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CLINICAL STUDY

Pelvic floor muscle injuries in women with a history of Caesarean section

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ABSTRACT

OBJECTIVE: The aim of the paper is to determine the prevalence of levator ani muscle injuries and identify risk factors among women undergoing vaginal birth after Caesarean section (VBAC) compared to those with elective repeat Caesarean section (ERCS).

MATERIAL AND METHODS: This prospective observational comparative study was conducted at the 2nd Clinic of Gynaecology and Obstetrics of FM CU and UN Bratislava. Women with a history of one Caesarean section were included in the study. They were divided into those who had a successful VBAC and those who delivered by ERCS. The mothers underwent a 3D/4D ultrasound examination of the pelvic floor muscles 3–5 days after childbirth. The study evaluates the frequency and risk factors of avulsion injury of the levator ani muscle (LAM) in a group of 46 women after a successful vaginal delivery after a previous Caesarean section and 32 women after ERCS using 3D/4D transperineal ultrasound examination of the pelvic floor.

RESULTS: A total of 78 women were included in the study, 46 after VBAC and 32 after ERCS. In the first group, we recorded LAM avulsion injury in 13 cases (28.3 %); in the post-ERCS group, we did not record this injury ($p < 0.0001$). We also found an overdistended hiatal area (21.0 vs 19.4 cm^2) and a more frequent occurrence of the area exceeding 25 cm^2 (21.3 % vs 6.2 %, $p = 0.0340$) which was approaching the statistical significance. In the first group, we identified an increase in weight during pregnancy to 15 kg and a neonatal birthweight of 4,000 g or higher as risk factors for LAM injury.

CONCLUSION: In the group of women with VBAC, there is a statistically significant risk of LAM avulsion and a higher occurrence of the overdistended area of the *hiatus urogenitalis*, especially in women with larger foetuses and in those who experienced greater weight gain during pregnancy *(Tab. 3, Ref. 50)*. Text in PDF *www.elis.sk*

KEY WORDS: pelvic floor, levator ani muscle avulsion, vaginal birth after Caesarean section.

Introduction

Due to our upright body position and relatively large foetal head, pregnancy and childbirth have become a significantly stressful process for the anatomical structure and function of the pelvic floor in humans. At the same time, vaginal delivery is a significant risk factor for the occurrence of avulsion injury of the levator ani muscle (1, 2, 3). The levator ani muscle is the largest component of the pelvic floor muscles and is of fundamental importance in supporting the pelvic organs (4, 5). It is a functional muscle complex anatomically consisting of three components: the pubococcygeus muscle, the iliococcygeus muscle and the coccygeus muscle (6). The line of the muscle is V-shaped, which forms an anorectal junction loop posterior to the transition from the anus to the anal opening and attaches to the lower edge of the symphysis (7). The muscle line potentially defines the largest hernial portal in the human body, i.e., levator hiatus and plays a key role in supporting the pelvic organs (8, 9, 10). The levator ani muscle (LAM) has a complex structure composed mainly of striated muscles with a minority of smooth muscle fibres. Innervation of the muscle is provided through somatic and visceral nerve fibres (11, 12). During vaginal delivery, LAM fibres are stretched more than three times due to the pressure of the presentation part of the foetus and pushing forces of the mother (13). Stretching greater than usually tolerated by the skeletal muscle can lead to expansion of the levator hiatus (so-called ballooning) and, in some women, results in injury of this muscle. Avulsion of the levator ani muscle is characterised by a complete traumatic separation of the muscle from

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its insertion in the pubic bone (14, 15, 16). It is a well-known fact that vaginal delivery is a risk factor for developing pelvic organ prolapse due to LAM avulsion injury (17, 18, 19).

