

# Diagnostic tool for the diagnosis of physiological and pathological conditions of the uterus in cows postpartum

## Instrument zur Diagnose physiologischer und pathologischer Zustände des Uterus bei Kühen post partum

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### Schlüsselwörter

Rind, postpartale Periode, Uterussubinvolution, Endometritis

### Key words

Cattle, postpartum period, uterine subinvolution, endometritis

received 17.12.2019

accepted 26.04.2021

### Bibliography

Tierarztl Prax Ausg G Grosstiere Nutztiere 2021; 49: 229–233

DOI 10.1055/a-1525-9036

ISSN 1434–1220

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Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

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### ZUSAMMENFASSUNG

**Gegenstand und Ziel** Eine wichtige Aufgabe von Tierärzten in der Rinderhaltung ist die frühzeitige Diagnose postpartaler Komplikationen, die zu Unfruchtbarkeit führen können. Ziel der Studie war, eine neue Methode zur Unterscheidung zwischen physiologischen und pathologischen Zuständen des postpartalen Uterus zu evaluieren. Sie basiert auf einer Bestimmung des Zeitpunkts der Uterusinvolution und Untersuchung der physikochemischen Eigenschaften des Vaginalausflusses (Lochien) in den ersten Wochen nach dem Abkalben.

**Material und Methoden** Insgesamt 173 Kühe der Rasse Holstein Friesian Farbrichtung Schwarzbunt wurden 1–2, 6–8 und 11–14 Tage sowie bei pathologischen Befunden zusätzlich 18–22, 23–27 und 28–30 Tage nach dem Abkalben auf pathologische Veränderungen der Uterusinvolution untersucht. Zur Differenzierung zwischen physiologischer und pathologischer Uterusinvolution diente neben der Standarduntersuchung von Kühen post partum ein neu entwickeltes diagnostisches Instrument („Metrastatum“). Es ermöglicht die Bestimmung des Abstands zwischen Zervix und Vulva (AZV) und die gleichzeitige Gewinnung von Lochialsekret.

**Ergebnisse** Als bester Zeitpunkt zur Anwendung des Instruments erwies sich der Zeitraum 10–16 Tage post partum. Bei gesunden Kühen mit ungestörtem Puerperium betrug in dieser Phase der AZV im Mittel 25,7 cm ( $\pm 0,8$  cm). Dieser Abstand verringerte sich gegenüber den ersten beiden Tagen um  $12,5 \pm 0,3$  cm. Dagegen war bei Kühen mit postpartalen Störungen der AZV in diesem Zeitabschnitt mit  $31 \pm 0,7$  cm signifikant größer ( $p < 0,001$ ). Bei diesen Tieren reduzierte sich im Vergleich zu den ersten Tagen der AZV nur um durchschnittlich  $8,4 \pm 0,6$  cm. Auch die Lochien, die mit dem kuppelförmigen Gummitrichter des Instruments gewonnen wurden, unterschieden sich bei den Kühen der beiden Gruppen. Bei gesunden Kühen ohne puerperale Störung waren sie mukös, farblos, transparent und manchmal trüb. Kühe mit gestörtem Puerperium wiesen dagegen dünnflüssigen, hellroten bis rotbraunen Vaginalschleim mit Flocken auf, der je nach Form der Entzündung einen unangenehmen Geruch hatte.

**Schlussfolgerung** Die Doppelfunktion des Geräts „Metrastatum“ hilft bei der frühzeitigen Diagnose von Puerperalstörungen bei Kühen und dadurch bei der Auswahl gesunder Tiere für die Reproduktion und kranker Kühe für die Behandlung in Abhängigkeit von der Form der vorliegenden Uterusentzündung.

### ABSTRACT

**Objective** An important task of veterinarians in cattle husbandry is the early diagnosis of postpartum complications that can lead to infertility. The aim of the study was the evaluation of a new device to distinguish between physiological and pathological conditions of the uterus based on the determination of the time of uterine involution and the physicochemical properties of the vaginal discharge (lochia) during the first weeks after parturition.

**Material and methods** A total of 173 black-and-white Holstein-Friesian dairy cows were examined for any pathological alteration of the uterine involution on days 1–2, 6–8, 11–14 postpartum and, in case of pathological findings, additionally on days 18–22, 23–27 and 28–30 after parturition. In addition to the standard examination a newly developed hand-held instrument (“Metrastatum”) was used to differentiate between physiological and pathological uterine involution. It allows determination of the distance between the cervix and vulva (DCV) and simultaneous collection of lochial secretions.

