Risk of uterine rupture in women undergoing trial of labour with a history of both a caesarean section and a vaginal delivery

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Abstract
Purpose To determine the risk of uterine rupture for women undergoing trial of labour (TOL) with both a prior caesarean section (CS) and a vaginal delivery.
Methods A systematic literature search was performed using keywords for CS and uterine rupture. The results were critically appraised and the relevant and valid articles were extracted. Odds ratios were calculated and a pooled estimate was determined using the Mantel–Haenszel method.
Results Five studies were used for final analysis. Three studies showed a significant risk reduction for women with both a previous CS and a prior vaginal delivery (PVD) compared to women with a previous CS only, and two studies showed a trend towards risk reduction. The absolute risk of uterine rupture with a prior vaginal delivery varied from 0.17 to 0.46%. The overall odds ratio for PVD was 0.39 (95% CI 0.29–0.52, \( P < 0.00001 \)).
Conclusion Women with a history of both a CS and vaginal delivery are at decreased risk of uterine rupture when undergoing TOL compared with women who have only had a CS.

Keywords Uterine rupture · Trial of labour · VBAC · Caesarean section · Meta-analysis

Introduction
Traditionally the Netherlands have a low rate of caesarean sections (CS), but this rate has risen from 8% in 1993 to 15.1% in 2007 [1]. One of the reasons for this increase is that the higher rates of maternal and neonatal complications are reported [2, 3] for women undergoing trial of labour (TOL) after a first caesarean section. One of the most serious complications is the rupture of the uterus [4]. In general, the success rate of TOL is approximately 75% [5] and the associated risk of uterine rupture 0.4–0.7% [4, 6–8]. This risk increases when there is a classical or lower uterine segment vertical incision scar [9–12], or when labour is induced using oxytocin [13–15] or prostaglandins [7, 15, 16]. A risk reduction [17, 18] has been described for women with a prior vaginal delivery (PVD); however, no systematically reviewed data exist concerning the magnitude of the effect. This may play an important role in the decision whether to initiate TOL. Therefore, the aim of our study is to perform a systematic literature review to determine the risk of uterine rupture for women with a history of both a caesarean section and a vaginal delivery.

Methods
Search strategy
A literature review was conducted in the Medline database using the Pubmed search engine as well as in the Embase database, the Cochrane library and CINAHL.
We conducted the search using keywords for the patient population and outcome, see Table 1.

We used the following exclusion criteria: articles not in English, Dutch or German, case reports or no full text available. Inclusion criteria were that the study population included women with a history of caesarean section, a prior vaginal delivery and uterine rupture as an outcome measure. The search was conducted in June 2010. To assess the eligibility of the studies, two authors independently appraised and cross-checked the extracted studies. The included studies were screened for related articles.

Critical appraisal

The resulting articles were more closely looked at in the critical appraisal. Both the relevance and validity were evaluated. Studies were deemed relevant when patient population, predictor and outcome measures were in accordance with the predefined criteria as outlined in Table 2. To evaluate the validity, a set of criteria was established to rate the included studies on study design, selection bias, study size and outcome measures. To determine the criterion of population size, an a priori power analysis was conducted. For all criteria used, see Table 2. The level of evidence was graded according to the Harbour and Miller criteria [19], but this was not used as an independent criterion. Studies with both moderate to good relevance and validity were used to answer the clinical question.

Statistical analysis

Data on rates of uterine rupture in women with a history of both a CS and a PVD versus women with a history of solely a CS were extracted from the included studies. For one study [5], the original dataset was used in addition to the published article. The data were subsequently summarized in $2 \times 2$ tables. Where needed, missing values were computed on the basis of odds ratios and sample sizes using the quadratic formula. Statistical analysis was performed using RevMan 5 software [20]. Results were aggregated using the Mantel–Haenszel method [21] for fixed effects models, and the odds ratio of the pooled data was calculated with 95% confidence intervals.

Results

Search

The search query returned 3,578 articles across all search engines. Screening the results based on title and abstract resulted in 54 articles. Upon examination of the full text article, 9 articles were selected for further appraisal. Additionally one related article was found, see Fig. 1.

Critical appraisal

Ten articles [9, 22–29] were assessed in the critical appraisal. The criteria for the critical appraisal are outlined in Table 2. Six studies were selected, five of which were used for final analysis. All of them were cohort studies, three retrospective and two prospective. Population size varied from 2,204 to 35,854 patients. Four studies included women with a single caesarean section, while Kwee 2007 used one or more caesarean section as criterion. Hendler 2004 used a single previous vaginal delivery as predictor whereas the rest used one or more vaginal deliveries. The outcome measure was clinically evident uterine rupture for all studies. Although it is not explicitly stated that the dataset in Grobman 2008 is identical to the dataset in Grobman 2007 [23], presumably the same population is described. The data from Grobman 2008 [24] were, therefore, not used in further analysis.

