency caesarean	54	0	49	0	22	6 (27%)	6	2 (33%)
Elective caesarean	21	0	20	2 (10%)	53	5 (10%)	31	6 (19%)
Total	278	0	177	3 (2%)	136	14 (10%)	51	8 (16%)

*Ruptures only could be diagnosed in this group.

Table 2: **Distribution of defects according to lower uterine segment thickness and mode of delivery**

	Sensitivity	Specificity	Positive predictive value	Negative predictive value
≤4·5 mm	100%	45·0%	6·9%	100%
≤3·5 mm	88·0%	73·2%	11·8%	99·3%
≤2·5 mm	32·0%	93·0%	15·7%	97·1%

Table 3: **Predictive values according to cut-off point**

Patients with defective scars did not differ significantly from those whose scars were intact as regards mother's age, duration of gestation at delivery, infant's birthweight, and the use of oxytocin (16·6% of patients with defective scars *vs* 19·4% of those without defects, p=0·81) or epidural anaesthesia (80·0% *vs* 86·5%, p=0·35).

The thickness of the lower uterine segment, measured by ultrasound among these women ranged from 1·9 to 12·3 mm (median 3·95 mm; table 1). The median thickness of the lower uterine segment among the 25 patients who had a defect of the lower segment was 2·9 mm (10th–90th centile range 2·1–3·8). Of these patients, 12 had only one scar (3·0 mm [2·3–3·6]), ten had two scars (2·3 mm [2·0–3·3]), and three had three scars (3·4 mm, 3·8 mm, and 3·9 mm).

For the purposes of analysis, we defined four categories of uterine lower segment thickness, as measured ultrasonographically: more than 4·5 mm, 3·6–4·5 mm, 2·6–3·5 mm, and 1·6–2·5 mm. None of the 278 women with lower-uterine-segment thicknesses of 4·5 mm or more had dehiscence or rupture (table 2). The proportion of defects rose as the thickness decreased. In the 3·6–4·5 mm group there were 177 patients, of whom three had defects (two dehiscences, one rupture). 14 (10%) of 136 patients with thicknesses of 2·6–3·5 mm had defects (five dehiscences, nine ruptures), and in the group with thicknesses of 1·6–2·5 mm there were 8 (16%) defects (three dehiscences, five ruptures).

The differences between the groups in the proportions with defects were significant ($p<0·05$), except that between the two groups with the thinnest uteruses ($p=0·31$).

Table 3 gives the sensitivity, specificity, positive predictive value, and negative predictive value for each cut-off thickness.

The relative risk of a defect (odds ratio) was 20·1 (95% CI 8·3–48·9) when the lower uterine segment was 3·5 mm or less, and 6·3 (2·8–13·9) when the lower uterine segment was 2·5 mm or less at the beginning of the 9th month.

Discussion

This prospective study has shown that among patients with a scarred uterus the risk of a defect during

subsequent labour is directly correlated to the degree of lower uterine segment thinning measured at around 37 weeks, and that ultrasound examination provides excellent negative predictive value for that risk.

We believe selection bias linked to the risk of defect is unlikely. Such bias could be introduced only by the patients to whom measurement was not proposed (and not by those who did not meet the inclusion criteria); this omission apparently resulted from attending obstetricians' forgetting to propose the study protocol measurement to patients rather than from deliberate or systematic choice. We assume that this neglect did not lead to any selection bias, but we do not have data to remove all doubts, so it is impossible to be sure. The only information we have is that among the excluded group, there were two uterine ruptures (with no neonatal or maternal effects), both in women with only one scar who delivered vaginally (a prevalence of 1%).

This study is the first to examine a large enough sample to allow the value of ultrasonography in estimating the risk of uterine rupture to be assessed; in view of the low prevalence of defects, a large population is necessary. There is surprisingly little published on this subject, even though the risk of uterine rupture is a major problem in the management of patients with a scarred uterus.[16-21] Araki and Inooka reported that among 21 patients with a scarred uterus, three had dehiscences when the interval from bladder wall to fetal surface was 0 mm, and two had thin scars, when the interval was 3 mm. The high rate of defects (25%) probably reflected selection of the studied population. Michaels et al[15] reported the largest series, of 58 women. The proportion with defects was very high (21%), more than five times higher than those in other studies, perhaps because of selection bias, and surely because of the small number of cases studied as well as the definition of defect. That study was observational and not functional; all patients underwent elective caesarean; and a confirmed defect was defined as a thinning or deformity of the lower uterine segment as observed during the operation. This criterion is subjective, and, in our view, inappropriate because anatomical abnormalities do not necessarily have functional consequences. This definition leads to a substantial overestimation of the potential seriousness of anatomical abnormalities. In our study, for example, among 47 patients with a lower uterine segment measuring only 1·6 to 2·5 mm, only eight had proven defects.

Our study also establishes a relation between the anatomy revealed by the sonographic image and the functional status of the scarred lower uterine segment. Our results show that the risk of uterine rupture or dehiscence from a defective scar is directly related to the degree of lower uterine segment thinning measured at or around 37 weeks, and in particular, that this risk increases significantly when the thickness is 3·5 mm or less.