**Results** The best time to use the new instrument was 10–16 days postpartum. In healthy cows without disturbed puerperium, the average DCV was 25.7 cm ( $\pm 0.8$  cm) in this phase. This distance decreased by  $12.5 \pm 0.3$  cm compared to the first

days. In contrast, in cows with postpartum problems, the DCV was significantly greater at ( $31 \pm 0.7$  cm) ( $p < 0.001$ ). In these animals, the AGV was reduced only by an average of  $8.4 \pm 0.6$  cm when compared to the first days. The mucus obtained with the dome-shaped rubber funnel of the instrument also differed in the cows of the 2 groups. In healthy cows without puerperal problems, the lochia were thick, colorless, transparent and sometimes cloudy. In case of puerperal disorders, the discharge was thin, light red to reddish brown, contained flakes and had a nasty odor depending on the form of the inflammation.

**Conclusion** The dual function of device helps to early diagnose puerperal disorders in cows and to select healthy animals for reproduction and sick cows for treatment depending on the form of uterine inflammation.

## Introduction

Postpartum pathologies in cattle are one of the main causes of decreased reproductive function [1]. These include uterine subinvolution, postpartum endometritis, metritis, and subclinical endometritis [2][3]. The prevalence of these pathologies varies and depends on many factors [2][4][5][6]. In the study of Potter et al. [7] the incidence of cattle with endometritis was up to 27%. LeBlanc [8] determined that 15–20% of cattle are affected by clinical endometritis within 4–6 weeks after parturition; another 30–35% have subclinical endometritis from 4 to 9 weeks after parturition. Economic losses from these diseases are associated with a decrease in fertility and a decrease in milk yield [9][10].

The traditional clinical approach to the diagnosis of postpartum pathologies is based on an examination of the reproductive organs of animals, most often by vaginal and rectal methods [3][11]. If purulent discharge from the uterus into the vagina is found during the examination, the endometritis type can be determined by the nature, odor and color of the discharge [8][9][12]. Vaginoscopy can be applied to determine the condition of the cervix and the presence of exudate. However, this method is not widely used on farms [3]. Manual examination can be used to obtain mucus discharging from the cervix for analysis [13]. This technique is cheap and rapid, and also allows to determine the odor of vaginal contents [8]. The device “Metricheck™” (Simcro, New Zealand) is an alternative method for collecting vaginal mucus with a gloved hand or vaginoscopy. The use of “Metricheck™” proved to be 10.7% more effective in the diagnosis of endometritis compared to the use of a vaginal speculum or the gloved hand in the study of Pleticha et al. [14] and 17% more effective than using a vaginal speculum in the study of McDougall et al. [15].

Laboratory methods comprise bacteriological, cytological, and histological examinations, but most often require a lot of time and are difficult to implement in the field [10][16][17]. None of these methods is widely used in production conditions, therefore, the diagnosis of uterine diseases, as a rule, depends entirely on clinical examination [13]. The use of sonography allows to more objectively assess the diameter of the uterine horns, cervix and to determine the presence of fluid in the uterine cavity [10]. With the help of a sonographic examination the period of uterine involution

can be traced. For example, Okano and Tomizuka [18] determined the uterine involution to be completed 40 days after parturition.

In general, the diagnosis of the uterus is carried out by a comprehensive examination, including clinical, laboratory, and biophysical methods. Each of the methods used has its own advantages and disadvantages: costs, inconvenience to use, lack of effectiveness, etc. Therefore, we set ourselves the task of developing a device that could be used to obtain several signs of the state of the genital organs in the postpartum period. On the one hand, it should be possible to measure the degree of uterine involution in order to assess its progress as a function of the days after birth, and on the other hand, it should allow sampling of vaginal secretions (lochia, mucus) for physicochemical examination.

