



# The Study of Cows' Uterine Tone in Normal and Pathological Postpartum Periods

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**Abstract** | The objective of the work has been to study the contraction of uterine muscles in cows during the placenta stage and the postpartum period. For the first time, a new device for determining uterine contractions has been used to study the strength, duration, and frequency of uterine contractions to diagnose early signs of postpartum disease in the uterus. The experimental part of the work was carried out based on the farms of agrofirm "Kolos", LLC in the Tetyush district of the Republic of Tatarstan and MBS "Zhayik" in the Akzhaik district of the West Kazakhstan region of the Republic of Kazakhstan. The contraction activity of the uterine muscles after fetal excretion was studied by means of a device for determining uterine contractions, which consisted of a pressure rubber ball, discharge valve, manometer, handle, rubber tube, catheter, rubber camera, and rubber camera pin. Thirty minutes after fetal excretion, a 0.1 kPa decrease in uterine contraction strength and a 0.96 min reduction in the duration of the uterine contractions resulted in the retained placenta, while a 0.91 kPa decrease and a 0.37 min reduction in 10 min after the placenta expulsion in cows resulted in subinvolution of the uterus and postpartum endometritis. The device for determining uterine contractions allows for early diagnosis of uterine abnormalities in the placenta stage and the postpartum period.

**Keywords** | Interval of uterine contractions, Postpartum endometritis, Retained placenta, Strength of uterine contractions, Uterine subinvolution, Device for determining uterine contractions.

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## INTRODUCTION

Abnormalities in the contractile function of the myometrium during labor and the postpartum period play a significant role in the pathogenesis of many obstetric and gynecological diseases in cows (Shabunin et al., 2014; El-Din et al., 1995; Heppelmann et al., 2013). Weak uterine contractions and their absence are one of the main direct causes of retained placenta (Dervishi et al., 2018; Mahnani

et al., 2021; Borisov, 2017). At the beginning of the postpartum period, the size of the muscular fibers of the horns and the body of the uterus are progressively reduced, which is also facilitated by regular uterine contractions after labor (Shabunin et al., 2011; Konopeltsev, 2017; Vergara et al., 2014; Beagle et al., 2010). The contracting muscle fibers of the uterus, blood vessels, tissue formations, mucous membranes, and carunculi begin to undergo fatty growth from the very first days, which leads to the destruction of

uterine tissue, especially its mucous membranes and carunculi, which accumulate in the uterine cavity (Demchuk and Skorik, 2016; Suleymanov et al., 2018; Williams et al., 2007). Together with residual amniotic fluid and mucus, they are extracted by uterine contractions in the form of so-called postpartum excretions, or lochia. In the first days, lochia are reddish or brownish because they are mixed with the blood that was poured out during labor from torn vessels in the fetal shells and umbilical cord. On day 7-8, they become transparent, and 14-17 days after labor, their secretion stops, and the cervical canal of the uterus closes (Pascottini et al., 2015; Leutert et al., 2012; Sheldon et al., 2019; Oruc et al., 2015).

The emergence of uterine abnormalities or the absence of uterus contractions is mainly caused by vitamin and mineral deficiencies, the absence of regular motions, and inflammatory processes in cows' genitals (Roche, 2006; Abuelo et al., 2016; Grummer et al., 2004; Cardoso et al., 2020). If these contractions are absent or weak, lochia accumulate in the uterine cavity and postpartum diseases (uterine subinvolution, retention of the placenta, endometritis) develop. These diseases of the uterus are always associated with a weakening of the body's resistance, impaired uterine tone, the absence of uterine abbreviations, delayed excretion of lochia and their accumulation in the uterine cavity. If microorganisms penetrate the uterine cavity during subinvolution, they gradually decompose lochia and develop postpartum endometritis (LeBlanc, 2014; Barlund et al., 2007; LeBlanc et al., 2002; Stehen et al., 2011).

The aim of the work was to study the tone of the uterus in normal and pathological courses of the postpartum period in cows using a device for determining uterine contractions.

## MATERIALS AND METHODS

### ETHICAL STATEMENT

The study was discussed and approved at the meeting of the Scientific and Technical Council of the West Kazakhstan Agrarian and Technical University of the Ministry of Agriculture of the Republic of Kazakhstan, Protocol No. 1 of September 24, 2018.

