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Оценка факторов, влияющих на исход родов у женщин с абдоминальными родами в анамнезе

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Обоснование. Стремительный рост частоты кесарева сечения привел к возникновению особой группы пациенток с рубцом на матке, желающих родить через естественные родовые пути, поскольку повторное оперативное родоразрешение сопряжено с высокими рисками как интраоперационных, так и послеоперационных осложнений.

Цель исследования — создать модель, позволяющую на основе комплексной оценки факторов риска прогнозировать исход родов у женщин с абдоминальными родами в анамнезе.

Материалы и методы. Проведен ретроспективный анализ 173 историй родов женщин с рубцом на матке после предшествующего кесарева сечения, родоразрешенных на базе Городского родильного дома в г. Чите за период 2021–2022 гг. Выделено три группы пациенток: в I группу включены 110 женщин, родоразрешенных путем кесарева сечения в плановом порядке; во II группу — 20 женщин, родоразрешенных путем кесарева сечения в процессе самопроизвольных родов; в III группу — 43 женщины, родившие через естественные родовые пути. Группы сопоставимы по национальности, возрасту, материальным и социальным условиям жизни женщин. Накануне родов всем пациенткам выполнены общеклиническое и акушерское ультразвуковые исследования, а также уточнение особенностей анамнеза. Статистическая обработка результатов осуществлена с помощью программы IBM SPSS Statistics Version 25.0.

Результаты. На основе бинарной логистической регрессии разработана модель прогнозирования исхода родов через естественные родовые пути у женщин с рубцом на матке с учетом таких статистически значимых показателей, как срок гестации, предполагаемая масса плода, паритет родов, а также наличие хронического эндометрита и слабости родовой деятельности в анамнезе. Чувствительность разработанной прогностической модели составляет 0,86, специфичность — 0,70. Площадь под ROC-кривой составляет 0,87 (95 % доверительный интервал 0,78–0,96; $p < 0,001$).

Заключение. Комплексный анализ факторов риска позволяет прогнозировать исход естественных родов у женщин с рубцом на матке, что в перспективе поможет оптимизировать тактику их родоразрешения и предупредить развитие осложнений в родах у матери и плода.

Ключевые слова: рубец на матке; роды с рубцом на матке; кесарево сечение.

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Evaluation of the factors influencing labor outcomes in women with a history of abdominal delivery

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BACKGROUND: The rapid increase in the frequency of caesarean sections has led to the emergence of a special group of patients with a uterine scar who want to give birth through the natural birth canal. Repeated operative delivery is associated with high risks of both intraoperative and postoperative complications, therefore, every year the number of women with a uterine scar who prefer natural childbirth is growing.

AIM: The aim of this study was to create a model that allows, based on a comprehensive assessment of risk factors, for predicting the outcome of childbirth in women with a history of abdominal childbirth.

MATERIALS AND METHODS: We carried out a retrospective analysis of 173 birth histories of women with a uterine scar after a previous caesarean section, delivered in the Chita City Maternity Hospital in 2021–2022. Three groups of individuals were designed for the study: Group 1 included 110 women delivered by caesarean section in a planned manner; Group 2 comprised 20 women delivered by caesarean section during childbirth, while Group 3 consisted of 43 women who gave birth through the natural birth canal. The groups were comparable in terms of nationality, age, material and social conditions of the patients. On the eve of delivery, all patients underwent general clinical and obstetric ultrasound examination, with the anamnesis details clarified. The data obtained were processed statistically using the IBM SPSS Statistics version 25.0.

RESULTS: Using binary logistic regression, a model was developed to predict the outcome of childbirth through the natural birth canal in women with a uterine scar, which takes into account statistically significant indicators such as gestational age, estimated fetal weight, parity, and the presence of chronic endometritis and weakness of labor activity in history. The sensitivity of the developed prognostic model is 0.86, the specificity being 0.70. The area under the ROC curve is 0.87 (95% confidence interval 0.78–0.96; $p < 0.001$).