Published data also confirm that LAM trauma is a primary factor in the aetiology of pelvic organ prolapse (POP) and subsequent occurrence of pelvic floor dysfunction of varying degrees and nature (18). As a result of the increase in the frequency of Caesarean sections, especially among primiparous women, the number of pregnant women and women with a history of Caesarean section is increasing (20, 21). Information about the consequences of a natural birth on the condition of the pelvic floor muscles is also important as part of counselling on childbirth management. According to some data, a higher incidence of sphincter ani muscle injuries can be expected in women after vaginal delivery after a previous Caesarean section (22). In the literature published so far, there is not enough reliable data focused on LAM injury in women with a history of vaginal birth after Caesarean section (VBAC). Women with a history of Caesarean section usually have the option of choosing a delivery method and sign an informed consent for elective vaginal delivery. Their decisions can be influenced not only by the known risks of childbirth (rupture in the area of the uterine scar, the risk of prolonged labour or postpartum bleeding) but also by information about the impact of vaginal delivery after Caesarean section on long-term quality of life and the occurrence of pelvic dysfunctions. Although there is ample existing literature on the risk factors of LAM injury in primiparous women, there is a lack of data regarding women who undergo VBAC. Therefore, the main objective of the study is to diagnose LAM avulsion injury in women with a history of vaginal delivery after Caesarean section as compared to women after elective repeat Caesarean section (ERCS) and identify individual risk factors leading to the occurrence of this injury.

Material and methods

This prospective observational study included women with a history of Caesarean section who decided to give birth at the 2nd Clinic of Gynaecology and Obstetrics of the Faculty of Medicine, Comenius University and University Hospital Bratislava in the period from January 1, 2021, to December 31, 2021. Inclusion criteria were the history of one Caesarean section, no vaginal delivery in the past, the age over 18 years, singleton pregnancy at term, vertex presentation, and consent to be included in the study. Exclusion criteria were a dead foetus, known growth restriction of the foetus, known congenital developmental defects of the foetus, and severe general neurological diseases of the mother.

Women were divided into two groups according to their preference to give birth vaginally or by elective Caesarean section. In the VBAC group, only those who successfully gave birth vaginally without the use of extraction surgery (vacuum extraction or forceps) were included in the follow-up.

In both monitored groups, on postpartum days 3–5, an ultrasound examination of the pelvic floor was performed using a 3D/4D convex probe with a GE Voluson E8 ultrasound device. The examination was performed by one instructed person. LAM avulsion on ultrasound examination was diagnosed by discontinuity of the muscle fibres in 3D imaging and by separation of part of the muscle from the symphysis with minimal or no muscle movement anteriorly and superiorly during contraction attempts in 4D imaging (23, 24, 25, 26). The examination was performed in different conditions, including rest, muscle contraction and the Valsalva manoeuvre. The 4D loops were recorded and later analysed using *TUI (tomographic ultrasound imaging)* and *OmniView* software functions (26). Expansion of the area of the *hiatus urogenitalis* (so-called ballooning) is defined as an area > 25 cm^2 during the Valsalva manoeuvre (27, 28). The obtained data were recorded in the Microsoft Excel system and statistically processed using OpenEpi software. Parametric data were compared using Student's t-test, and categorical data using Fisher's test. We used $p < 0.05$ as a statistically significant value. The study was approved by the Ružinov University Hospital Ethics Committee on January 1, 2021.

Results

During the mentioned period, 3,139 women gave birth at the 2nd Clinic of Gynaecology and Obstetrics, of whom 318 women had a history of Caesarean section in the past, 78 mothers met the inclusion criteria, of whom 46 gave birth vaginally after Caesarean section, and 32 had their pregnancy terminated by elective Caesarean section. Table 1 includes a comparison of some parameters in both monitored groups. We found a statistically significant age difference; women undergoing elective Caesarean section were slightly older on average (36.0 vs 33.9, $p = 0.0310$). However, we

Tab. 1. Comparison of some parameters in both monitored groups.