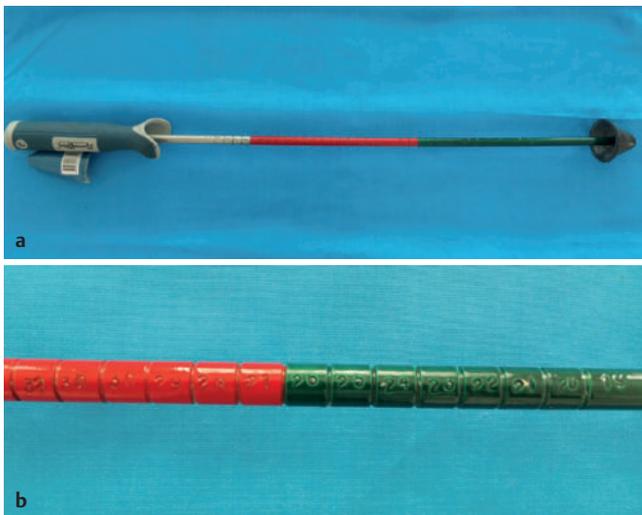
## Material and methods

The research was carried out at S. Seifullin Kazakh Agro Technical University JSC, in the scientific laboratory of veterinary medicine in agricultural units of Akmola region (Kazakhstan). All activities involving animals were carried out in accordance with the “Law on Responsible Animal Handling” of the Inter-Parliamentary Assembly of the Member States of the Commonwealth of Independent States (March 27, 2017 No. 46–15).

## Cows and performed examinations

The study population comprised 173 black-and-white Holstein-Friesian dairy cattle in the postpartum period. Based on the results of gynecological examinations, the animals were divided in 2 groups: healthy cows with a normal postpartal period and cows with puerperium disorders for control in the following days. All animals were examined 1–2 days after parturition, then again on days 6–8 and 11–14. In case of a healthy uterus the examination was terminated ( $n = 41$ ). In the case of pathologies, examinations were continued at 18–22; 23–27; 28–30 days ( $n = 132$ ).

Gynecological examination was carried out according to generally accepted methods. During an external examination, attention was paid to the presence and nature of discharge from the vulva and contamination at the root of the tail. Internal examination included vaginoscopy and rectal palpation. Vaginoscopy was



► **Fig. 1** “Metrastatum” device for determining normal and pathological conditions of the uterus in cows postpartum. **a** Depiction of the complete device. **b** Magnification of the two-color graduated scale. Source: © I. Jakupov.

► **Abb. 1** Instrument “Metrastatum” zur Differenzierung zwischen physiologischen und pathologischen Zuständen des Uterus von Kühen post partum. **a** Ansicht des gesamten Geräts. **b** Vergrößerte Darstellung der zweifarbigen Skala. Quelle: © I. Jakupov.

performed using a vaginal speculum to determine the condition of the cervix and the presence of secretions in the vagina. With rectal diagnosis, topography, uterus involution and consistency of the uterus were determined.

### Application of the new instrument

The newly developed hand instrument “Metrastatum” is used as part of the standard gynecological examination for the diagnosis of pathological changes of the uterus in the postpartum period. “Metrastatum” (► **Fig. 1**) is a stainless steel rod that contains a two-color graduated scale with 2 zones for measurement of the distance from the cervix to the external genitalia (vulva): The green zone at its tip has a length of 26 cm, the adjacent red zone covers the range of 26 to 45 cm. The tip of the rod carries a dome-shaped rubber funnel which allows the collection of vaginal secretions. At its other end there is a handle with a hole for a rope for fixing the instrument.

Before using the instrument on each animal, it was cleaned and disinfected with a cloth and disinfectant solution (the examination of larger herds therefore requires a corresponding number of devices). Following fixation of the animal to ensure safety and access the perineum was thoroughly cleaned to avoid feces entering the vagina. The “Metrastatum” was inserted into the vagina without strong pressure, and the depth of immersion, i. e. the distance from the cervix to the vulva in centimeters, was measured. Following removal of the device the mucus in the rubber tip was collected and analyzed determining color, texture, odor, presence of blood and blood pigments [9].

### Statistical analysis

For statistical analysis the group comparison with the covariate time, a one-way analysis of covariance was conducted using the

statistical software package BMDP, particularly the program BMD-P1V (BMDP Statistical Software; University of California, LA, USA). A  $p$  value  $< 0.05$  was considered statistically significant.

