



Ultrasonographic M-mode for diagnosing uterine inertia and comparative analysis of blood parameters in canines[#]

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Abstract

The study compared haematological and serum biochemical parameters in bitches with complete primary uterine inertia (PUI) and obstructive dystocia (OD), and evaluated a non-invasive method for monitoring uterine contractions using M-mode ultrasonography. Twelve full term pregnant bitches with dystocia were equally divided into PUI (n=6) and OD (n=6) groups. Radiography was used to determine foetal number and confirm obstruction in OD cases. Ultrasonographic examination was performed in all animals, with M-mode used to assess myometrial activity. Blood samples were analysed for complete blood count, glucose, calcium, and progesterone levels. Data were analysed using an independent t-test following Shapiro–Wilk normality testing. M-mode ultrasonography revealed active myometrial contractions in OD (wavy pattern), whereas PUI cases showed absence of contractions (straight line pattern). No significant differences ($p > 0.05$) were observed in haematological or biochemical parameters between groups. The findings indicate that variations in calcium, glucose, or progesterone may not underlie PUI in otherwise healthy bitches. M-mode ultrasonography is a useful tool for early diagnosis of uterine inertia.

Keywords: Primary uterine inertia, Obstructive dystocia, haematology, serological analysis, M-mode

Identifying the type of dystocia and its timely management are of profound clinical importance in canine obstetrics. Dystocia in canines is defined as a difficult birth or the inability of the bitch to expel foetuses through the birth canal without assistance (Scully, 2023). Overall, the incidence is about 5% in canines, but in certain dog breeds like English Bulldog, it can approach 100% (Linde-Forsberg & Eneroth, 2000; Stengel, 1997; Trautmann, 2003). Failure to produce expulsive contractions after a period of dilatation, with the birth canal unobstructed, is known as primary uterine inertia. In a research report by Polster (2006), 22.5% of dogs with dystocia had primary uterine inertia as their cause. This might be associated with many underlying factors, including serum calcium, serum glucose, and progesterone levels. The current study analysed these factors to find out its association with uterine inertia. Obstructive dystocia is due to faulty

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foetal disposition or foetal oversize. An existing method for monitoring contractions non-invasively is external tocodynamometry as described by Maul et al. (2003), and Li et al. (2003), Davidson (2010), Jayakumar et al. (2019) and Magnus et al. (2022). The present investigation evaluated the feasibility of M-mode ultrasonography to assess myometrial activity in diagnosing uterine inertia.

Materials and methods

Twelve healthy bitches presented to the Teaching Veterinary Clinical Complex, Mannuthy and the University Veterinary Hospital, Korkkakai with the complaint of difficulty in parturition were used for the study. The bitches were screened for uterine contractions by M-mode ultrasonography, followed by a clinico-gynaecological examination. The selected animals were divided into Group 1 (n=6) with primary uterine inertia and Group 2 (n=6) with obstructive dystocia. Dogs that started the second stage of labour were chosen for the study if they had an open, relaxed cervix with gestational sacs visible on vaginocopy, green discharge from a marginal haematoma, or the discharge of foetal fluids as described by Magnus et al. (2023)^b. The selected animals underwent ultrasonographic analysis. The uterine wall was focused with B-mode and later switched to M-mode. M-mode was used to obtain a continuously updated graph of the uterine wall motion relative to the transducer over time. The monitoring was performed using an ultrasound scanner (MyLabX8exp, EsaoteSpA, Italy) with a microconvex array transducer (1-8 MHz). In dogs with obstructive dystocia, the obstruction was confirmed by radiography, which showed foetal malpositions in all six bitches. Blood samples were collected from the cephalic vein of all the bitches and transferred to an EDTA vial and a serum vial (Ultimate moulds and products, Thrissur, Kerala, India). The blood was analysed for complete blood

count using (Mythic 5Vet PRO, Orphee, Switzerland) Veterinary Auto Haematology Analyzer. The serum was separated, and the levels of glucose, total calcium and progesterone were analysed. Total calcium was estimated using Arsenazo III Kit method (AGD Biomedicals (P)Ltd.) in the Screen Master T analyser (Hospitex diagnostics, Italy). Glucose level was assessed in the same analyser. The progesterone was evaluated using Chemiluminescent Immunoassay (CL-900i, Mindray, Shenzhen, China). The data were checked for normality using Shapiro-Wilk test. As the data was following a normal distribution, further analysis was done using an independent t-test.