We studied the risk of a defect according to each thickness category by calculating the odds ratio; a cut-off point of 3·5 mm was most useful, because the relative risk is highest at this value. Furthermore, if we take a value of 3·5 mm or less as pathological, a large proportion of our patients (71%) are at low risk of uterine rupture. This cut-off point or threshold allows excellent sensitivity (88·0%) and negative predictive value (99·3%).

This relation, based on the thickness of the lower uterine segment rather than on the scar (rarely visible on the ultrasound), suggests that problems arise from an abnormality of the structure of the scarred lower uterine segment. Two main processes might explain the mechanism. First, enlargement might be impeded by the scar tissue and might occur in only the healthy part of the lower uterine segment, which is then excessively stretched. Alternatively, the inflammation that occurs when the scar is forming might affect the regeneration of the isthmus of the uterus, which would become thinner. The thinning could lead, during subsequent enlargement, to a thinner lower uterine segment.

Two findings support these hypotheses. First, we noticed that lower uterine segments with several scars were more likely than single-scarred uteruses to measure 3·5 mm or less. This observation may also explain why the rate of caesarean delivery increased as thickness decreased: normally, when a uterus has several scars delivery is by elective caesarean. Second, repeated ultrasound surveillance of the lower uterine segment has shown that enlargement occurs earlier in women who have previously had a caesarean delivery than in women who have not.[15]

The positive predictive value of the ultrasound measurement was weak in our study, suggesting that all thin lower uterine segments are not abnormal. On the other hand, the ultrasonographic measurement had a good negative predictive value, confirming that a thick lower uterine segment is usually strong. In addition, since the negative prediction can be obtained at the beginning of the 9th month, the results of this examination can easily be included among the factors for selecting the type of delivery. The high negative predictive value of this ultrasound examination may encourage obstetricians in hospitals where routine elective repeat caesarean section is still the norm to offer patients a trial of labour, when the lower uterine segment is shown to measure 3·5 mm or more on ultrasound. In some difficult obstetric settings, such as a history of two or more previous caesareans, breech presentation associated with previous caesareans, and twin pregnancy associated with previous caesareans, ultrasound examination of the lower segment may also help physicians to select more appropriately patients to whom a trial of labour could be proposed (when the thickness of the lower uterine segment is >3·5 mm).

We conclude that ultrasonographic examination permits a better assessment of the potential risk of uterine rupture in patients who have previously had caesarean deliveries and could accordingly allow safer management of this important obstetric danger. A new strategy to try to reduce the risk of uterine rupture, integrating ultrasound examination of the lower uterine segment into the conclusive appraisal of the type of delivery for women with a scarred uterus, is presently being assessed in our department.

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Occupational exposure to metal or wood dust and aetiology of cryptogenic fibrosing alveolitis

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Summary

Background We have previously suggested that cryptogenic fibrosing alveolitis (CFA) may be caused by occupational exposures, particularly to metal or wood dust. We have specifically investigated this hypothesis in a case-control study of patients with CFA.

Methods We obtained lifetime occupational histories by postal questionnaire from 218 patients with CFA and 569 controls matched for age, sex, and community, living in the Trent region of the UK. Information was subsequently verified by telephone interview in 165 cases and 408 controls. Serum IgE, rheumatoid factor, and antinuclear antibodies and skin sensitivity to common allergens were measured in cases and in one matched control for each.

Findings The relative risk of CFA, after adjustment for smoking, was significantly increased in relation to questionnaire-reported exposure to metal dust (odds ratio 1·68 [95% CI 1·07–2·65], p=0·024) or to wood dust (1·71 [1·01–2·92], p=0·048). Similar results were obtained with the telephone interview data. Significant exposure-response effects were found for both metal-dust and wood-dust exposure. CFA was also associated with the presence of rheumatoid factor or antinuclear antibodies, but not with positive allergen skin tests or raised IgE concentrations. There was no evidence of interaction between the effects of rheumatoid factor, antinuclear antibodies, positive skin allergen tests, or IgE concentrations and exposure to metal or wood dust. The combined aetiological fraction attributable to exposure to metal or wood dust was of the order of 20%.

Interpretation Occupational exposures to metal or wood dust are independent risk factors for CFA. Avoidance or limitation of these exposures may provide an opportunity to prevent the disease.

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Introduction

Cryptogenic fibrosing alveolitis (CFA) is an interstitial lung disease that affects up to 20 adults per 100 000.[1] The disease is characterised by progressive dyspnoea, dry cough, inspiratory crackles on auscultation of the chest, and restrictive lung function. It is more common in men than in women and in older than in younger people.[1] The median survival time from diagnosis is about 5 years.[2] The causes are as yet unknown.

We have previously shown that mortality from CFA in the UK is increasing and tends to be higher in areas of the country that traditionally had high levels of employment in manufacturing industries.[3] We presented preliminary evidence that occupational exposure to metal or wood dust may be a cause,[4] and also suggested atopy as a risk factor for the disease.[4,5] We have tested these hypotheses in a case-control study specifically designed to investigate the role of occupational exposure to metal, wood, and other dusts as risk factors for CFA, and whether susceptibility to occupational causes of CFA is influenced by atopy, cigarette smoking, and autoimmune status.

Patients and methods

Cases and controls

We identified all potential cases of CFA seen in four teaching hospitals and five district general hospitals (total catchment