CONCLUSIONS: The comprehensive analysis of risk factors allows for predicting the outcome of natural childbirth in women with a uterine scar, which in the future will optimize the tactics of their delivery and prevent the development of complications in childbirth for the mother and fetus.

Keywords: uterine scar; labor with a uterine scar; cesarean section.

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BACKGROUND

In modern obstetrics, choosing the delivery method for patients with the operated uterus syndrome has become a severe issue [1]. Due to the development of general surgery and operative obstetrics, as well as advancements in pharmacology and anesthesiology, the cesarean section has become an integral element of modern obstetrics [2, 3]. Achievements in neonatology and the development of medical industry have led to the possibility of successful nursing newborns with low or extremely low body weight, allowing the fetus to be considered as a patient on equal terms with the mother. All of this has significantly increased the number of invariable and relative indications for cesarean section [4]. In a number of countries, patients have the opportunity to choose the method of delivery, which has consequently led to surgeries without medical indications [5]. In all developed countries, reduced delivery times, scheduling of surgery, short-term postpartum benefits, the impact of a supportive regulatory environment, patient readiness for operative delivery, and the perceived safety of surgery have induced an incredibly high rate of increase in cesarean section rates [6].

However, as it turned out later, the safety of this surgery was initially overestimated. The risks of hemorrhage, thromboembolic, and infectious complications are known to increase after cesarean section. These complications occur in 4% of cases during the initial surgery, but during the repeated surgery, the frequency of intraoperative complications increases sharply by five times and amounts to 20.5% [7, 8]. The history of cesarean section performed twice becomes an invariable indication for subsequent surgeries, which also increases the risk of adverse perinatal outcomes [8].

It should be noted that abdominal delivery is not absolutely safe and preferable for the fetus. There is evidence that adaptation failures, respiratory, and endocrinological disorders are more often registered in newborns when using cesarean section. These children more often have immune system disorders, asthma, and obesity in late childhood [9]. However, the analysis of the prospective follow-up of children born by cesarean section should be studied in more detail to identify other possible consequences of the surgery [10].

Separately, it is important to emphasize the late complications of cesarean section. Together with the increase in the frequency of this surgery, obstetricians and gynecologists register increasingly more often an incompetent uterine scar, the ovum implantation in the scar on the uterus, or uterine rupture along the scar during pregnancy and childbirth. Various abnormalities of placentation are recognized as the most hazardous complications since an increase in their incidence is linearly related to the increase in the frequency of cesarean section, which could not but affect the level of maternal

mortality. In Russia, the frequency of cesarean section ranges from 16% to 29%, and in the third level hospitals, it reaches 40%–50% [11]. At the same time, more than 60% of surgeries are performed in primiparity [12]. A similar trend has been registered in other countries. The cesarean section rate in the USA has increased from 5% to 32% from 1987 to the present. At the same time, the maternal mortality rate also increased from 7.2 to 17.4 lethal outcomes per 100,000 live births over the corresponding period of time [13]. At the same time, 1.7% of maternal deaths are associated with placenta previa and placenta increta [1].

Thus, a cesarean section rate of more than 10% in a population is above the limit recommended by the World Health Organization and not only does not improve perinatal outcomes, but also leads to increased maternal and neonatal morbidity and mortality [14]. Ignoring these data and refusing to reduce the frequency of cesarean sections will certainly lead to further maternal and perinatal losses, and their number will increase simultaneously with the increase in the number of surgeries.

The study aimed to develop algorithms for the management of patients with the operated uterus syndrome to prevent the consequences described, which enable to identify a group of patients with vaginal delivery, safe for both mother and fetus, and to determine the factors that affect significantly the outcome of childbirth in this group of female patients.

MATERIALS AND METHODS

To achieve this aim, a retrospective analysis of 173 birth histories of women with a uterine scar after a previous cesarean section with a transverse incision in the lower uterine segment was performed. These women gave birth at the Chita City Maternity Hospital between 2021 and 2022.

The inclusion criteria were the history of one cesarean section in the lower uterine segment, gestational age of 37–42 weeks, cephalic presentation of the fetus, and normal pelvic dimensions.