	VBAC (n=46)	%	ERSC (n=32)	%	p, RR
Mean age	33.9 (22–42)		36.0 (24–45)		0.0310
Age 35 years or older	19	41.3	18	56.3	0.1424
BMI average before pregnancy	22.5 (17.8–33.4)		23.9		0.1179
BMI > 25 before pregnancy	8	17.4	11	34.3	
Average weight gain	13.5 (5–27)		13.6 (4–26)		0.9273
Weight gain > 15 kg	14	30.4	8	25.0	0.3077
Average foetal weight	3,454.6 (2,370–4590)		3,488.1 (2,330–4,320)		0.2550
Weight 4,000 g or more	6	13	6	18.8	0.7790
Signs of m. levator ani avulsion	13	28.3	0		$p < 0.0001$
Hiatus area (cm^2)	21.0 (14–28)		19.4 (14–25)		0.0675
Area 25 cm2 or larger	10	21.3	2	6.2	0.0340

ERSC – elective repeat Caesarean section; VBAC – vaginal birth after Caesarean section

did not find a statistically significant difference in the representation of women over 35 years of age. There was no statistically significant difference in BMI before pregnancy, weight gain during pregnancy and average foetal weight in both groups.

We demonstrated a statistically significantly higher incidence of LAM injury in women who gave birth vaginally after Caesarean section as compared to women who gave birth by elective Caesarean section (28.3 % vs 0 %, $p < 0.001$). At the same time, overdistended hiatus urogenitalis was more often present in women after VBAC (21.28 %) compared to those after ERCS (6.25 %; $p = 0.0340$).

When determining risk factors for avulsion injury in women with VBAC, it was necessary to analyse some parameters in the group with and without injury. Table 2 includes some birth characteristics of the entire group after vaginal delivery. The most common birth injury was a second-degree perineal tear in 56.5 % of cases. Table 3 compares the incidence of some characteristics in the VBAC group with avulsion (13 women) and without avulsion (33 women). As statistically significant, we found a higher weight gain during pregnancy, the number of women who gained more than 15 kg during pregnancy, a higher average weight of the foetus and the number of foetuses weighing 4,000 g or more. Women with LAM avulsion also had a larger hiatal area on average and more frequent hiatus dilation of 25 cm^2 or larger. We did not find a statistically significant difference in age, administration of oxytocin during the first stage of labour, epidural analgesia, or in other birth injuries.

Tab. 2. Birth characteristics in VBAC group (n=46).

	n	%
Induction of labour	11	23.9
Augmentation of labour with oxytocin	10	21.7
Epidural analgesia	26	56.5
Rupture of the cervix	7	15.2
Episiotomy	14	30.4
Second-degree perineal tears	26	56.5
Third- and fourth-degree perineal tears	1	2.2
Vaginal tear	10	21.7

Tab. 3. Comparison of risk factors for avulsion injury in VBAC.

	avulsion (n=13)		no avulsion (n=33)		p
	n	%	n	%	
Mean age	36.5 (31–43)		34.4 (23–39)		0.0770
Age 35 years or older	9	69.2	15	45.4	0.1299
BMI before pregnancy	23.0 (19.0–29.8)		20.2 (17.8–33.4)		0.6069
BMI over 25	2	15.4	6	18.2	0.5971
Average weight gain during pregnancy (kg)	16.2 (5–27)		12.3 (3–23)		0.0162
Weight gain > 15kg	8	61.5	11	33.3	0.0488
Average foetal weight (g)	3,798 (2,990–4,590)		3,319 (2,370 – 4,500)		0.0022
Weight 4,000 g or more	5	38.5	1	3.0	0.0024
Hiatus area (cm^2)	24.0 (20–27)		19.5 (14–28)		$p < 0.0001$
Area 25 cm^2 or larger	6	46.1	6	18.2	0.0036
Augmentation of labour with oxytocin	2	15.4	8	24.2	0.2785
Epidural analgesia	9	69.2	17	51.5	0.1503
Rupture of the cervix	1	7.7	6	18.2	0.2143
Episiotomy	3	23.1	11	33.3	0.2652
Second-degree perineal tears	9	69.2	16	48.5	0.1131
Third- and fourth-degree perineal tears	1	7.692	0		0.1413
Vaginal tear	2	15.3	8	24.2	0.2785

