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Short Paper

Tocodynamometric study of uterine contractions during parturition in queens

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Abstract

Background: Tocodynamometry is an approach in small animal obstetrics to diagnose initiation, progress, completion, and problems related to parturition in queens. **Aims:** The present study was conducted to monitor uterine contractions using tocodynamometry at full term pregnancy and during queening and to correlate uterine contractile pattern with progression of queening. **Methods:** Once the signs of impending parturition were noted, the pressure transducer of tocodynamometer was placed on the lateral abdomen to monitor queening. The recordings were plotted as graph of time against pressure in mmHg. Uterine contractile patterns were assessed in order to study their relation to the progression of queening. **Results:** The initial uterine contractions had a baseline and peak pressures of 7-20 and 15-36.5 mmHg with mean time interval and frequency of 5.53 min and 1.91 peaks per 10 min, respectively, with mean change of amplitude of 15.35 mmHg. The progressive baseline and peak pressures of 15-32.5 and 24-62.3 mmHg increased to 20-55 and 30-89.2, respectively, with an increase in mean frequency from 3.88 to 5.25 peaks per 10 min and increase in mean change of amplitude from 25.21 to 33.87 mmHg, followed by decrease in mean time interval from 2.82 to 1.91 min in expulsive uterine contractions. **Conclusion:** Monitoring uterine contractions using tocodynamometer helps in understanding progression of queening and problems that may rise during parturition. It was observed that during queening, baseline and peak pressures of uterine contractions remain the same, irrespective of presentation of kittens at birth.

Key words: Pressure, Queening, Tocodynamometer, Uterine contraction

Introduction

The domestic queen has unique reproductive physiology among domestic species. In a single reproductive season, they are capable of achieving multiple pregnancies, making them one of the most prolific domestic species. The importance of having sound knowledge of the events and course of normal parturition is necessary for prompt intervention and the rapid diagnosis of a problem to improve the outcome. Because uterine contractions are not visible from the outside, determining their quality in terms of strength, duration, and frequency is crucial to understanding typical parturition.

The physiologic process by which a foetus is expelled from the uterus through the vaginal canal is known as labour, and it is characterised by regular uterine contractions, cervical effacement, and dilatation (Maul *et al.*, 2003). Normal gestation in the queen is approximately 65 days which ranges from 52 to 72 days post-breeding (Johnston *et al.*, 2001; Kustritz, 2006). Better monitoring of queens with higher risk pregnancies and/or when litters are highly priced is a need and might be comparable to what is a standard of practice in human and canine obstetrics.

Uterine contraction monitoring is useful in detecting the onset of parturition since the process of queening is highly variable. When the gestational length is not

accurately known and surgical intervention is judged necessary due to maternal foetal mismatch, the use of a uterine monitoring allows for proactive detection of labour in order to perform a planned caesarean section.

Tocodynamometry is an approach in small animal obstetrics that can diagnose the initiation, progress, and problems related to parturition in queens. A tocodynamometer is a device that measures external pressure and is used to detect uterine contractions. The primary advantage of a non-invasive method in recording uterine contractions and foetal heart rate has led to broad usage of this device for most pregnancies without risk to the foetus or the mother (Maul *et al.*, 2003).

Monitoring of strength, frequency, time interval, and change in amplitude of uterine contractions with the progression of queening by veterinarian helps to understand the state of parturition and to decide about the plausible obstetrical measures.

Thus, the present research work was designed to monitor uterine contractions at full term and during queening using a tocodynamometer and to correlate uterine contractile pattern with progression of queening.

Materials and Methods

The present study was carried out at the Department of Animal Reproduction, Gynaecology and Obstetrics, Mumbai Veterinary College, Parel and Goregaon, Bai Sakarbai Dinshaw Petit Hospital for Animals (BSDPHA), Mumbai.

Selection of animals

Twelve queens at the final stages of pregnancy irrespective of age, breed and weight with no history of preexisting clinical problems were selected for the study.