Mercer [27] and Shimonovitz [30] were excluded since they studied a prior vaginal birth after caesarean section.
Table 2 Critical appraisal overview

| Study                      | Relevance | Validity | Blinding for PVD status | Selection bias | Population size | Subset analysis | Prediction rules | Outcome measures | Level of evidence | Overall validity |
|---------------------------|-----------|----------|-------------------------|----------------|----------------|----------------|------------------|------------------|------------------|------------------|
|                           | Patients | Predictor | Outcome | Overall relevance | Study design | Control group |                |                  |                  |                  |                  |
| Bedoya et al. [22]        | +        | +/-      | +/-      | 2                  | +/-          | +            | -                | +/-              | -                | 2                | 3                |
| Shimonovitz et al. [30]   | +        | -        | +/-      | 1.5                | -            | +            | -                | +/-              | +                | -                | 2                | 3.5              |
| Zelop et al. [29]         | +        | +/-      | +        | 2.5                | +/-          | +            | -                | +/-              | +                | +/-              | 2                | 5                |
| Hendler and Bujold [25]   | +        | +        | +/-      | 2.5                | +/-          | +            | -                | +/-              | +                | +/-              | 2                | 5                |
| Smith et al. [28]         | +/-      | +/-      | +/-      | 2                  | +/-          | +            | -                | +/-              | +/-              | +                | 2                | 4.5              |
| Macones et al. [26]       | +/-      | +/-      | +/-      | 1.5                | -            | +            | -                | +/-              | +                | +/-              | +                | 2                | 4.5              |
| Grobman et al. [23]       | +        | +/-      | +/-      | 2                  | +            | +            | -                | +                | +                | +/-              | +                | 2                | 6.5              |
| Kwee et al. [5]           | +/-      | +/-      | +        | 2                  | +/-          | +            | -                | +/-              | +                | +/-              | 2                | 5                |
| Grobman et al. [24]       | +        | +/-      | +/-      | 2                  | +            | +            | -                | +                | +/-              | +                | 2                | 6.5              |
| Mercer et al. [27]        | +/-      | -        | +/-      | 1                  | +            | +            | -                | +                | +/-              | +                | 2                | 6.5              |

**Footnotes:**
a, one caesarean section; +/-, one or more caesarean sections; +/-, both caesarean section and induction of labour
b, one prior vaginal birth; +/-, one or more vaginal deliveries; +/-, subset; -, VBAC
c, +, absolute and relative risk of uterine rupture; +/-, only relative or absolute risk
d, +, prospective; +/-, retrospective cohort study; -, case-control study; -, other
e, +, no prior vaginal birth; -, no control group
f, +, present; -, no blinding or not described
g, +, unlikely; +/-, unclear; -, likely
h, +, >10,000; +/-, 1,500–10,000; -, <1,500
i, +, vaginal delivery before or after caesarean section; +, >1 vaginal births; +, >1 caesareans; +, scar type; +, induction of labour; +/-, none
j, +, prediction model; +/-, no prediction model
k, +, externally validated clinically manifest uterus rupture; +/-, clinically manifest uterus rupture; -, not clearly described
l, According to the criteria of Harbour and Miller [14]
Prior vaginal delivery and uterine rupture

All studies found a lower risk of uterine rupture for women with a previous PVD, three studies showing a significant risk reduction and two studies showing a strong trend. Odds ratios varied from 0.18 (Zelop et al. [29]) to 0.47 (Kwee et al. [5]), with an absolute risk of uterine rupture with a PVD varying from 0.17% (Smith et al. [28]) to 0.82% (Kwee et al. [5]). When the results are pooled, the combined OR is 0.39 (95% CI 0.29–0.52, \( P < 1 \times 10^{-10} \)), see Fig. 2. Results are summarized in Table 3.

Discussion

Faced with choosing an intended route of delivery after a low-transverse caesarean section, women must choose between an elective caesarean section, with increased maternal morbidity on the short term and more long-term reproductive consequences [6, 31] and TOL, which involves a concurrent higher risk of uterine rupture. In order to make an informed decision, pregnant women with a previous caesarean delivery must be made aware of this risk of uterine rupture.

