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Risk factors of uterine rupture with a special interest to uterine fundal pressure

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Abstract

Purpose: Uterine rupture is a rare but serious event with a median incidence of 0.09%. Previous uterine surgery is the most common risk factor. The aim of our study was to analyze retrospectively women with uterine rupture during labor and to evaluate postulated risk factors such as uterine fundal pressure (UFP).

Methods: Twenty thousand one hundred and fifty-two deliveries were analyzed retrospectively. Inclusion criteria were 22 weeks and 0 days–42 weeks and 0 days of gestation, singleton pregnancy and cephalic presentation. Women with primary cesarean section were excluded. A logistic regression analysis adjusting for possible risk factors was conducted and a subgroup analysis of women with unscarred uterus was performed.

Results: Twenty-eight cases of uterine rupture were identified (incidence: 0.14%). Uterine rupture was noticed in multipara patients only. In the multivariate analysis among all study patients, only previous cesarean section remained a statistically significant risk factor [adjusted odds ration (adj. OR) 12.52 confidence interval (CI) 95% 5.21–30.09]. In the subgroup analysis among women with unscarred uterus (n=19,415) three risk factors were associated with uterine rupture: UFP (adj. OR 5.22 CI 95% 1.07–25.55), abnormal placentation (adj. OR 20.82 CI 95% 2.48–175.16) and age at delivery >40 years (adj. OR 4.77 CI 95% 1.44–15.85).

Conclusions: The main risk factor for uterine rupture in the whole study population is previous uterine surgery. Risk factors in women with unscarred uterus were UFP, abnormal placentation, and age at delivery >40 years. The only factor which can be modified is UFP. We suggest that UFP should be used with caution at least in presence of other supposed risk factors.

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Keywords: Abnormal placentation; maternal age; multiparity; uterine fundal pressure; uterine rupture.

Introduction

Uterine rupture is a serious, life-threatening event with a high risk of maternal and fetal morbidity and mortality. Several risk factors have been identified, the most important being a uterine scar, mostly from previous cesarean section [1–3]. The median incidence of uterine rupture based on studies in high-income countries is around 0.09% [3]. After previous cesarean section, the incidence varies between 0.4% and 0.9% [3, 5] whereas in women without prior uterine surgery the incidence of uterine rupture is about 0.006%–0.02% [4, 5]. In addition to previous cesarean section, postulated risk factors for uterine rupture are induction of labor, maternal age, multiparity, gestational age at delivery, vacuum-assisted birth, fetal birth weight, short inter pregnancy interval, prolonged second stage of labor, abnormal placentation, and uterine fundal pressure (UFP) [2, 6–15]. Although UFP is widely used [16] – a survey in the US found that in 80% of institutions UFP was applied [17] – there is scarce data about its' association with uterine rupture [16, 17]. UFP involves the application of manual pressure on the uppermost part of the uterus, directed towards the birth canal in an attempt to shorten the second stage of labor [16]. Thereby, the intrauterine pressure in the second stage of labor transiently increases by up to 86% [18], which might pose a relevant factor in the pathophysiology of uterine rupture.

The aim of our study was to perform a retrospective analysis of women with uterine rupture during labor and to evaluate postulated, less studied risk factors such as UFP. UFP so far was not studied in a sufficiently powered study population with an appropriate statistical analysis that includes the adjustment for other possible risk factors in a multivariate regression.

Materials and methods

A retrospective cohort study at the University hospital of Zürich was directed by obtaining data from our electronic database Perinat.

