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Endometrial cytology as a diagnostic tool for subclinical endometritis in beef heifers

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Abstract: The obstetric assistance of dystocia in field conditions promotes greater bacterial contamination of the uterus, causing subclinical endometritis. The aim of this study was to determine the occurrence of subclinical endometritis in beef heifers receiving professional calving assistance, and to evaluate endometrial cytology as a diagnostic technique compared to uterine biopsy. A group of 829 Angus heifers were assisted at calving. Dystocia was classified based on difficulty at assistance, which was estimated as complex or simple. At the end of the calving season, 93 dystocic heifers were reported (10.7%). The percentage of simple resolution and complex resolution was 88.2% and 11.8%, respectively. After 60 days of calving, all animals underwent a gynecological examination, endometrial cytology, and uterine biopsy. In all, 38.9% of heifers presented subclinical endometritis diagnosed by endometrial cytology (sensitivity = 78.6%, specificity = 95.8%). There was a significant association (r = 0.8528) between uterine cytology and uterine biopsy. No associations were observed between endometrial cytology or biopsy and calf viability, or between endometrial cytology or biopsy and calving resolution. Endometrial cytology is a noninvasive technique with high specificity and repeatability for the diagnosis of subclinical endometritis postpartum in dystocic beef heifers.

Key words: Beef heifers, cytology, biopsy, dystocia, subclinical endometritis

1. Introduction

Sustainability of beef cattle breeding systems in extensive conditions is based primarily on herd reproductive efficiency, since alterations of the reproductive cycle generate important production losses (1). Perinatal losses are considered significant causes of this decline, which often represent the main difference between pregnancy rate and weaning rate (2,3). Dystocia is a major cause of perinatal and neonatal mortality, causing serious losses in breeding herds (4,5).

Obstetric assistance of dystocia in field conditions promotes greater bacterial contamination of the uterus. The causing bacteria are not specific and include *Arcanobacterium pyogenes*, *Escherichia coli*, *Fusobacterium necrophorum*, and *Prevotella melaninogenicus* (6). Bacterial colonization of the uterine lumen produces immune response stimulation. Polymorphonuclear cells inflame the endometrium, installing subclinical endometritis without systemic signs that delay uterine involution (7).

Postpartum endometritis has a negative effect on reproductive performance, causing an increase in the number of services per pregnancy and in the length of the calving–conception interval (8). Scientific studies on the etiology, pathophysiology, diagnosis, and treatment of endometritis have generally been conducted on dairy cattle (9), as repetition of heat after consecutive services is a characteristic usually reported on dairy farms.

In beef cattle breeding systems under extensive conditions, signs of subclinical endometritis cannot be observed in the animals due to handling characteristics. However, any animal suspected of suffering from this pathology, such as cases of dystocia, is considered systematically unproductive and discarded from the system.

Several diagnostic methods for endometritis determination have been implemented in dairy cows that show consecutive repeats of heat after artificial insemination, and are diagnosed as clinically normal by rectal palpation and ultrasonography (10). These methods are biopsy (11), uterine lavage (12), and endometrial cytology (13).

A safe and proper technique for the collection of representative cells from the endometrial surface is needed in order to obtain consistent and reliable cytological results. Endometrial biopsy is an invasive technique used in dairy cattle that could increase the calving–conception interval (14). The uterine lavage provides a representative sample; however, it can cause irritation of the endometrium, and

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the time of sample processing can affect the cell structure (15). One technique of cytologic sampling is the swab, whose main disadvantage is the structural alteration of the cells obtained (16). The cytobrush, modified for large animals, is considered an alternative technique that preserves cell architecture (15).

References to the use of these diagnostic techniques in beef cattle are scarce (17). Endometrial cytology could be a useful tool to estimate the reproductive future of dystocic heifers in order to avoid their systematic rejection from the production systems.

The aim of this study was to determine the occurrence of subclinical endometritis in beef heifers receiving professional calving assistance, and to evaluate endometrial cytology as a diagnostic technique compared to uterine biopsy.