### GENERAL INFORMATION

The research was carried out between 2018 and 2020 based on the cattle farms "Kolos", LLC of the Tetyush district of the Republic of Tatarstan of the Russian Federation and MBS "Zhayik" of the Akzhaik district of the West Kazakhstan region of the Republic of Kazakhstan and at the departments of therapy and clinical diagnostics with radiology and surgery, obstetrics and pathology of small animals of the Bauman Kazan State Academy of Veterinary

Medicine and "Veterinary and Biosafety" Higher School of West Kazakhstan Agrarian-Technical University named Zhangir khan.

### SAMPLING

The objects of research were black-motley cows (500 heads) with an average live weight of 550-600 kg at the age of 2-3 years. The feeding of the experimental livestock was carried out according to the rations accepted in the farm. Calculation of rations was carried out taking into account the daily milk yield, lactation stage of cows. For the normal development of the fetus and the normal course of metabolism, the cows were provided with high-quality hay, feed, vitamins and minerals. The diet of an adult dairy cow consisted of the following ingredients: hay, root crops, silage, concentrated feed.

During research and production tests, attention was paid to the process of labor and the postpartum period in cows. The selection of experimental cows in the groups was carried out using the principle of analogs. In these cows with normal and pathological placenta stages and postpartum periods (with further development of retention of the placenta, subinvolution of the uterus, postpartum endometritis in cows), the strength, duration, and frequency of uterine contractions after fetal excretion and in the postpartum period were studied.

### MATERIALS

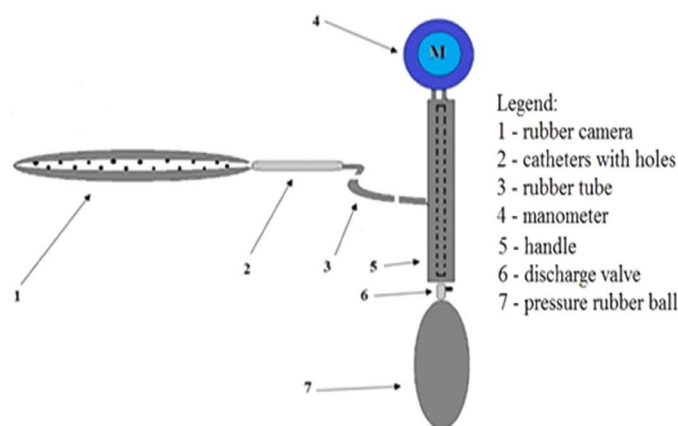
The following materials were used to study the strength, duration, and frequency of uterine contractions in cows: antiseptic solvents for the treatment of the external genitalia of cows, obstetric gloves, veterinary vaseline, a disposable rubber camera, and a device for determining the contractile activity of the uterine muscles after fetal excretion (certificate for rationalization proposal No. 483 from "03". 12.2015 issued by the Kazan State Academy of Veterinary Medicine named after N.E. Bauman" in accordance with paragraph 75 of the Regulations on discoveries, inventions and rationalization proposals, approved by the decision of the Council of Ministers, issued to Yusupov S.R., Darменова A.G.), which consists of a pressure rubber ball, discharge valve, manometer, handle, rubber tube, catheter, rubber camera, and rubber camera pin (Figure 1).

### PROCEDURES

The survey was conducted according to the following scheme: animal preparation=> specialist preparation=> device preparation.

Diagnostic tests require washing and disinfection of the external genitalia and tail. The root and base of the cow's tail should be bandaged. So that it does not interfere during work, it is better to take it to the side and tie it with a

band or a rope fixed around the animal's neck.



**Figure 1:** Device for determining uterine contractions

The specialist's hands were disinfected with 65° alcohol or a 3% solution with iodized alcohol. A catheter with a rubber camera was also treated with disinfectants.

The external genital organs of cows and the surface of the rubber chamber of the device should be washed before starting the study.

To determine intrauterine pressure, a disinfected catheter with a rubber camera was injected through an open cervical canal into the uterine cavity. When the outlet valve was closed, the pressure rubber ball was pumped into the rubber camera until the pointer of the manometer was deflected and a minimum pressure of 0.5 kPa was created, which was not taken into account in determining the strength of contractions. The presence of uterine contractions was judged based on changes in pressure and the deviation of the manometer pointer, considering the minimum and maximum values of these deviations. The duration of uterine contractions was determined using a stopwatch. The frequency of uterine contractions was measured in 10, 20, 30, 60, 120, 180, 240, 300, 360, 420, 480, 540 and 600 minutes (within 10 h) after fetal excretion, as well as in 10, 20, 30, 120 and 180 minutes (within 3 h) after retained placenta. The strength, duration, and frequency of uterine contractions were determined using a stopwatch and a manometer (0 to 2.5 kPa).