## Results

In **healthy cows** an average distance between cervix and vulva (DCV) of  $38.2 \pm 1.1$  cm was measured 1–2 days after parturition. The DCV was  $32.1 \pm 0.6$  cm on days 6–8 combined with a red-brown, light brown, thick, odorless discharge. On days 10–16 the well contracted uterus was located in the pelvic cavity with a DCV of  $25.7 \pm 0.8$  cm and a clear mucous discharge. From days 18–30 the DCV ranged between  $24.4 \pm 1.2$  and  $23.8 \pm 0.4$  cm. In **cows with pathological conditions** the DCV 1–2 days after parturition was  $39.4 \pm 1.3$  cm. The uterine contraction (involution) was delayed. On days 6–8 the uterus was located in the abdominal cavity with a DCV of  $35.3 \pm 0.9$  cm. Red-brown or dark red, bloody lochia of liquid consistency could be observed. On days 10–16 a DCV of  $31 \pm 0.7$  cm was measured and the discharge was reddish with a liquid consistency. Data for both groups are summarized in ► **Table 1**. When comparing the obtained values at 1–2 days and 10–16 days after parturition in both groups, the mean DCV of cows with a normal puerperium had decreased by 12.5 cm due to the uterine contraction but only by 8.4 cm in cows with a disturbed puerperal phase.

► **Table 2** displays the use of the device for the diagnosis of the normal and pathological condition of the uterus in 173 cows according to the topography of the uterus and physicochemical properties of the discharge. Based on the data obtained we developed the following diagnostic criteria:

- Normal condition: On days 10–16 postpartum the depth of immersion of the device extends to the green zone with a length of up to 26 cm. The mucus is thick, colorless, transparent, and sometimes cloudy.
- Pathological condition: On days 10–16 postpartum the depth of immersion of the device reaches the red zone with a length of 27 to 45 cm. The secretions change in color, texture, and odor depending on the nature of the uterine inflammation.
- Uterine subinvolution: On days 3–15 there is bloody discharge in a color from red-brown to light red. On days 22–30 the color of the discharge becomes light brown to grey.
- Metritis forms are diagnosed at 6–8 days postpartum. The immersion depth of the device is 27–45 cm, which indicates a delay in uterine involution and the location of the uterus in the abdominal cavity.

## Discussion

The aim of the study was to test the effectiveness of the instrument “Metrastatum” to diagnose normal and pathological conditions of the uterus based on the degree of uterine contraction according to the depth of immersion of the device and the nature of the discharge being collected with the instrument. In healthy animals the immersion depth remained in the green zone (up to 26 cm) and the mucus was thick, colorless, and transparent. In cases with pathologies, the immersion depth extended into the red zone ( $\geq 27$  cm) and the discharge was red-brown to light red, bloody and liquid.

► **Table 1** Distance between cervix and vulva (cm) in the postpartum period in healthy cows (n = 41) and in cows with an impaired puerperium (n = 132). Values are indicated as mean and standard deviation.

► **Tab. 1** Abstand zwischen Zervix und Vulva bei gesunden Kühen (n = 41) mit und bei Kühen mit gestörtem Puerperium (n = 132). Angabe als Mittelwert mit Standardabweichung.

Groups	Days postpartum					
	1–2 days	6–8 days	10–16 days	18–22 days	23–27 days	28–30 days
Healthy cows	38.2 ± 1.1	32.1 ± 0.6	25.7 ± 0.8	24.4 ± 1.5	23.5 ± 1.2	23.8 ± 0.4
Cows with pathologies	39.4 ± 1.3	35.3 ± 0.9	31.0 ± 0.7	30.1 ± 2.5	27 ± 2.6	25.2 ± 0.4

► **Table 2** Parameters used for diagnosing the condition of the uterus in cows and the physicochemical properties of the discharge at days 10–16 postpartum.

► **Tab. 2** Parameter zur Diagnose des Zustands des Uterus bei Rindern und der physikochemischen Eigenschaften der Lochien an den Tagen 10–16 post partum.