2. Materials and methods

2.1. Animals and experimental design

Pregnancy diagnosis by rectal palpation was performed in a group of 829 heifers at an agricultural farm in Laprida, Buenos Aires, Argentina. At 15 months of age, these animals received natural service before being checked for genital tract development, pelvic area measurement, and individual weight.

Calving assistance of heifers was conducted by a veterinarian (Department of Medical and Surgical Clinics in Ruminants, Faculty of Veterinary Sciences, Buenos Aires University, Argentina) and 2 qualified operators on a daily basis from 18 July to 11 September 2011.

The difficulty of dystocia resolution was used to classify the heifers into 2 groups: simple and complex resolution. This classification simplifies the conventional calving score from 1 (eutocic calving) to 5 (extremely difficult calving), as described by Djemali et al. (18). Calving that required the assistance of 1–2 persons in the force traction (scores 2 and 3) was considered simple dystocia. Calving requiring mechanical extraction (score 4) or surgical procedures (score 5) was considered complex resolution. Eutocic heifers (score 1) constituted the control group.

Data for heifers' pelvimetry, feasibility, and weight were recorded at each birth using a Krautmann –Litton hydraulic transrectal pelvimeter.

All procedures were performed focusing on a low bacterial load. The obstetric and surgical instruments were sterilized by chemical method (immersion for 2 h in 5% chloroxylenol antiseptic solution).

At the end of the calving season, 93 heifers with dystocia were reported, representing 10.7% of total pregnant females. In all dystocic heifers, the puerperal period was assessed 60 days after the calving period by gynecological examination of the size, position, wall thickness, and luminal contents of the uterus.

The animals that presented clinical uterine signs of inflammation/infection (clinical endometritis) were excluded from the study. Only dystocic heifers with no clinical evidence of endometritis were included, and were subjected to endometrial cytology and uterine biopsy. Uterine biopsy was considered as the gold standard method for the diagnosis of subclinical endometritis (19).

Twenty eutocic heifers were selected for the control group, and a gynecological examination, endometrial cytology, and uterine biopsy were performed.

Prior to sampling, the perineal area was washed with water and neutral soap to remove residual feces or vaginal fluxes. A 10% povidone–iodine solution was sprayed to diminish the bacterial load and prevent contamination during sampling.

2.2. Cytology

The cytobrush was made by inserting the standard used in human gynecology into the plunger of an insemination rod. The plunger was then placed inside the metal sleeve of the gun and, finally, the entire device was covered with a plastic sheath. After threading through the cervix and once into the uterus, the cytobrush was exposed. The sample was obtained by moving the cytobrush clockwise around its longitudinal axis. The cytobrush was subsequently retracted into the plastic sheath for protection.

The sample was extended on a clean and degreased slide. Each sample was air-fixed for subsequent staining with Romanowsky stain (Diff–Quick, Puerto Rico). An optical microscopy with 100× magnification under oil immersion was used for smear observations. Each slide was divided into 3 sectors (far left, center, and far right). In each sector, a total of 100 cells were counted, avoiding high cellularity areas, and the number of polymorphonuclears (PMN) was registered. The sample result consisted of the average cell count.

2.3. Biopsy

The core needle biopsy was made of stainless steel and consisted of an outer jacket (54.5 cm, 0.5 cm internal diameter) and a stylus (62 cm length, 0.35 cm width), with a cutting surface (2 cm long, 0.3 cm wide, 0.3 cm deep) at the free end.

The core needle biopsy, covered with a plastic bag, was introduced into the cervix and once threaded, the plastic sheet was drilled. Once in the uterine lumen at the middle of the horn, the cutter was exposed and the sample was drawn with slight digital pressure (14).