This database is a local comprehensive electronic health record containing all diagnoses and parametriced detailed clinical data about the course of pregnancy, delivery, maternal and infant outcome. The study has ethical affirmation according to the Institutional Review Bord decision for the use of anonymized patient data for medical research (January 2000–December 2013), based on the World Medical Association Declaration of Helsinki. All deliveries between January 2000 and December 2013 were included. Twenty thousand one hundrd and fifty-two deliveries fulfilled the inclusion criteria (≥22 weeks and 0 days of gestation, singleton pregnancy, cephalic presentation). The exclusion criteria were primary cesarean section, breech presentation, multiple pregnancy, and incomplete documentation. Information about the following obstetric parameters was collected: maternal age, parity, gestational age at delivery, post term pregnancy, previous uterine surgery, mode of delivery, use of UFP, medical induction of labor, duration of second stage of labor, abnormal placentation (placenta increta, accreta or percreta), and fetal birth weight. Previous uterine surgery was defined as surgery involving the uterine wall and the mucosa of the uterus, in most cases due to cesarean section. To identify patients with uterine rupture and exclude patients with uterine dehiscence only, surgery reports of all suspected cases of uterine rupture were studied. Uterine rupture was determined as a full-thickness disruption of the uterine wall that also involves the overlying visceral peritoneum (uterine serosa). Statistical analysis was performed using Sigmaplot 12.0 (Systat Software Inc., CA, USA). The incidence of risk factors for uterine rupture and baseline characteristics in patients with and without uterine rupture were compared using the *z*-test. The level of statistical significance was set at $P<0.05$. A multivariate logistic regression analysis adjusting for the postulated risk factors for uterine rupture (maternal age, post term pregnancy, previous uterine surgery, vacuum assisted delivery, use of UFP, medical induction of labor, duration of second stage of labor, abnormal placentation, and fetal birth weight) was conducted. In a second step, a subgroup analysis of women with scarred and unscarred uterus was performed.

Results

Twenty thousand one hundrd and fifty-two deliveries at the University hospital of Zürich between January 2000 and December 2013 were examined. Seventeen thousand nine hundred and fifty-seven vaginal births (89.1%) were observed, from 13,787 spontaneous vaginal deliveries, 1225 vaginal deliveries with UFP, 2723 vacuum-assisted deliveries and 222 vacuum-assisted deliveries with UFP. Two thousand one hundred and ninety-five women had a secondary cesarean section (10.9%). Twenty-eight cases of uterine rupture were identified (0.14% of the observed population). Out of these, 22 women had a cesarean section during labor and six a vaginal birth with postpartum diagnosis of uterine rupture. Among these six women with uterine rupture during vaginal birth, one had a spontaneous delivery, three a vacuum-assisted delivery, and UFP was applied in two women (Figure 1). All patients with uterine rupture were multipara while in patients without uterine rupture multiparity was seen in 51.5% ($P=0.01$) (Table 1). Of the patients with uterine rupture 53.6% had prior surgery compared to 3.6% of patients without uterine rupture ($P<0.01$). Five patients (17.9%) with uterine rupture were over 40 years old at time of delivery compared to 5.9% in the group without uterine rupture ($P=0.02$). Another statistically significant difference was found in patients with induction of labor and previous uterine surgery: in the group of women with uterine rupture, 14.3% of patients had this combination of risk factors compared to only 0.6% of patients in the

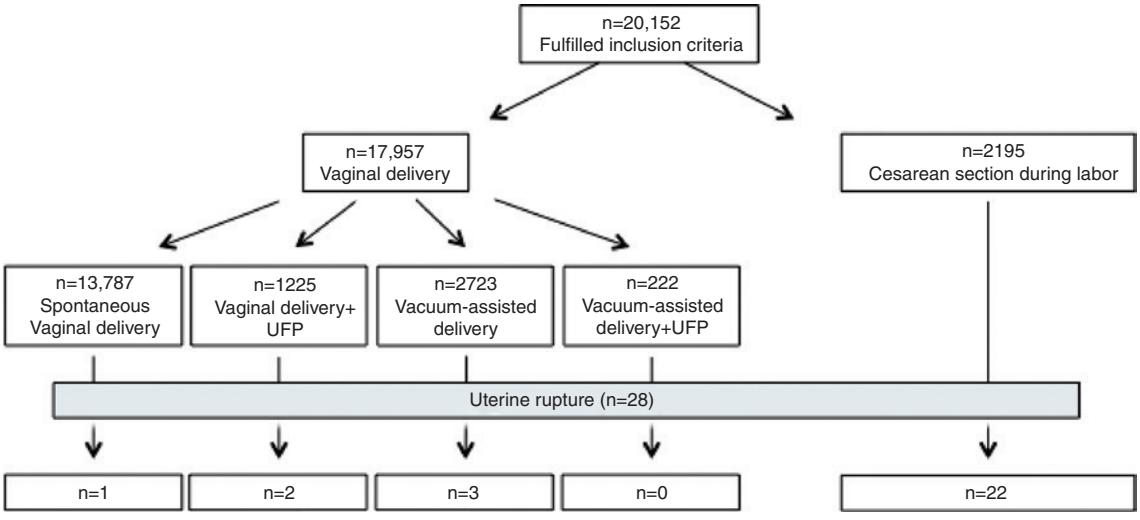

Figure 1: Occurrence of uterine rupture according to birth mode. UFP=Uterine fundal pressure.