Based on the study of the strength, duration, and frequency of uterine contractions using a device for determining uterine contractions in farm cows, a method was developed for diagnosing early signs of postpartum obstetric and gynecological diseases (retention of the placenta, subinvolution of the uterus, postpartum endometritis).

The device for determining uterine contractions meets the criterion "Significant difference". The device is characterized by simplicity and allows determining at no extra cost

the strength, duration, and frequency of uterine contractions in cows after giving birth for early diagnosis of postpartum uterine diseases.

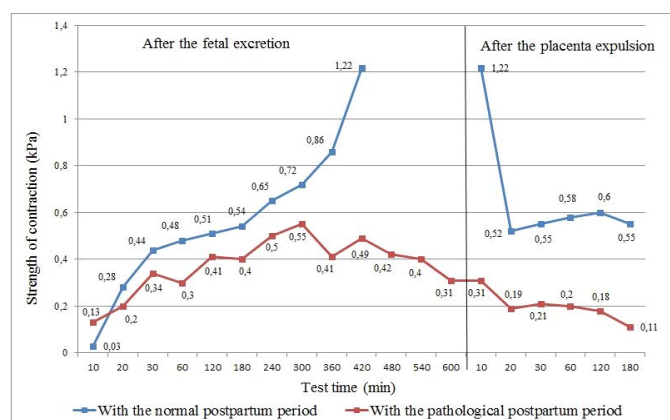
## STATISTICAL ANALYSIS

The statistical analysis of the digital data obtained was saved using standard Microsoft Excel programs. The reliability of the differences between the groups to be compared was assessed using the Student table.

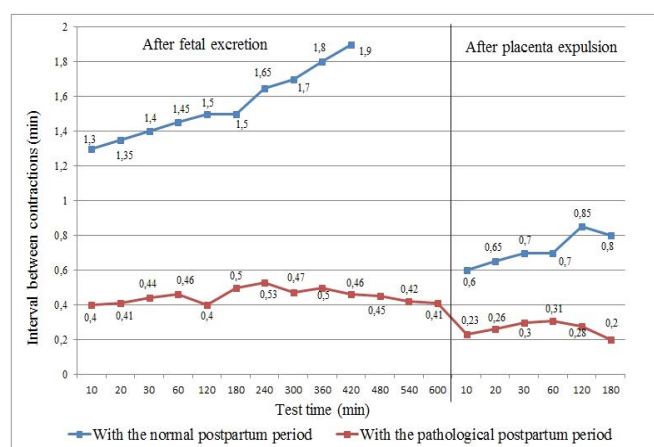
## RESULTS AND DISCUSSION

According to the results of studies of 500 black-motley cows, the normal course of the postpartum period was found in 340 cows, respectively, in 160 cows, a pathological course of the postpartum period was noted (with further development of retention of the placenta, subinvolution of the uterus, postpartum endometritis in cows).

Features of changes in strength, duration, and frequency of uterine contractions in cows with normal and pathological postpartum periods are given in Tables 1-3 (Figure 2-4).



**Figure 2:** Comparative index of cow uterine contraction strength at normal and pathological postpartum periods.



**Figure 3:** Comparative index of the duration of uterine contractions in cows at normal and pathological postpartum periods.