The sample was placed in a 5-mL hemolysis tube in 10% formaldehyde solution. Once in the laboratory, samples were processed under standard histopathologic techniques. Readings were performed using an optical microscope with 10× and 40× magnification. Signs considered as inflammation indicators were edema zones bearing polymorphonuclear leucocytes, foci of

mononuclear infiltration, areas of tissue degeneration, and necrosis (14).

2.4. Statistical analysis

Logistic regression was performed to study the association between calving types and calf viability. The odds ratio and confidence interval (95% coverage) were also calculated, and a proportion test for these 2 variables was performed. The relationship between calving type, pelvic area, and calf body weight was ascertained by parametric analysis of variance (ANOVA test). A multiple comparison test (LSD) was performed in the cases where ANOVA was significant. Pearson and Spearman correlation was used to analyze the degree of association between several variables such as calving resolution, heifer pelvic area, calf body weight, calf viability, endometrial cytology, and uterine biopsy. The polymorphonuclear leucocytes percentage difference between positive and negative cytology was determined by a nonparametric analysis of variance (Kruskal–Wallis test). Sensitivity and specificity calculation was performed for endometrial cytology. Optimal cutoff point, aimed at determining the relationship between uterine biopsy and cytology polymorphonulear leucocytes percentage, was calculated using receiver operating characteristic (ROC) curve. A 2 × 2 chi-square analysis, studying the degree of association between calving resolution and calf viability, was performed for each group according to the cytology results (positive and negative). Statistical analyses were performed using Statistix version 8.0 (Analytical Software, Tallahassee, FL, USA), MedCalc version 12.7.0.0 (MedCalc Software, Mariakerke, Belgium), SPSS version 21.0.0.0 (IBM Corporation, USA) and Infostat version 2013 (InfoStat Group, National University of Córdoba, Argentina). The level of significance was set at $P < 0.05$.

3. Results

Out of 93 cases of dystocia, 88.2% were considered simple resolutions, while calving assistance classified as complex resolution comprised the remaining 11.8%.

Differences between proportions of live calves based on calving characteristics were assessed using a test of proportions. The rate of live calves in eutocic births was 94.3%, similar to that obtained in simple resolution dystocia (90.2%), and there was no statistically significant difference between the 2 types of births. In cases of dystocia of complex resolution, the percentage of live calves decreased to 45.5%. This proportion was significantly lower than in dystocia of simple resolution ($P < 0.05$) or in eutocic calving ($P < 0.05$). Data for calving characteristics associated with the viability of calves are observed in Table 1. The probability of obtaining a dead calf in complex resolution calving is almost 20 times higher than in eutocic birth (OR = 19.83; 95% CI (5.81–67.64); $P > 0.05$). However, no difference was observed in calf mortality between eutocic birth and simple resolution calving (OR = 1.79; 95% CI (0.81–3.95); $P < 0.05$).

After 60 days of calving, a gynecological examination, uterine cytology, and uterine biopsy were performed on the 93 dystocic heifers. Three (3.2%) heifers were excluded from the study because their anatomical puerperium was substandard. The uterus was located in the abdominal cavity and showed thickened wall and contents, which are clinical signs of endometritis. The dystocia of 2 heifers was solved by partial fetotomy with static fetal correction, whereas the 3rd required cesarean section.

The remaining heifers (90) had normal puerperium with a primarily pelvic uterus, standard wall thickness, and no apparent content. Retrospectively, 91.1% of this group had been assisted at calving by simple resolution and 8.9% by complex resolution.

The average pelvic area at calving of dystocic heifers that completed a normal anatomic puerperium was 192.41 ± 27.94 cm^2. The average weight of calves born to these females was 29.69 ± 2.82 kg. The pelvic area of the eutocic heifers was 197.35 ± 22.48 cm^2, and average calf weight was 28.50 ± 1.91 kg. Table 2 shows the results in terms of mean ± standard deviation of pelvic area and calf weight by type of calving resolution. No significant differences were established by ANOVA in the pelvic area between the 2 groups (simple or complex resolution) of calving ($P > 0.05$) or between these and eutocic births ($P > 0.05$).