The exclusion criteria were the following:

- myomectomy and reconstructive surgeries on the uterus;
- two or more cesarean sections in history;
- corporal, isthmic-corporal, bottom, and other techniques of cesarean section in history, leading to the formation of an incompetent uterine scar;
- gestational age at the time of delivery of less than 37 weeks and more than 42 weeks;
- breech and extension presentations;
- oblique and shoulder presentation of the fetus;
- anatomically narrow pelvis;
- impaired development of the genital organs;
- history of pelvic trauma;
- complications of pregnancy which required early delivery (preeclampsia, HELLP-syndrome, etc.).

Three groups of patients were identified. Group I included 110 female patients with elective delivery by cesarean section; group II included 20 female patients with delivery by cesarean section in the process of spontaneous delivery; and group III consisted of 43 female patients with vaginal delivery.

All women were examined in accordance with clinical guidelines approved by the Russian Ministry of Health [8, 15, 16]. The groups were comparable in terms of nationality, age, material, and social conditions of life of the women.

When conducting statistical analysis, the authors were guided by the principles of the International Committee of Medical Journal Editors and the recommendations of Statistical Analysis and Methods in the Published Literature [17, 18]. Analysis of normality of the distribution of signs, considering the predominant number of the study groups of less than 50 women, was performed using the Shapiro–Wilk test. Taking into account the distribution of signs that was different from normal in all the studied groups, the data obtained were presented as a median, first and third quartiles (Me [Q₁; Q₃]). To compare three independent groups for one quantitative attribute, the Kruskal–Wallis rank analysis of variance (*H*-test) was used. In the presence of statistically significant differences with the Bonferroni correction, a pairwise comparison was performed using the Mann–Whitney *U*-test. Nominal data were described in terms of absolute values and percentages and compared using Pearson's chi-square test, which assesses the significance of differences between the actual number of outcomes or qualitative characteristics of the sample in each category and the theoretical number expected in the study groups if the null hypothesis is true. The odds ratio was used to assess the significance of differences in nominal data in groups II and III based on the retrospective analysis of the resulting and factor signs. Statistical significance (*p*) was determined by the value of the 95% confidence interval and the number of degrees of freedom (*df*). In all cases, *p* < 0.05 was considered statistically significant. In a predictive model based on logistic regression analysis, the most significant risk factors for poor outcome of vaginal delivery in women with a uterine scar were included. The diagnostic information content of the model developed was determined by receiver operating characteristic (ROC) analysis. Statistical processing of the research results was performed using the IBM SPSS Statistics Version 25.0 software package (International Business Machines Corporation, USA).

RESULTS

The parity of deliveries in the study groups was distributed as follows. Patients of group I had a delivery 2 (2.0 [2.0; 2.3]), patients of group II also had a delivery 2

(2.0 [2.0; 2.1]), and in patients of group III had delivery 2 or delivery 3 (2.5 [2.4; 2.7]) (*H* = 12.3, *df* = 2, *p* = 0.002), which confirms the significance of vaginal delivery in history for a favorable outcome of the upcoming birth. It is noteworthy that the parity of childbirth in patients of groups I and II did not reveal statistically significant differences (*U* = 942.0; *p* = 0.12).

A history of medical abortions was noted in 28.2% (31/110) of female patients in group I, in 50.0% (10/20) in group II, and in 27.9% (12/43) in group III ($\chi^2 = 4.0$; *df* = 2; *p* = 0.14). It may seem that the absence of statistically significant differences in this indicator is due to the inclusion of the study group I in the comparison. However, pairwise comparison of groups II and III also revealed no differences ($\chi^2 = 2.9$; *df* = 1; *p* = 0.09). The incidence of miscarriages in the history of patients in all three groups was almost equal and averaged 20.0% ($\chi^2 = 0.02$; *df* = 2; *p* = 0.99).