Results and discussion

M-mode ultrasonographic tocodynamometry

M-mode ultrasonography demonstrated absence of myometrial contractions in primary uterine inertia cases, evidenced by a stable hyperechoic straight line with no shift in uterine wall linearity when examined with a linear transducer. In obstructive dystocia cases, M-mode ultrasonography showed a wavy pattern indicative of myometrial contractions, with the horizontal axis representing time and the vertical axis representing the amplitude of uterine wall displacement (Fig.1). A similar pattern has been reported by Campbell and England (2002), where uterine contractions in equines appeared as positive deviations from the baseline on M-mode, consistent with the observations of the present study in the dog.

Distribution of myometrial contractions were assessed by M-mode ultrasonography in primary uterine inertia and obstructive dystocia groups which showed complete absence in former group.

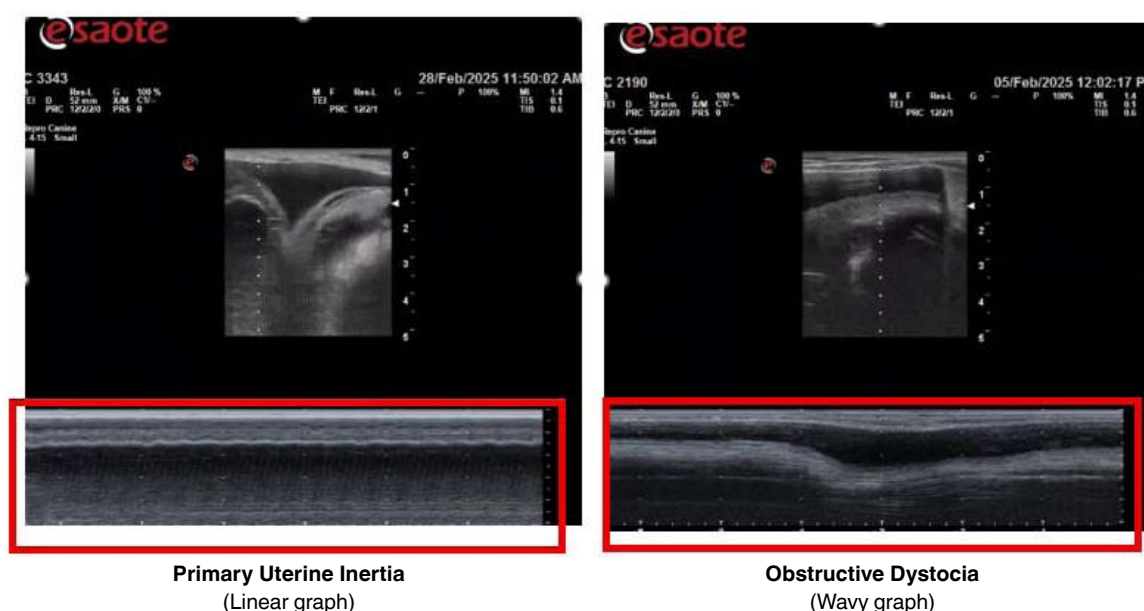


Fig. 1: M-mode images

Evaluation of haematological parameters

The various haematological parameters are shown in Table 1. Dogs typically have WBC counts between 5.0 and $14.1 \times 10^3/\mu\text{L}$ (Cynthia & Scott, 2010). The two groups did not differ significantly. The average WBC counts for obstructive dystocia and primary uterine inertia were $14.42 \pm 1.51 \times 10^3/\mu\text{L}$ and $17.08 \pm 2.07 \times 10^3/\mu\text{L}$, respectively. These values contradicted those reported by Magnus et al. (2023)^a, which were within the normal range ($11.51 \times 10^3/\mu\text{L}$ in complete primary uterine inertia and $13.23 \pm 2.28 \times 10^3/\mu\text{L}$ in foetal cause of dystocia). Doxey (1966) and Frehner et al. (2018) both documented this leukocytosis. According to Frehner et al. (2018), the WBC count in cases of uterine inertia with obstructive dystocia was $14.5 \pm 3.6 \times 10^3/\mu\text{L}$. This increased leukocyte count may be related to the inflammatory circumstances associated with termination of parturition, which are characterised by raised cortisol and prostaglandin concentrations and decreased progesterone concentrations (Dimco et al., 2013; Frehner et al., 2018).