Table 1. Calving characteristics and viability of calves.

Calving characteristics	Live calves	Dead calves	Total
Dystocia simple resolution	74 (8.92%)[b]	8 (0.97%)	82 (9.89%)
Dystocia complex resolution	5 (0.61%)	6 (0.72%)[a]	11 (1.33%)
Eutocic calving	694 (83.71%)[b]	42 (5.07%)	736 (88.78%)
Total	773 (93.24%)	56 (6.76%)	829 (100%)

[a] Significance: $P < 0.05$ for logistic regression.
[b] Significance: $P < 0.05$ for proportion test.

Table 2. Pelvic area at birth and weight for calves of dystocic and eutocic heifers.

Calving characteristics	Pelvic area (cm^2)	Weight of calves (kg)	
	Mean ± SD	Mean ± SD	LSD
Dystocia simple resolution	191.51 ± 29.49	30.63 ± 2.98[a]	A
Dystocia complex resolution	197.81 ± 17.69	31.75 ± 1.50[a]	A
Eutocic calving	197.35 ± 22.48	28.50 ± 1.91[a]	B

[a] ANOVA: $P < 0.05$ means comparisons.
LSD: multiple comparison test.

However, significant differences among the 3 calving groups were defined by ANOVA by comparing calf weight ($P < 0.05$).

LSD showed that calves born in eutocic calving presented, on average, significantly lower weight than those born in dystocic calving. There was no difference in this parameter between simple or complex resolution dystocia.

The medians for the pelvic area at calving (196 cm^2) and calf weight at birth (31 kg) were calculated in order to obtain a cutoff value to evaluate associations of both parameters with the type of calving resolution (Table 3).

The Pearson correlation test found no significant correlation ($P > 0.05$) between calving resolution with the pelvic area of heifers or the weight of calves at birth. However, the Spearman correlation test showed a significant association ($P < 0.05$) between calving resolution and calf viability ($r = 0.4196$).

Considering the uterine biopsy as the gold standard test for the subclinical endometritis diagnosis, samples were divided into 2 groups according to biopsy results (positive or negative). In each group, the mean standard deviation and median of respective cytologies were calculated and expressed as % PMN (Table 4).

Cytologies expressed as % PMN did not show a normal distribution (Shapiro–Wilk test, $P < 0.05$). Thus, in order to determine the differences between positive and negative cytologies, a Kruskal–Wallis test was conducted. A highly significant difference between positive and negative cytologies was observed ($P < 0.05$). Based on an ROC curve, a cutoff point of >5.5% polymorphonuclear cells was highly correlated with positive uterine biopsy; this cutoff point was 95.8% specific and 78.6% sensitive ($P < 0.05$) for predicting subclinical endometritis (Figure). The mean standard deviation and the median of percentage of

Table 3. Distribution of pelvic area of dystocic heifers, viability, and weight of calves according to median division.

	Pelvic area at birth		Calf viability		Calf weight	
Dystocia	>196 cm^2	≤196 cm^2	Live	Dead	>31 kg	≤31 kg
Simple resolution	39	43	75[a]	7	35	47
%	43.33	47.78	83.33	7.78	38.89	52.22
Complex resolution	4	4	4[a]	4	3	5
%	4.44	4.44	4.44	4.44	3.33	5.56
Total	43	47	79	11	50	40
%	47.78	52.22	87.78	12.22	55.56	44.44

[a] Significance: $P < 0.05$ for Spearman correlation test.

Table 4. Polymorphonuclears (in %) according to positive and negative biopsies.

% PMN	Negative biopsies	Positive biopsies
Mean	0.88	10.66[a]
Standard deviation	1.08	7.12
Median	0.33	10.00

[a] Significance: $P < 0.05$ for Kruskal–Wallis test.