Parameter	Normal	Pathological
Distance between cervix and vulva	21–26 cm	27–45 cm
Physicochemical properties of the discharge	thick, colorless, transparent mucus	liquid, bloody, red-brown or dark red lochia with endometritis according to the characteristics of secretions
Color of genital mucosa	pink	striped hyperemia, red

According to the results of our study the best time for diagnosis was 10–16 days postpartum. During this period the uterine involution led to a mean DCV of 12.5 cm in healthy cattle, while it was 8.4 cm (31 ± 0.7 cm) in cattle with pathologies. On days 10–16 the discharge was thick, colorless, transparent, and sometimes cloudy in healthy animals. With subinvolution of the uterus, the discharge was red-brown, light red, bloody, and liquid for about 3–15 days. With endometritis, depending on the form of inflammation, the timing of its manifestation, color, texture, odor, and the presence of impurities are determined. The use of the “Metrastatum” enabled the diagnosis 72.6% of cows with pathologies 10–16 days after parturition.

The degree of uterine involution and the nature of the secretions allow us to determine healthy animals that will exhibit the first stages of the reproductive cycle. In cows with normal course of involution, the difference in distance of the DCV from 1–2 days to 6–8 days postpartum was 6.1 cm. From 6–8 days to 10–16 days the DCV decreased by 6.4 cm. From day 16, the involution speed slowed down resulting in a difference of 1.3 cm between 10–16 days and 18–22 days after parturition. Based on the data obtained, an intense uterine contraction was observed within the first 2 weeks after parturition. In addition we observed that by day 30 uterine involution completed to almost the same extent both in healthy an-

imals and cows with pathologies. This is due to the fact that from 8–10 days after parturition sick animals were treated, which affected the involution rate.

Active contraction, release of the contents and mobilizing the body's natural defenses is needed to restore the uterus [3]. Long-term contractions of the uterus up to 7 days after parturition and the formation of folds in the cervix within 5–10 days were determined by Wehrend et al. [19]. Grunert and Arbeiter [11] described the following stages of the postpartum period: an early postpartum period of up to 10 days, a clinical postpartum period of up to 21 days, and a complete restoration of uterus at the microscopic level by day 42. The first 4 days of vasoconstriction and peristaltic contractions represent the strongest period of uterine involution. In the next 5 days, this happens much more slowly [11]. With the development of the economies of countries, the need for intensive reproduction in large industrial complexes increases. This leads to rise in load on cattle, and the time of uterine involution increases. The recovery and service period of cattle on commercial farms can vary depending on the breed, nutrition, conditions, milk yield, season and the presence of a nursing calf [15].

The present study showed that the degree of uterine involution after parturition and the development of pathologies are interdependent. The advantage of using the device “Metrastatum” for diagnosing normal and pathological conditions of the uterus in cattle is that in addition to measuring the DCV lochia remain on the rubber tip and its physicochemical properties are one of the main criteria for diagnosing pathologies. Odor and color of the vaginal mucus also reflect the number of bacteria in the uterus that cause endometritis [20][21][22]. Thus, the nature of the mucus can also determine the form of endometritis (► **Table 3**). Compared with the well-known tool Metrichcek™ described by some authors, our device performs a dual function by determining the rate of involution and the nature of the discharge, which describes the form of inflammation in dynamics. McDougall et al. [15] noted that the Metrichcek™ has a high sensitivity and a lower specificity, which may be associated with limited use aimed only at detecting mucus.

► **Table 3** Description of the types of endometritis [5].

► **Tab. 3** Beschreibung der Endometritisformen [5].

Type of endometritis	Description
Catarrhal endometritis	Mucous, yellow with white flakes
Purulent catarrhal endometritis	From gray to yellow-brown color at 8–10 days postpartum
Fibrinous endometritis	Yellow-brown color, containing grains and flakes of fibrin, dense consistency
Necrotizing metritis	Red, red-brown color, fetid odor and tiny necrotic masses
Postpartum gangrenous septic metritis	Brown-red, brown, almost black with an admixture of mushy masses from decayed tissues with an ichorous odor, 5th–8th day postpartum
Chronic endometritis	Turbid mucus, exudate of creamy consistency for 2–3 months after parturition during the stage of excitation of the sexual cycle

### CLINICAL RELEVANCE

The device “Metrastatum” was developed for use in clinical practice for an early diagnosis of puerperal disorders. It allows to determine the degree of uterine involution by measuring the distance between the cervix and vulva and to collect discharge for an examination. This dual function of the device helps to diagnose more accurately and to select healthy animals for reproduction and sick cows for treatment depending on the form of uterine inflammation. The device is especially valuable in countries where ultrasound devices are not available for routine examinations.

### Conflict of interest

The authors confirm that they do not have any conflict of interest.

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