The differential granulocyte count was 82.02 ± 1.46 per cent in the primary uterine inertia group and 85.6 ± 2.28 per cent in the obstructive dystocia group, both of which fell within the typical range of 58–85 per cent. This agreed with the study by Magnus et al. (2023)^a which showed values within the normal range. The groups did not differ significantly from one another. The results of Dimco et al. (2013) and Frehner et al. (2018), on the other hand, observed granulocytosis and connected it to lower progesterone levels and the inflammatory environment linked to pregnancy.

Both groups' differential monocyte counts fell within the typical range of 2–10 per cent. For the primary uterine inertia and obstructive dystocia groups, it was 4.28 ± 0.51 per cent and 5.31 ± 1.5 per cent, respectively, with no discernible difference between the groups. Pregnant dogs in the studies by Dimco et al. (2013), Frehner et al. (2018) and Magnus et al. (2023)^a had differential monocyte counts of 6.5 per cent and 5.1 per cent, respectively, which were likewise within the normal range. The consistency across these studies reinforces the notion that monocyte levels remain relatively stable during normal and complicated parturition, and are not significantly influenced by conditions such as primary uterine inertia or obstructive dystocia.

The two groups' differential lymphocyte counts fell within the typical range. Lymphocytes ranged from 8 to 21 percent (Cynthia & Scott, 2010). With 12.04 ± 1.87 per cent in Group 1 and 8.66 ± 1.29 per cent in Group 2, there was no significant difference between the groups. The findings of the current study were at odds with those of Dimco et al. (2013), who discovered that lymphopenia in pregnant dogs is associated with physiological stress. Another report suggested that lymphocytosis may result

from an immune reaction against the corpus luteum in active CL lysis associated with periparturient luteolysis, which involves several cytokines and lymphokines (Zatta et al., 2017; Magnus et al., 2023^a). Although overt lymphocytosis was not observed in the present study, the relatively maintained lymphocyte levels could reflect a balance between stress-induced lymphopenia and immune-mediated lymphocytic activation.

Group 1's RBC count was $5.06 \pm 0.14 \times 10^6/\mu\text{L}$, falling within the typical range of 4.95 – $7.87 \times 10^6/\mu\text{L}$ (Cynthia & Scott, 2010). Group 2's value was lower at $4.52 \pm 0.33 \times 10^6/\mu\text{L}$. The two groups did not differ significantly from one another. According to Doxey (1966), pregnancy-related anaemia may account for the results close to the lower margin. Concannon et al. (1989), Verstegen-Onclin & Verstegen (2008), Frehner et al. (2018) and Magnus et al. (2023)^a determined that this anaemia was caused by hemodilution associated with foetal circulation.

Group 1's haemoglobin concentration was 11.98 ± 0.33 g/dL, which was not significantly different from Group 2's 12.29 ± 0.68 g/dL. These results were close to the lower end of the canine species' reference range of 11.9–18.9 g/dL (Cynthia & Scott, 2010). The values reported by Magnus et al. (2023)^a were lower than those in the present study.

There was no significant difference between the haematocrit readings of the primary uterine inertia group (35.66 ± 1.12 per cent) and the obstructive dystocia group (36.44 ± 2.3 per cent). The average haematocrit value for canines ranges from 35 to 57 per cent, with the animals in this study at the lower end of this range. This is consistent with the results of Frehner et al. (2018) with 45.3 ± 5.9 per cent and De Cramer et al. (2016) with 44.2 ± 4.2 per cent. Study by Frehner (2018) reported 14 per cent of bitches with values between 30 and 37 per cent due to haemodilution. However, the values obtained by Magnus et al. (2023)^a were much lower, indicating greater anaemia intensity, with 31.22 ± 1.65 % in the complete primary uterine inertia group and 30.72 ± 2.32 % in the foetal cause of dystocia group.