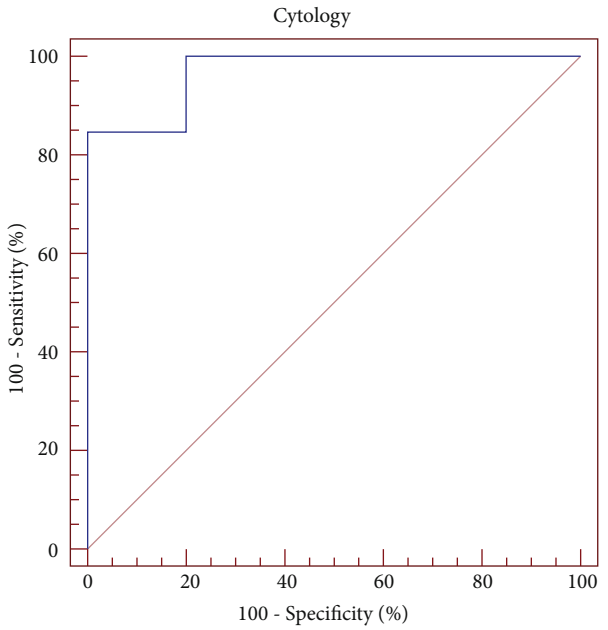

Figure. ROC curve for percentage of polymorphonuclear cells as a predictor of subclinical endometritis in beef cattle.

polymorphonuclear pursuant to positive or negative cytology (cutoff 5.5%) are shown in Table 5.

Analysis of the ROC indicated that the use of a cutoff point higher than 5.5% PMNs was 95.83% specific and 78.57% sensitive for the detection of subclinical endometritis (P = 0.0001).

The results of positive and negative cytology and biopsies and their relationship with the type of resolution of dystocia are detailed in Table 6.

The results of endometrial cytologies associated with calf feasibility and dystocia resolution are shown in Table 7. In turn, the results of cytologies from 20 eutocic heifers were randomly selected as a negative control. In beef heifers with positive endometrial cytologies, an association between dystocia resolution and calf feasibility was observed. A similar association was observed in the group of beef heifers with negative endometrial cytologies (P < 0.05).

All uterine cytologies from eutocic heifers were negative. Notably, 27.3% of complex resolution cases, which were excluded from the study for presenting clinic uterine pathologies, had positive uterine cytologies and biopsies.

Cytology sensitivity and specificity were calculated in the study population by using biopsy results as the true values of presence and absence of subclinical endometritis. The obtained sensitivity value was 78.6%, while the specificity value was 95.8%.

An association and correlation between both diagnostic techniques was evaluated, as well as a statistically significant association (P < 0.05) between the uterine cytology and biopsy with a Pearson correlation of r = 0.8528. No associations were observed between endometrial cytology, biopsy, and calf viability (P > 0.05). Finally, no significant associations were found between endometrial cytology, biopsy, and calving resolution (P > 0.05).

Table 5. Polymorphonuclears (in %) according to positive and negative cytologies.

% PMN	Negative cytology	Positive cytology
Mean	0.81	11.78[a]
Standard deviation	1.57	6.95
Median	0.33	11.00

[a] Significance: P < 0.05.

Table 6. Cytologies and biopsies related to dystocia resolutions.

Dystocia	Positive cytologies	Negative cytologies	Positive biopsies	Negative biopsies
Simple resolution	33 (36.67%)[NS]	49 (54.44%)	40 (44.44%)[NS]	42 (46.67%)
Complex resolution	2 (2.22%)[NS]	6 (6.67%)	2 (2.22%)[NS]	6 (6.67%)
Total	35 (38.89%)	55 (61.11%)	42 (46.66%)	48 (52.34%)

[NS] No significance P > 0.05.

Table 7. Endometrial cytologies related to calf viability and dystocia resolution.

Cytology	Positive		Negative	
	Live calves	Dead calves	Live calves	Dead calves
Simple resolution	31[a]	3	43[b]	5
Complex resolution	0[a]	1	4[b]	3
Eutocic calving	0	0	20	0

[a] $P < 0.05$ for 2 × 2 chi-square analysis in positive cytologies.
[b] $P < 0.05$ for 2 × 2 chi-square analysis in negative cytologies.