**Table 1:** Comparative index of cow uterine contraction strength at normal and pathological postpartum periods.

Strength of contraction (kPa)	Test time (min)	With the normal postpartum period (M±m)	Test time (min)	With the pathological postpartum period (M±m)
After the fetal excretion				
	10	0.03±0.01	10	0.13±0.03
	20	0.28±0.03	20	0.20±0.04
	30	0.44±0.05	30	0.34±0.05 <sup>b</sup>
	60	0.48±0.04	60	0.30±0.05
	120	0.51±0.05	120	0.41±0.06
	180	0.54±0.04	180	0.40±0.05
	240	0.65±0.05	240	0.50±0.06
	300	0.72±0.05	300	0.55±0.06
	360	0.86±0.04	360	0.41±0.07
	420	1.22±0.09	420	0.49±0.07
			480	0.42±0.06
			540	0.40±0.06
			600	0.31±0.05 <sup>a</sup>
After the placenta expulsion				
	10	1.22±0.09	10	0.31±0.03
	20	0.52±0.04	20	0.19±0.03
	30	0.55±0.05	30	0.21±0.04 <sup>a</sup>
	60	0.58±0.03	60	0.20±0.04
	120	0.60±0.02	120	0.18±0.03
	180	0.55±0.02	180	0.11±0.02

<sup>a</sup> Values within a row differ significantly at P<0.05; <sup>b</sup> Values within a row differ significantly at P<0.01

**Table 2:** Comparative index of the duration of uterine contractions in cows at normal and pathological postpartum periods.

Interval between contractions (min)	Test time (min)	With the normal postpartum period (M±m)	Test time (min)	With the pathological postpartum period (M±m)
After fetal excretion				
	10	1.30±0.09	10	0.40±0.02
	20	1.35±0.08	20	0.41±0.02
	30	1.40±0.13	30	0.44±0.01
	60	1.45±0.12	60	0.46±0.01 <sup>b</sup>
	120	1.50±0.14	120	0.40±0.01 <sup>a</sup>
	180	1.50±0.14	180	0.50±0.02 <sup>b</sup>
	240	1.65±0.11	240	0.53±0.02
	300	1.70±0.09	300	0.47±0.01
	360	1.80±0.09	360	0.50±0.01
	420	1.90±0.07	420	0.46±0.01
			480	0.45±0.01
			540	0.42±0.01
			600	0.41±0.01
After placenta expulsion				
	10	0.60±0.07	10	0.23±0.03

20	0.65±0.08	20	0.26±0.01
30	0.70±0.09	30	0.30±0.01
60	0.70±0.06	60	0.31±0.04
120	0.85±0.05	120	0.28±0.02
180	0.80±0.09	180	0.20±0.01

<sup>a</sup> Values within a row differ significantly at  $P<0.05$ ; <sup>b</sup> Values within a row differ significantly at  $P<0.01$

**Table 3:** Comparative index of cow uterine contraction frequency in normal and pathological postpartum periods.

Frequency of contractions	Test time (min)	With the normal postpartum period (M±m)	Test time (min)	With the pathological postpartum period (M±m)
After fetal excretion				
	10	1.90±0.11	10	1.70±0.16
	20	2.00±0.16	20	1.80±0.14
	30	2.90±0.11	30	1.90±0.11
	60	5.40±0.28 <sup>a</sup>	60	4.60±0.23
	120	11.30±0.28 <sup>c</sup>	120	8.50±0.28
	180	11.50±0.18 <sup>c</sup>	180	8.80±0.21
	240	11.90±0.19 <sup>c</sup>	240	8.40±0.23
	300	12.00±0.22 <sup>c</sup>	300	8.60±0.17
	360	12.20±0.14 <sup>c</sup>	360	8.60±0.17
	420	12.30±0.16 <sup>c</sup>	420	8.70±0.16
			480	8.70±0.39
			540	8.90±0.11
			600	8.20±0.31
After placenta expulsion				
	10	1.80±0.14	10	1.60±0.17
	20	1.90±0.11	20	1.70±0.16
	30	2.00±0.11	30	1.80±0.14
	60	5.00±0.22 <sup>b</sup>	60	4.00±0.31
	120	11.50±0.24 <sup>c</sup>	120	8.60±0.17
	180	11.80±0.14 <sup>c</sup>	180	8.80±0.14

<sup>a</sup> Values within a row differ significantly at  $P<0.05$ ; <sup>b</sup> Values within a row differ significantly at  $P<0.01$ ; <sup>c</sup> Values within a row differ significantly at  $P<0.001$