Table 1: Incidence of risk factors for uterine rupture and baseline characteristics in patients with and without uterine rupture.

	With uterine rupture (n=28)	Without uterine rupture (n=20,124)	Total (n=20,152)	P-value
Secondary cesarean[a]	**78.6%** (22)	**10.8%** (2173)	11% (2195)	<**0.001**
Vaginal birth with fundal pressure	7.1% (2)	6.0% (1223)	6% (1225)	0.818
Vacuum assisted delivery	10.7% (3)	13.5% (2720)	13.5% (2723)	0.876
Previous uterine surgery[a]	**53.6%** (15)	**3.6%** (722)	3.7% (737)	<**0.001**
Maternal age ≥40 years[a]	**17.9%** (5)	**5.9%** (1189)	5.9% (1194)	0.022
Multiparity[a]	**100%** (28)	**51.5%** (10358)	51.5% (10386)	<**0.001**
Medical induction of labor	25.0% (7)	19.8% (3974)	19.8% (3981)	0.651
Induction of labor+scarred uterus[a]	**14.3%** (4)	**0.6%** (128)	0.7% (132)	<**0.001**
2nd stage of labor ≥120 min	3.6% (1)	15.8% (3181)	15.8% (3182)	0.131
Birth weight >4 kg	3.6% (1)	8.5% (1709)	8.5% (1710)	0.555
Abnormal placentation	3.6% (1)	0.3% (65)	0.3% (66)	0.147
Gestational age ≥40 weeks	32.1% (9)	43.9% (8839)	43.9% (8848)	0.286

Data are expressed as % UFP=Uterine fundal pressure. Risk factors indicated by superscript 'a' mean significant result. Values highlighted in bold also indicate significant result.

group of patients without uterine rupture (P<0.01). There was no statistically significant difference regarding other investigated risk factors such as abnormal placentation, protracted second stage of labor, birth weight over 4 kg, and post-term pregnancies (Table 1). In the multivariate regression analysis, only previous uterine surgery was associated with uterine rupture (adj. OR 12.52, CI: 95% 5.21–30.09). Further explored risk factors (UFP, vacuum-assisted birth, multiparity, induction of labor, induction of labor in patients with previous uterine surgery, age >40 years, prolonged second stage of labor >2 h, post-term pregnancy, abnormal placentation, infants' birth weights >4 kg) did not result in a statistically significant association (Table 2). In a second step, a subgroup analysis was performed and patients with or without previous uterine surgery were analysed separately. The analysis of the subgroup of women with previous uterine surgery (n=737) did not show any further association of another risk factor with uterine rupture. In the subgroup of women with unscarred uterus (n=19,415), three risk factors were associated with the occurrence of uterine rupture: abnormal placentation (adj. OR 20.82 CI 95% 2.48–175.16), application of UFP (adj. OR 5.22 CI 95% 1.07–25.55) and age at delivery over 40 years (adj. OR 4.77 CI 95% 1.44–15.85) (Table 3). These findings remained when only multipara patients were analyzed (data not shown).

Discussion

The overall incidence of uterine rupture was 0.14% (28 of 20,152) which is higher than the median incidence of uterine rupture based on studies in high-income countries (0.09%) [3]. This finding may be related to the thorough assessment of a single center-database. Rupture in patients with previous uterine surgery was seen in 2.04% (15 of 737), compared to 0.9%–1% in other large retrospective studies [3, 20]. Also in the subgroup of women with an unscarred uterus, in our collective a higher incidence of uterine rupture was observed as compared to the published incidence in other studies (0.067% vs. 0.02%–0.006%) [3–5]. The results in our study population allow three main conclusions: firstly and in accordance to many other publications, we found that the main risk factor for uterine rupture is previous uterine surgery [3, 19, 21]. Secondly, uterine rupture was found in multipara patients only. Thirdly, in our subgroup analysis of women with unscarred uterus, three risk factors were associated with uterine rupture: UFP, abnormal placentation and maternal age ≥40 years. Apart from previous uterine surgery as an accepted main risk factor in the literature, there is less consent about other possible risk factors. Many studies investigate only few possible risk factors without performing a multivariate logistic regression analysis [7, 19]. It is methodologically disputable to postulate a risk factor for uterine rupture without adjustment for previous uterine surgery. Kaczmarczyk published solid data using accurately a logistic regression model for the identification of risk factors for uterine rupture [3]. However, the influence of UFP was not evaluated. Therefore, we conducted a multivariate analysis that included the factor UFP [3, 13, 21]. Use of UFP is only indicated in case of complications such as prolonged second stage of labor, which represents another risk factor for uterine rupture itself [13]. Adjustment for this possible confounder is inevitable in a risk evaluation. In our study population, women with unscarred uterus had a five-fold risk for uterine rupture after use of UFP. This finding is even more important, as UFP is widely used although there is scarce data about its safety [12, 16, 17]. We further confirm risk factors such