In 2012, the dystocic heifers that presented negative endometrial cytologies entered natural service and a pregnancy rate of 85.7% was obtained.

4. Discussion

This study determines the occurrence of subclinical endometritis in Aberdeen Angus heifers that received calving assistance using endometrial cytology at 60 days postpartum, following natural service at 15 months of age.

The 15-month natural service in heifers, to reach at calving at 2 years old, is a tool used to increase their productive life. However, this category is prone to dystocia.

The factors associated with dystocia in Aberdeen Angus heifers are weight at calving, age at calving, calf weight at birth, and calf sex (2). This category requires 1.5-fold more calving assistance than adult cows (20).

In this study, the prevalence of dystocia was 11.2%, mainly conditioned by the selection criteria of heifers and bulls. Other studies with similar management reported a dystocia prevalence of 6.7% (21), 9.1% (22), and 11.1% (23).

In Argentine herds with no selection of heifers and bulls, dystocia prevalence reportedly ranged from 22.2% (1) to 32.5% (24). International values of dystocia in heifers ranged from 13% (25) and 18% (4) to 29.7% (3).

The selection of animals with characteristics that allow greater calving ease (low weight at birth, age, weight, pelvic area of heifers, and bulls that produce calves with low weight at birth) significantly reduces the rate of dystocia, as evidenced in the present work.

The calving resolutions were classified as simple or complex depending on the type of assistance required. Calving resolutions were consistent with a similar assay in Angus heifers, where the eutocic calving rate was 85.2%, simple resolution dystocia 11.9%, and complex resolution 3.0% (26). The great variability observed in the rates of calving assistance is due to the different classifications applied to dystocia by the authors. Turner et al. (2) reported 34% dystocia in Angus heifers, of which 49% presented slight difficulties, 41% had considerable difficulties, and 5% needed a cesarean section. The remaining 5% experienced wrong fetal static.

In this study, total mortality of calves during the calving season was 6.76%. Similar rates, reported by other authors, ranged from 3% to 6.4% (3,27). However, the higher mortality of calves, such as 12.4% (27) and 28.2% (24), suggests that a rigorous monitoring of heifers at calving should be implemented.

In the present work, dystocia cases were assisted by qualified professionals. Heifer and calf care under low bacterial charge conditions may have influenced the number of dead calves, which merely amounted to 1.7%. The high mortality rate observed in dystocia of complex resolution was associated with intrauterine calf death, attributable to various causes (perosomus elumbus, teratogenic diseases, choking, etc.), and a lower proportion died within 24 h. In all probability, the intrauterine death of calves led to the complex resolution of dystocia.

Meijering (5) determined a high association between calving difficulty, pelvic area, and calf weight. In this study, however, the pelvic area showed no significant correlation with calving difficulty. Similar results were observed by Laster et al. (25), who defined a pelvic area at calving of 231 ± 2 cm^2 for 2-year-old Angus heifers, and found no association between the former and calving difficulty. Other authors also failed to determine the association (2,22,28). These results were in agreement with the expressed values. Due to the high heritability of this parameter in 2-year-old heifers (40%–50%) and the continuous selection of heifers, rapid progress towards large pelvic areas in the herd is obtained.

Heifer weight at calving, age at calving, calf weight at birth, calf sex, and the pelvic area/calf weight ratio are variables that have been correlated with dystocia (2,22,28,29). The factor with the greatest impact on the occurrence of dystocia is calf weight. In this study, significant differences were observed between the average weight of calves born by eutocic and dystocic calving. Calves born by complex resolution were heavier than those born by simple resolution or eutocic calving.

However, calves with weight exceeding 31 kg showed no difference between simple and complex resolutions. These results are consistent with Navarro et al. (22), who showed a correlation between 35.5 kg calf weight at birth and dystocia, regardless of resolution characteristics (in contrast to the eutocic calving weight of 29.6 kg), as the animals included in the study were selected to produce calves of low weight at birth.