The gestational age at the time of delivery in groups I and II differed insignificantly and amounted to 39.0 (38.9; 39.1) and 39.0 (38.7; 39.2) weeks, respectively (*U* = 1,074.5, *p* = 0.86); while in group III, the indicators were significantly lower, namely, 38.0 (38.0; 38.5) weeks (*H* = 10.9, *df* = 2, *p* = 0.004). This fact is probably associated not only with a progressive increase in fetal weight as the gestational age increases, but also with the earlier maturation of the birth canal and readiness for childbirth of both the female body as a whole and the myometrium. Refusal of patients from further independent labor in group II was noted in 30% (6/20) of cases ($\chi^2 = 47.6$; *df* = 2; *p* < 0.001).

Immediately prior to delivery, each patient underwent ultrasound fetometry. Using the F. Hadlock's, M. Hansmann's, and V.N. Demidov's equations, the estimated fetal weight was calculated, and the average value of this indicator in groups was derived. The estimated fetal weight was 3,505.0 g (3,470.3; 3,560.8) in the group of patients with elective caesarian section, 3,580.0 g (3,390.4; 3,572.5) in patients with emergency cesarean section in spontaneous labor, and 3,230.0 g (3,185.3; 3,350.5) in patients with vaginal delivery (*H* = 8.3, *df* = 2, *p* = 0.016). The estimated weight of the fetus in the study group II was 1.11 [1.01; 1.12] times higher than the corresponding indicator in group III (*U* = 300.5, *p* = 0.049).

An immature birth canal by the time a full-term pregnancy is a factor that reduces the probability of successful vaginal delivery. This factor was noted in 10.0% (11/110) of group I patients and was not detected in patients of groups II and III ($\chi^2 = 6.7$; *df* = 2; *p* = 0.03).

An analysis of the structure of inflammatory diseases of the pelvic organs showed that chronic endometritis before the current pregnancy was diagnosed in 20.0% (22/110) of female patients in group I, in 10.0% (2/20) in group II, and in 37.2% (16/43) in group III ($\chi^2 = 7.3$; *df* = 2; *p* = 0.03). On the eve of childbirth, vaginitis of various etiologies was diagnosed in

13.6% (15/110) of group I patients, in 20.0% (4/20) of group II, and in group III patients at the time of delivery, inflammatory diseases of the vagina were not detected ($\chi^2 = 7.8$; $df = 2$; $p = 0.02$). Therefore, an acute infectious pathology of the birth canal affects negatively the success of independent childbirth in women with a uterine scar. It can be assumed that vaginitis contributed to the occurrence of untimely discharge of amniotic fluid, which could affect significantly the outcome of vaginal delivery. However, this assumption has not been confirmed, and prenatal discharge of amniotic fluid was diagnosed in 9.1% (10/110) of group I patients but was not registered in patients of groups II and III ($\chi^2 = 6.1$; $df = 2$; $p = 0.05$). Infectious pathology of another localization also did not have a statistically significant effect on the outcome of childbirth in patients with a uterine scar. Thus, chronic cervicitis of various etiologies, registered in 13.6% (15/110) of patients of group I, was not noted in patients of group II but was found in 14.0% (6/43) of group III patients ($\chi^2 = 3.1$; $df = 2$; $p = 0.2$).

Similar results were obtained in the analysis of the effect of chronic pathology of the urinary system on the success of vaginal delivery. Chronic pyelonephritis was noted in 14.5% (16/110) of group I patients, in 35.0% (7/20) of group II patients, and in 20.9% (9/43) of group III patients ($\chi^2 = 4.9$; $df = 2$; $p = 0.09$). Chronic kidney disease was detected only in 9.1% (10/110) of female patients in group I, in 20.0% (4/20) of cases in group II, and in 18.6% (8/43) of patients in group III ($\chi^2 = 3.6$; $df = 2$; $p = 0.2$), which also confirms the exclusive role of endometritis in the processes of myometrium repair.