The platelet count did not differ significantly across the groups and was within the usual range of 211 – $621 \times 10^3/\mu\text{L}$ (Cynthia & Scott, 2010). The primary uterine inertia group's platelet count was $394.33 \pm 47.61 \times 10^3/\mu\text{L}$, which is less than the obstructive dystocia group's level of $450.33 \pm 64.1 \times 10^3/\mu\text{L}$. This is comparable to the pattern found in the Magnus et al. (2023)^a study, in which the main uterine inertia group had a lower platelet count than the obstructive dystocia group. Consistent with the current study, Frehner et al. (2018) reported a platelet count of $460 \pm 86 \times 10^3/\mu\text{L}$. Platelet production and regulation are primarily controlled by bone marrow activity and thrombopoietic mechanisms, and are not typically affected by uterine contractility or mechanical obstruction during parturition

Overall, the haematological parameters evaluated in both primary uterine inertia and obstructive dystocia groups remained largely within physiological limits, with no significant differences between the groups. Mild leucocytosis observed in both conditions may be attributed to stress and the inflammatory milieu associated with parturition, rather than the underlying cause of dystocia. Erythrocytic parameters, including RBC count, haemoglobin, and haematocrit, were at the lower end of the normal range, suggesting mild pregnancy-associated anaemia likely due to haemodilution. Differential leukocyte counts and platelet values remained stable, indicating that these parameters are not markedly influenced by uterine contractility or mechanical obstruction. Collectively, these findings suggest that haematological alterations during whelping are more reflective of physiological and endocrine changes of parturition rather than being specific to primary uterine inertia or obstructive dystocia.

Serum biochemistry

The mean calcium concentration in the primary uterine inertia group was 7.66 ± 0.20 mg/dL, which is not statistically different from the mean of 7.81 ± 0.41 mg/dL in the obstructive dystocia group. Hollinshead et al. (2010) reported lower calcium concentrations in dogs with primary uterine inertia compared to those with obstructive dystocia, which is comparable to the findings of the present study. Dogs in both conditions exhibited hypocalcaemia, with total serum calcium levels below the normal range of 9.1 to 11.7 mg/dL. This is consistent with a study by Frehner et al. (2018) that found decreased calcium levels in 68% of dogs with dystocia. The animals' hypocalcaemia may have resulted from prolonged exertion or an innate deficit that led to hypocalcaemia.

The mean glucose concentration was 80.92 ± 10.79 mg/dL in the primary uterine inertia group and 89.41 ± 11.78 mg/dL in the obstructive dystocia group. According to Bachmann (2018), venous blood glucose levels in canines typically ranged from 68.4 to 115.2 mg/dL. The values in the current study fell within this range. According to reports by Bergstrom et al. (2006), Lucio et al. (2009), and Hollinshead et al. (2010), canine uterine inertia or dystocia was not caused by low blood glucose. According to the present study, there was no correlation between inertia and glycaemic level since the bitches were euglycaemic.

Overall, serum biochemical parameters did not differ significantly between dogs with primary uterine inertia and obstructive dystocia. Although hypocalcaemia was observed in both conditions, it was not specific to either group and may reflect the physiological demands or underlying metabolic status during parturition. Blood glucose levels remained within the normal range in both groups, indicating that hypoglycaemia is unlikely to be a contributing factor to uterine inertia or obstructive dystocia. These findings suggest that variations in calcium and glucose levels are not primary determinants distinguishing the two conditions, but rather represent general metabolic changes associated with whelping. The serum biochemistry depicted in Table 2.