Expected consequences following dystocia include increase in calf mortality, reduction in future conception rate, and increase in calving intervals. Dystocia requires assistance by trained personnel because incorrect methods increase the occurrence of clinical or subclinical uterine diseases.

In this study, the prevalence of clinical endometritis in dystocic heifers was 3.2%. Without discriminating between calving characteristics, 9.1% of clinical endometritis was reported in dairy cattle. This prevalence shows that subclinical endometritis in heifers from beef cattle at 60 days postpartum (17%) is lower than that reported in dairy cattle (17). In the present work, the prevalence of subclinical endometritis among dystocic heifers was 46.7% with biopsy diagnosis, or 38.9% with cytological techniques. Other authors determined a 10%–19% prevalence in dairy cattle at 50–60 days postpartum (30). In the present work, the prevalence of subclinical endometritis in dystocic heifers was determined by cytology and biopsy.

Equality observed in the viability of calves in dystocia of complex resolution was relative, due to the exclusion of heifers with clinical endometritis and heifers whose calves were dead prior to the assistance.

Diagnostic techniques used to evidence uterine pathologies are endometrial cytology by lavage or cytobrush, vaginoscopy, rectal palpation, ultrasound, and uterine biopsy. The gold standard technique for subclinical endometritis detection is the uterine biopsy (19). Bonnett et al. (14) reported that uterine biopsy showed 92% sensitivity and 77% specificity in dairy cattle at 120 days postpartum. This technique has been associated with a decrease in the conception rate at first service and uterine infections (11,19). Endometrial cytology is associated with cellular defense mechanisms of the uterus (15,19). By differentiating the polymorphonuclear counts obtained by cytology according to the result of biopsies (positive and negative), significant differences between averages were observed, which allowed us to conclude that cytology is useful to determine the occurrence of subclinical endometritis in beef heifers. The average PMN was 10.7% for positive animals (positive biopsy) and 0.9% for negative animals (negative biopsy). The correlation between uterine biopsy and endometrial cytology was significant, with a value of 0.8137. A similar value (r = 0.83) was obtained by Santos et al. (17) in a correlation between clinical assessment measured by score and endometrial cytology.

Using ROC curves, the cutoff of % PMN obtained by cytobrush technique at 60 days postpartum was determined. An efficient discrimination between positive and negative animals is defined by 5.5% PMN. These values are consistent with Santos et al. (17) and Gilbert et al. (9), who reported values of 5.5% and 4%, respectively, at 40–60 days postpartum. The sensitivity and specificity of the endometrial cytology in this study resulted in 76.9% and 100%, respectively. These values are consistent with a study in Angus heifers using the same diagnostic technique, whose sensitivity value was 78% and specificity value was 100% (17). When evaluating the results of cytologies and biopsies according to calving resolution, high correspondence was observed for both techniques. No association was found between the results of cytologies or biopsies with calf viability and calving characteristics. Therefore, calf viability and calving characteristics were not decisive in the development of subclinical endometritis in the animals under study.

Retention of placenta, calving characteristics, calving of twins, and assistance have been linked to uterine diseases (8,17). In this study, the lack of association among these parameters could be consistent with the intervention of qualified personnel and the use of sterile materials and proper techniques to reduce the bacterial load to a minimum. The occurrence of uterine diseases, such as subclinical endometritis, decreases reproductive performance for future conception (9). In this study, the pregnancy rate in the next breeding season was 85.7%, consistent with the 87% observed by Santos et al. (17).

To conclude, the results of this study showed that endometrial cytology could be a useful tool for estimating the reproductive future of dystocic heifers, in order to avoid their systematic rejection from the production systems. Based on current results, future studies could use endometrial cytology as a monitoring tool of antibiotic efficiency in endometritis therapy of beef heifers.

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