Table 1 (Figure 2) shows that in cows with the normal postpartum period, the strength of uterine contractions after fetal excretion within 7 hours (420 min) increased from 0.03±0.01 to 1.22±0.09 kPa. Spontaneous placenta expulsion in these cows took place on average 7 hours (420 min) after fetal excretion, after which the strength of uterine contractions during the first 10 min decreased from 1.22±0.09 to 0.52±0.04 kPa and then gradually increased to 0.60±0.02 kPa during 2 hours (120 min), after which it began to decrease to 0.55±0.02 kPa by 3 hours (180 min). In cows with a pathological postpartum period, the strength of uterine contractions was wave-like and gradually increased from 0.13±0.03 to 0.55±0.06 kPa within 10 hours after the fetal excretion. In these cows, an average of 10 hours (600 minutes) later, an operative placenta expulsion was used. These cows had weaker uterine contractions

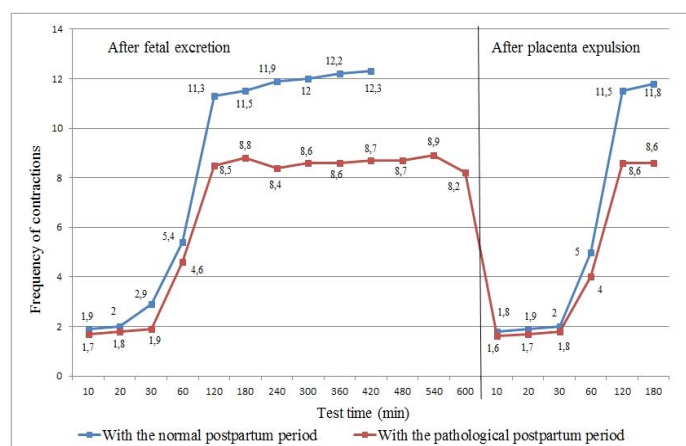
than cows with the normal postpartum period, which was observed already by 20 min — 0.08 kPa, by 30 min — 0.1 kPa, by 60 min — 0.18 kPa, by 120 min — 0.1 kPa, by 180 min — 0.14 kPa.

Table 2 (Figure 3) shows that in cows with a normal postpartum period, the duration of uterine contractions after fetal excretion increased from 1.30±0.09 to 1.90±0.07 minutes within 7 hours. Spontaneous placenta expulsion in these cows took place on average 7 hours (420 min) after fetal excretion, after which the duration of uterine contractions in the first 10 min was reduced from 1.90±0.07 to 0.60±0.07 and then gradually increased to 0.85±0.05 min within 2 hours (120 min), after which it began to decrease and decreased to -0.80±0.09 min by 3 hours (180 min).



The graphical data shows that in cows with a pathological postpartum period, the duration of uterine contractions after fetal excretion ranged from  $0.40 \pm 0.02$  to  $0.53 \pm 0.02$  within 10 hours. In these cows, an operational placenta expulsion was conducted within 10 hours (600 min) on average, after which the duration of uterine contractions during the first 10 min was reduced from  $0.41 \pm 0.01$  to  $0.23 \pm 0.03$  min and then gradually increased to  $0.31 \pm 0.04$  within 1 hour (60 min). The duration of uterine contractions then began to decrease (120 min —  $0.28 \pm 0.02$  min, 180 min —  $0.20 \pm 0.01$ ).

When labor and the postpartum period were normal, the frequency of uterine contractions in cows gradually increased from 1 to 13 times within 10-420 minutes after fetal excretion (Table 3, Figure 4). The uterus contracted 1-2 times ( $1.90 \pm 0.11$ ) after 10 minutes, 1-3 times ( $2.00 \pm 0.16$ ) after 20 minutes, 1-3 times ( $2.90 \pm 0.11$ ) after 30 minutes, and 4-6 times ( $5.40 \pm 0.28$ ) after 60 minutes, in 120 min — 10-12 times ( $11.30 \pm 0.28$ ), in 180 min — 11-12 times ( $11.50 \pm 0.18$ ), in 240 min — 11-13 times ( $11.90 \pm 0.19$ ), in 300 min — 11-13 times ( $12.00 \pm 0.22$ ), in 360 min — 12-13 times ( $12.20 \pm 0.14$ ), and in 420 min — 12-13 times ( $12.30 \pm 0.16$ ).



**Figure 4:** Comparative index of cow uterine contraction frequency in normal and pathological postpartum periods.

The frequency of uterine contractions, which were determined within 10-180 min after excretion of the placenta, was: in 10 min — 1-2 times ( $1.80 \pm 0.14$ ), in 20 min — 1-2 times ( $1.90 \pm 0.11$ ), in 30 min — 1-3 times ( $2.00 \pm 0.11$ ), in 60 min — 4-6 times ( $5.00 \pm 0.22$ ), in 120 min — 10-12 times ( $11.50 \pm 0.24$ ), and in 180 min — 11-13 times ( $11.80 \pm 0.14$ ).