Serum progesterone assay

Both groups did not differ significantly in progesterone levels, with Group 1 at 1.40 ± 0.34 ng/mL and Group 2 at 1.14 ± 0.22 ng/mL (Table 3). This is similar to the study by Magnus (2022) where the foetal cause of dystocia had a higher but non-significant value than primary uterine

Table 1. Haematological parameters of bitches affected with primary uterine inertia and obstructive dystocia

Variable	Group 1(n=6)	Group 2(n=6)	t-value	P-value
Total leucocyte count ($\times 10^3/\mu\text{L}$)	17.08 ± 2.07	14.42 ± 1.51	1.039 ^{ns}	0.323
Differential granulocyte count (%)	82.02 ± 1.46	85.6 ± 2.28	1.319 ^{ns}	0.217
Differential monocyte count (%)	4.28 ± 0.51	5.31 ± 1.5	0.650 ^{ns}	0.530
Differential lymphocyte count (%)	12.04 ± 1.87	8.66 ± 1.29	1.487 ^{ns}	0.168
Red Blood Cell Count ($\times 10^6/\mu\text{L}$)	5.06 ± 0.14	4.52 ± 0.33	1.523 ^{ns}	0.159
Haemoglobin concentration (g/dL)	11.98 ± 0.33	12.29 ± 0.68	0.406 ^{ns}	0.693
Packed Cell Volume (%)	35.66 ± 1.12	36.44 ± 2.3	0.305 ^{ns}	0.767
Thrombocyte count ($\times 10^3/\mu\text{L}$)	394.33 ± 47.61	450.33 ± 64.1	0.701 ^{ns}	0.499

*ns non-significant

Table 2. Comparison of parameters of serum biochemistry between primary uterine inertia and obstructive dystocia

Variable	Group 1(n=6)	Group 2(n=6)	t-value	P-value
Calcium (mg/dL)	7.66 ± 0.20	7.81 ± 0.41	0.337 ^{ns}	0.743
Glucose (mg/dL)	80.92 ± 10.79	89.41 ± 11.78	1.3 ^{ns}	0.22

*ns non-significant

Table 3. Comparison of serum progesterone between primary uterine inertia and obstructive dystocia

Variable	Group 1(n=6)	Group 2 (n=6)	t-value	P-value
Progesterone (ng/ml)	1.14 ± 0.22	1.40 ± 0.34	0.638 ^{ns}	0.538

*ns non-significant

inertia. Serum progesterone levels in prepartum luteolysis should be less than 2 ng/mL, according to Beccaglia et al. (2016) and Papa and Kowalewski (2020).

When progesterone levels start to drop, the microsomal compartment of foetal trophoblast cells in the placenta releases PGF2 α (Kowalewski et al., 2009; Gram et al., 2014), which coincides with low-frequency contractions of the myometrium (van der Weyden et al., 1989). However, this PGF2 α synthesis route is absent in non-pregnant dogs. PGF2 α will lyse the CL and stimulate the immune reaction to it. It also eliminates the immunosuppressive effect of progesterone, which causes the corpus luteum to be rapidly destroyed by the immune system (Zatta et al., 2017; Kowalewski et al., 2009). PGF2 α activity and immune-mediated corpus luteum destruction cause a sudden withdrawal of progesterone.

Serum progesterone levels did not differ significantly between dogs with primary uterine inertia and obstructive dystocia, with values in both groups remaining below 2 ng/mL, consistent with prepartum luteolysis. This indicates that normal progesterone withdrawal had occurred in all cases, irrespective of the underlying cause of dystocia. Therefore, progesterone levels do not appear to play a distinguishing role between primary uterine inertia and obstructive dystocia.

Conclusion

The study established that M-mode ultrasonography is an effective, non-invasive tool for identifying uterine inertia, characterised by absence of myometrial movement even after feathering during second-stage labour, in contrast to the wavy contraction patterns seen in obstructive dystocia. Haematological findings in both conditions revealed mild leucocytosis and pregnancy-associated anaemia, while differential counts and platelet values remained within normal limits, with no significant intergroup differences. Serum biochemical analysis showed hypocalcaemia and euglycaemia in all animals, indicating that calcium and glucose levels are not primary determinants of either condition. Progesterone concentrations were below 2 ng/mL in both groups, consistent with normal prepartum luteolysis and not contributory to the type of dystocia.

Overall, while blood and serum parameters reflect physiological changes of parturition, M-mode ultrasonography serves as a reliable diagnostic modality for early identification and differentiation of uterine inertia.

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