| Study or Subgroup | PVD - Events | Total | Weight | Odds Ratio M-H, Fixed, 95% CI | Odds Ratio M-H, Fixed, 95% CI |
|-------------------|--------------|-------|--------|-------------------------------|-------------------------------|
| Grobman 2007      | 26           | 5620  | 63     | 0.44 [0.28, 0.70]             |                               |
| Grobman 2008      | 24           | 5593  | 63     | 0.44 [0.28, 0.71]             |                               |
| Hendler 2004      | 2            | 517   | 26     | 0.24 [0.06, 1.03]             |                               |
| Kwee et al. 2007  | 7            | 850   | 42     | 0.47 [0.21, 1.05]             |                               |
| Smith 2004        | 22           | 12641 | 102    | 0.39 [0.25, 0.62]             |                               |
| Zelop 2000        | 2            | 1019  | 30     | 0.18 [0.04, 0.74]             |                               |
| Total (95% CI)    | 20647        | 35958 | 100.0% | 0.39 [0.29, 0.52]             |                               |
| Total events      | 59           | 263   |        |                               |                               |

Heterogeneity: \( \chi^2 = 2.07, \text{df} = 4 \; (P = 0.72); \; I^2 = 0\%

Test for overall effect: \( Z = 6.42 \; (P < 0.00001) \)
This systematic review of the literature has shown a previous vaginal delivery for women with a prior caesarean section, to be strongly predictive for the risk of uterine rupture, associated with a risk reduction of more than 60%. The evidence for this effect is strong due to the fact that the studies included have a relatively large sample size and because all studies are consistent in showing an effect in the same direction and of about the same magnitude. All but two studies showed a statistically significant effect. The pooled data showed a cumulative OR of 0.39.

It must be noted, however, that the analyzed studies, except for Hendler et al. [25], used one or more previous vaginal delivery as the predictor. This could have possibly augmented the found effect. Shimonovitz et al. [30], however, examined the effect of multiple VBAC attempts on the risk of uterine rupture and found no additional effect of two or more VBAC attempts. Mercer et al. [27] confirmed this finding. It is, therefore, unlikely that an increased number of previous vaginal deliveries will have a substantial additional effect.

Most of the data in Table 3 have been calculated using data extracted from the studies. Smith et al. [28] and presumably Hendler et al. [25] provided adjusted odds ratios. By means of comparing results and using previous vaginal delivery as an isolated predictor, unadjusted odds ratios needed to be calculated. It is conceivable that there are confounding factors present and, therefore, no conclusions can be drawn about a causative relation of PVD status with uterine rupture. However, this has no bearing on the usefulness of PVD status as an isolated predictor, which was the aim of this review.

Regarding the order of the caesarean section and the prior vaginal delivery, no data are available on its effect on the rate of uterine rupture. However, higher success rates for TOL are reported after a prior successful VBAC when compared with a vaginal delivery before the caesarean section [14, 32, 33]. It may, therefore, be conceivable that the risk of uterine rupture is lower for women who had a successful delivery after a caesarean section, in comparison to those who had a vaginal delivery prior to the caesarean section.

The abovementioned findings will be relevant for multiparae who have undergone a CS in the last pregnancy, as we have shown that a previous PVD is associated with a strongly reduced risk for uterine rupture and a high chance of success for TOL. Moreover, implications may extend to those women who had a CS in their first pregnancy and have to choose a delivery route for further pregnancies. The increased risk of placenta accreta and placenta praevia [34, 35] with each additional CS and the decreased risk of uterine rupture after VBAC, may be a reason to choose for TOL for families who plan on having more than two children.

| Study                  | Study design   | Population size | AR without vaginal delivery (%) | AR with vaginal delivery (%) | Odds ratio | 95% Confidence interval |
|------------------------|----------------|----------------|---------------------------------|-----------------------------|------------|-------------------------|
| Hendler and Bujold [25]| Retrospective cohort | 2,204         | 1.54                            | 0.39                        | OR 0.24*   | 0.06–1.03               |
| Smith et al. [28]      | Retrospective cohort | 35,854       | 0.43                            | 0.17                        | OR 0.39    | 0.25–0.62               |
| Zelop et al. [29]      | Retrospective cohort | 3,783         | 1.1                             | 0.20                        | OR 0.18    | 0.04–0.74               |
| Kwee et al. [5]        | Prospective cohort     | 3,273         | 1.7                             | 0.82                        | OR 0.47    | 0.21–1.05               |
| Grobman et al. [23]    | Prospective cohort     | 11,778        | 1.0                             | 0.46                        | OR 0.45    | 0.28–0.70               |
| Grobman et al. [24]a   | Prospective cohort     | 11,816        | 0.95                            | 0.43                        | OR 0.44    | 0.27–0.71               |

Calculated data have been italicized
* Not statistically significant
a Not used in the final analysis

Conclusion

Considering on the one hand the high quality of the evidence for PVD status as predictor for lower risk of uterine rupture, and on the other the severe consequences of uterine rupture for both mother and child, we strongly recommend the use of PVD status for deciding the intended delivery route.

Conflict of interest We declare that we have no conflict of interest.

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