Discussion

Most studies report that pelvic floor muscle injuries occur primarily during the first delivery (29, 30, 31). In addition to childbirth, microtraumas of the pelvic floor are also involved in pregnancy, in which the entire weight of the pregnant uterus rests on the levator plate, so it can be assumed that even women who gave birth to their first child by Caesarean section would have a different prevalence of pelvic floor injuries compared to women who have not yet given birth (32). VBAC has one more peculiarity compared to normal first birth, namely that Kristeller's expression is strictly contraindicated, which increases the risk of pelvic floor injury (33).

VBAC is a method of birth in which women are exposed to the risk of injury to the pelvic floor muscles as well as overdistention of the *hiatus urogenitalis* (*levator hiatus*) with possible permanent damage to their function. The results of our study show that the risk of LAM avulsion injury following vaginal delivery after Caesarean section is higher than after repeat Caesarean section. Our results are also comparable to previously published data. In a Czech observational multicentre a cohort study that included 141 women after VBAC, 32.6 % of women in this group had an avulsion injury. The results of this study also confirm an increased risk of LAM injury in women undergoing VBAC compared to primiparous women in their first vaginal delivery (32). Other studies comparing the risk of avulsion after VBAC have not been published yet. Another study reported a higher incidence of *hiatus urogenitalis* overdistention after vaginal delivery compared to Caesarean section (34). Data from an Australian study led by Shek et al report a higher prevalence of *hiatus urogenitalis* enlargement in women after vaginal delivery compared to women after Caesarean section (34). In their study focused on the presence of LAM avulsion injury in primiparous women, Cassadó et al reported that among examined women, the overall prevalence of levator muscle avulsion was 18.8 % (35).

Among the risk factors of avulsion injury, studies indicate, above all, the older age of women (36, 37, 38). In our study,

women with avulsion injury were slightly older (36.5 years versus 34.4 on average), but the difference was just below the threshold of statistical significance (p = 0.0770).

Similar to the studies on primiparous women, our findings indicate that a risk factor for avulsion injury in VBAC is primarily the higher foetal weight (39, 40). Extractive vaginal surgery is mentioned as a clear risk factor in the literature, while forceps are riskier in this regard (41, 42, 43, 44). As our aim was to determine non-iatrogenic factors, we excluded from the study women after vaginal extraction operations. In our group, foetal weight was a significant risk factor for avulsion injury. The mechanism is probably caused by excessive distention of the urogenital hiatus during the passage of a larger foetal head. This fact was proven in studies on primiparous women; even the foetal weight was a predictor of the later onset of pelvic organ prolapse (36, 45). However, not all studies have proven this fact; it is possible that patient management in the second stage of labour and delayed pushing during delivery of the foetal head also play a role.

The relationship between obesity and excessive maternal weight gain to birth injury also appears controversial (46). In the case of anal sphincter injury, obesity is a risk factor, but primarily because of its association with higher foetal weight (47). In the literature examining the levator ani muscle injury, we found no evidence of the effect of maternal weight. Our study did not prove obesity and overweight before pregnancy as risk factors, but excessive weight gain during pregnancy increased the risk. However, we assume it was related to excessive foetal weight, as excessive maternal weight gain is associated with foetal macrosomia.

Some studies have shown a protective effect of epidural analgesia, but in our case, we could not prove this effect (48). We were also unable to establish a connection with other injuries, as reported in the literature (49, 50).

Conclusion

Our results show that women undergoing VBAC have an increased risk of levator muscle injury compared to elective Caesarean section. The risk increases in women with excessive weight gain during pregnancy and in those with higher neonatal birth weight. Information about the effect of vaginal delivery after Caesarean section on long-term quality of life and the occurrence of pelvic dysfunctions could influence the method of delivery in women with a history of Caesarean section. In the case of elective vaginal delivery after a previous Caesarean section, mothers sign an informed consent, which should include information about the increased risk of injury to the levator ani muscle.

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