Analysis of the presence of extragenital pathology showed the following results. Alimentary-constitutional obesity was diagnosed in 26.4% (29/110) of pregnant women of group I, in 10.0% (2/20) of cases in group II, and in 9.3% (4/43) of patients in group III ($\chi^2 = 7.0$; $df = 2$; $p = 0.03$). Anemia of various origins during pregnancy was detected in 40.9% (45/110) of women in group I, as well as in 50.0% (10/20) and 25.6% (11/43) of patients in groups II and III, respectively ($\chi^2 = 4.4$; $df = 2$; $p = 0.2$). Varicose veins of the lower extremities were detected in 14.5% (16/110) of patients who underwent an elective caesarian section, in 20.0% (4/20) of patients who underwent an emergency caesarian section in spontaneous labor, and in 7.0% (3/43) of women with a uterine scar, after vaginal delivery ($\chi^2 = 3.1$; $df = 2$; $p = 0.2$). Syndrome of neurocirculatory dystonia was registered in 6.4% (7/110), 10.0% (2/20), and 4.7% (2/43) of patients of groups I, II, and III, respectively ($\chi^2 = 0.7$; $df = 2$; $p = 0.7$). Arterial hypertension that developed before pregnancy was detected in 7.3% (8/110) of group I patients, in 5.3% (1/20) in group II, and in 14.0% (6/43) of cases in group III ($\chi^2 = 2.1$; $df = 2$; $p = 0.4$). Thrombocytopenia without hemorrhagic syndrome of various etiologies during pregnancy was noted in 1.8% (2/110) of pregnant women of group I,

in 5.0% (1/20) of cases in group II, and was not detected in patients of group III ($\chi^2 = 2.0$; $df = 2$; $p = 0.4$). Thus, among chronic extragenital pathologies, only alimentary-constitutional obesity revealed statistically significant differences in the incidence in the studied groups. Consequently, metabolic disorders that often develop in obesity affect negatively the compensatory capabilities of scar tissue.

An association between gestational diabetes mellitus and the success of vaginal delivery has not been detected. Gestational diabetes mellitus complicated the course of pregnancy in 20.0% (22/110) of female patients in group I, 5.0% (1/20) in group II, and 16.3% in group III (7/43) ($\chi^2 = 2.7$; $df = 2$; $p = 0.3$).

Analysis of the course of previous births in patients of the studied groups showed poor uterine contraction strength in 34.5% (38/110) and 35.0% (7/20) of patients with elective and emergency caesarian sections, respectively. In group III patients after vaginal delivery, poor uterine contraction strength in previous births was registered only in 7.0% (3/43) of cases ($\chi^2 = 12.3$; $df = 2$; $p = 0.002$). The indication for operative delivery during the next childbirth in group II in 50.0% (10/20) cases was also the development of poor uterine contraction strength ($\chi^2 = 49.6$; $df = 2$; $p < 0.001$). This fact indicates that patients with a history of poor uterine contraction strength have an initial functional and probable structural failure of the myometrium, which prevents from expecting a favorable outcome of subsequent childbirth.

There were no statistically significant differences in other complications of the delivery process in the patients of the studied groups. 28.2% (31/110) of newborns of group I and 10.0% (2/20) of newborns of group II had a large birth weight; while in group III, macrosomia was not diagnosed ($\chi^2 = 16.5$; $df = 2$; $p < 0.001$). It should be noted that in group II, in all cases, fetal macrosomia was also not diagnosed, which determines the need to improve existing equations.

Given the dichotomous distribution of the dependent variable, indicating a favorable or poor outcome of vaginal delivery, binary logistic regression was used to create a predictive model (Table).

As a result of rounding the coefficients to simplify calculations in clinical practice, the following equation was obtained:

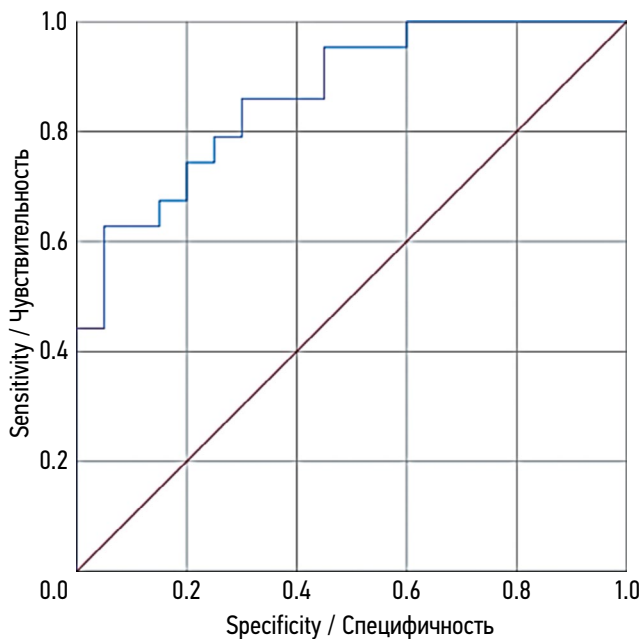
$$PLO = 1 / (e^{0.56 \cdot GA + 0.002 \cdot FW - 3.06 \cdot FD - 1.37 \cdot CE + 2.14 \cdot PUCS - 21}),$$

where PLO is the probability coefficient of a favorable outcome of vaginal delivery in a woman with a history of abdominal labor; 0.56, 0.002, 3.06, 1.37, and 2.14 are unstandardized B regression coefficients; GA is gestational age on the eve of childbirth (weeks); FW is estimated fetal weight, according to ultrasonic fetometry (g); FD is forthcoming delivery in succession (absolute number); CE and PUCS are indicators

Table. Significance of parameters in the structure of the predictive model, the degrees of freedom is 1**Таблица.** Значимость показателей в структуре прогностической модели, число степеней свободы равно 1

Indicator	Regression coefficient B	Root mean square error	Wald test	Statistical significance	Exposed odds value
Constant	20.983	13.206	2.525	$p = 0.112$	1296468314
Childbirth parity	3.058	1.287	5.649	$p = 0.017$	21.293
Gestational age	-0.558	0.346	2.598	$p = 0.107$	0.572
Fetal weight	-0.002	0.001	2.613	$p = 0.106$	0.998
Presence of chronic endometritis	1.373	0.952	2.079	$p = 0.149$	3.948
Poor uterine contraction strength in history	-2.144	1.021	4.411	$p = 0.036$	0.117

Note. The degree of freedom is 1.

**Figure.** Area under the ROC curve**Рисунок.** Площадь под ROC-кривой

that take the value "1" in the presence or "0" in the absence of chronic endometritis or poor uterine contraction strength in history, respectively; e is the exponent ($e \sim 2.72$); and 21 is a constant (regression coefficient B_0). When the value of the PLO coefficient is more than 0.5, there is a high probability of a poor outcome of vaginal delivery.

The sensitivity of the developed prognostic model is 0.86, and the specificity is 0.70. The area under the ROC curve is 0.87 (95% confidence interval 0.78–0.96; $p < 0.001$). The standard error is 0.046 (Figure).

The model developed enables to predict the outcome of vaginal delivery in women with a uterine scar with an accuracy of 81.0%. The absence of a functional relationship between the prognosis result and the objective reality is probably due to errors in calculating the fetal weight. However, it should be noted that the model could significantly improve the quality of medical care for this group of patients. The probability of the need for operative delivery with a coefficient value

of the model above the threshold (0.5) increases by four or more times (OR 14.39; 95% confidence interval 3.97–52.16, $p < 0.001$).

CONCLUSION

A comprehensive analysis of risk factors makes it possible to predict the outcome of vaginal delivery in women with a uterine scar, which in the future can optimize the approach of their delivery and prevent the corresponding complications in childbirth in the mother and the fetus.

ADDITIONAL INFORMATION

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Conflict of interest. The authors declare no conflict of interest.

Author contributions. *M.N. Mochalova* — the concept and design of the study, writing the article text; *A.Yu. Alekseeva* — analysis of literary sources, writing the article text; *E.S. Akhmetova* — collection and analysis of the study's results; *V.A. Mudrov* — the concept and design of the study, statistical analysis of the study's results. All authors made a significant contribution to the study and the article preparation, as well as read and approved the final version before its publication.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ

Источник финансирования. Исследование выполнено без использования спонсорских средств и финансового обеспечения.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

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