In the pathological course of labor and the postpartum period (further development in cows of the retained placenta, subinvolution of the uterus, postpartum endometritis), the frequency of uterine contractions was considered within 600 min after fetal excretion and was from 1 to 9 times

(in 10 min — 1-2 times ( $1.70 \pm 0.16$ ), in 20 min — 1-2 times ( $1.80 \pm 0.14$ ), in 30 min — 1-2 times ( $1.90 \pm 0.11$ ), in 60 min — 3-5 times ( $4.60 \pm 0.23$ ), in 120 min — 7-9 times ( $8.50 \pm 0.28$ ), in 180-600 min — 7-9 times (from  $8.20 \pm 0.31$  to  $8.90 \pm 0.11$ ).

After manual excretion of the placenta within 10-180 minutes, the uterus contractions were: in 10-30 minutes — 1-2 times (from  $1.60 \pm 0.17$  to  $1.80 \pm 0.14$ ), in 60 minutes — 3-5 times ( $4.00 \pm 0.31$ ), in 120-180 minutes — 8-9 times (from  $8.60 \pm 0.17$  to  $8.80 \pm 0.14$ ).

Studies conducted in cows 30 minutes after fetal excretion show that in the pathological process of the placenta period of labor, the strength of uterine contractions decreased by 0.1 kPa (from  $0.44 \pm 0.05$  kPa to  $0.34 \pm 0.05$  kPa), the duration of uterine contractions was 0.96 min shorter (from  $1.40 \pm 0.13$  to  $0.44 \pm 0.01$  min), and the frequency of uterine contractions was one time lower (from 2.9 to 1.9 times) than that of animals with the normal process, which may serve as a criterion for predicting retained placenta.

Studies carried out on cows 30 minutes after the placenta expulsion show that when the pathological postpartum period flows, the strength of uterine contractions decreased by 0.34 kPa (from  $0.55 \pm 0.05$  kPa to  $0.21 \pm 0.0$ ), the duration of uterine contractions was 0.40 min shorter ( $0.70 \pm 0.06$  min to  $0.30 \pm 0.04$  min), and the frequency of uterine contractions was 0.2 times shorter (from 2 to 1.8 times) than in animals with the normal process. This may serve as a criterion for predicting a delay in the excretion of congestion in the uterus of lochia, which leads to subinvolution of the uterus and postpartum endometritis.

## CONCLUSION

Summing up the data we obtained, it can be stated that in the normal postpartum period, the strength, duration, and frequency of uterine contractions in cows increased after fetal excretion, resulting in placenta expulsion. After placenta expulsion, the strength, duration, and frequency of uterine contractions were increased by 30 minutes, which contributes to normal postpartum uterine involution. The studied cows did not have retained placenta and postpartum pathologies (uterine subinvolution, endometritis), and genital involution ended within 30 days after labor.

Summarizing the data obtained, it can be stated that cows with the pathological postpartum period, compared to the normal period, had low rates of strength, duration, and frequency of uterine contractions after fetal excretion, which contribute to retained placenta, uterine subinvolution, and postpartum endometritis. On average, 10 hours (600 min) after the fetus was excreted, an operative placenta expul-

sion was carried out. These cows had a subinvolution of the uterus and postpartum endometritis, and the involution of the genitals lasted on average 62 days.

The use of a device for determining uterine contractions allows for early diagnosis of uterine abnormalities in the placenta stage and the postpartum period, and, therefore, associated uterine diseases in cows, for timely application of treatment measures.

## ACKNOWLEDGEMENTS

The article was prepared based on the results of studies carried out at the expense of the scientific fund of the West Kazakhstan Agrarian-Technical University and Bauman Kazan State Academy of Veterinary Medicine.

## CONFLICT OF INTEREST

There is no conflict of interest.

## NOVELTY STATEMENT

For the first time, a new device for determining uterine contractions has been used to study the strength, duration, and frequency of uterine contractions to diagnose early signs of postpartum disease in the uterus.

## AUTHOR CONTRIBUTIONS

All authors discussed the results and contributed to the final manuscript.

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