Table 2: Adjusted odds ratios for uterine rupture.

	Adj. odds ratio	CI 95%	P-value
Vaginal birth with uterine fundal pressure	2.46	0.56–10.85	0.234
Vacuum assisted delivery	1.45	0.35–5.95	0.604
Maternal age ≥40 years	1.43	0.48–4.24	0.524
Abnormal placentation	4.87	0.57–41.73	0.149
Gestational age ≥40 weeks	1.03	0.41–2.56	0.951
Medical induction of labor	1.28	0.35–4.66	0.712
Second stage of labor ≥120 min	1.17	0.29–4.79	0.825
Birth weight >4 kg	1.00	0.99–1.00	0.027
Previous uterine surgery	**12.51**	**5.21–30.01**	**<0.001**
Induction of labor and scarred uterus	1.54	0.27–8.96	0.630

CI=Confidence interval. Values highlighted in bold indicate significant result.

Table 3: Adjusted odds ratios for uterine rupture in women with unscarred uterus.

	Adj. odds ratio	CI 95%	P-value
Vaginal birth with uterine fundal pressure	**5.22**	**1.07–25.55**	**0.041**
Vacuum assisted delivery	2.65	0.47–14.99	0.263
Maternal age ≥40 years	**4.77**	**1.44–15.85**	**0.010**
Abnormal placentation	**20.82**	**2.48–175.16**	**0.005**
Gestational age ≥40 weeks	0.60	0.18–2.00	0.408
Medical induction of labor	0.96	0.26–3.61	0.948
Second stage of labor ≥120 min	4.15	0.95–18.25	0.058
Birth weight >4 kg	0.73	0.09–5.93	0.769

CI=Confidence interval. Values highlighted in bold indicate significant result.

as abnormal placentation and increased maternal age as already described [22]. Induction of labor is postulated as important risk factor by many other authors, although this conclusion was not supported by all published studies [3, 4, 23, 24]. In our study population, induction of labor in patients with previous uterine surgery seemed to be associated with uterine rupture ($P<0.01$). Interestingly, after logistic regression in a multivariate analysis, the adjusted odds ratio missed the level of statistical significance. A strength of our study is the adequate number of women with a standardized management during delivery. Our electronic database allows solid documentation of the requested information, which is filled in prospectively. Documentation is completed for every patient before discharge and supervised by the attending consultant. Hence, the database allows a reliable retrospective analysis. A multivariate logistic regression analysis adjusting for the postulated risk factors for uterine rupture was conducted, in opposition to many other studies [3, 13, 21]. The rarity of uterine rupture may result in a statistical inaccuracy in any single center study like ours. Wide 95% confidence intervals shall be expected in this situation. A large number of patients would be required to minimize the bias of different cofactors. Nevertheless, studies based on a multicenter or nationwide database may imply inaccuracy due to a varying quality level of documentation. It is known that especially the documentation and associated peripartal outcome after use of UFP is reported rather unreliably [17]. As a clinical consequence of our data, UFP should be used with caution. Previous uterine surgery, multiparity, abnormal placentation, and maternal age ≥40 years are pre-existing risk factors of the parturient woman. According to our results, the only parameter which can be modified with regard to uterine rupture, is UFP. We suggest that UFP should be avoided at least in presence of other supposed risk factors.

Compliance with ethical standards

Disclosure of potential conflicts of interest: The authors declare that they have no conflict of interest.

Research involving human participants and/or animals: For this type of study formal consent is not required. This article does not contain any studies with human participants or animals performed by any of the authors. The study has ethical affirmation according to the Institutional Review Bord decision for the use of anonymised patient data for medical research (January 2000–December 2013), based on the World Medical Association Declaration of Helsinki.

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