Ultrasonography

To predict the date of parturition and time to monitor the queening signs, abdominal ultrasonography was performed. The B-mode real-time ultrasonography (Sonoscape, Arrow scan BA 5) equipped with a 4-6 MHz micro-convex probe was used to scan all 12 pregnant queens in their second half of gestation.

Signs of approaching queening

The selected queens were monitored for approaching signs of parturition one to two days before the expected parturition date. The various signs exhibited by queens during 8 to 12 h before parturition were recorded. Hiding behaviour, restlessness, licking vulval region and enlarged mammary gland with milk, grooming, opaque mucous discharge, digging and occupying queening box were observed as signs of approaching queening. Signs were also recorded during stage I (stage characterised by synchronised uterine contractions with no signs of abdominal straining which results in cervical dilation) and stage II (stage characterised by stronger uterine contractions which effectively push the first foetus in to the pelvic inlet towards the cervix) of parturition (Davidson, 2001).

Uterine contraction monitoring

Each examination was recorded for a time period of 10-20 min. The recorded data was auto saved in PDF format. A cardiocography unit (CareMother Fetosense, Care Nx Innovations Private Limited, Navi Mumbai, India) was used for monitoring uterine contractions (Fig. 1).



Fig. 1: Cardiocography unit which was used for tocodynamometric study

Recording of uterine contractions was started when early signs of parturition close to predicted date were noted. The lateral abdomen was clipped and the animal was placed under lateral recumbency. Queens were allowed to rest in the queening box during the monitoring sessions. The tocodynamometry sensor was placed over the caudo lateral abdominal wall and was gently held by hand (Fig. 2). The recordings were taken when no external pressure was applied that would disturb the queen and the readings to be taken while the transducer was held in hand. The recordings were plotted as a graph of time against pressure in mmHg. The uterine contraction recordings were performed more frequently during second stage of labour till per-vaginum delivery of first kitten. Uterine monitoring was continued up to a maximum time of 10-20 min. Once the kitten was born, the next monitoring was started when the signs of readiness of the queen for the successive kitten's delivery was observed.



Fig. 2: Uterine contraction monitoring of a queen

The frequency, duration and amplitude (calculated by subtracting the baseline mmHg from peak mmHg for initial, progressive and expulsive contractions) of contractions were recorded and classified in three phases as follows (Chavan, 2021):

- Initial contractions - cervical dilatation and initiation of uterine contractions
- Progressive contractions - entry, movement and positioning of the foetus in the birth canal
- Expulsive contractions - expulsion of kitten

Stage one labour involves the initial phase of uterine contractions, while stage two labour involves the progressive and expulsive phase of uterine contractions.

Results

Signs of approaching queening

The various signs exhibited by queens during 8 to 12 h before parturition were recorded. It was evident that hiding behaviour, restlessness, licking vulval region and enlarged mammary gland with milk were evident in all the 12 queens in the present study. Inappetence and pacing were seen in 91.67% and 83.33% of queens, respectively. Followed by swollen and soften vulva and parenting of kittens of other litter was seen in 75% of the queens. Panting, become more affectionate with the owners, purring, grooming her body, opaque mucous discharge, digging and vocalizing were seen in less than 75% of the queens in the present study. As the queening progressed the signs like swollen and soften vulva, being more affectionate to owners, panting and grooming her body were seen in all the queens of the present study.

Uterine contraction monitoring

Advances in pregnancy management, early detection of foetal distress has led to monitoring parturition in small animal reproduction. In human modern obstetrics, as a part of care of mother and foetus, cardiotocography is used in every patient in present days (Sowmya *et al.*, 2018). In canines, there are several reports regarding the use of tocodynamometer for monitoring parturition (Davidson, 2001; Gropetti *et al.*, 2010; Chavan, 2021). The cardiotocographic monitoring devices can even be used on pregnant queens (Davidson, 2001).

Tocodynamometry of uterine contractions was started once the early signs of queening was observed. The

transducer of the tocodynamometer was placed on the caudo lateral abdomen and was held by hand. The contractions were recorded for 12 queens and each recording went up to 10 to 20 min. When early signs were observed, the external abdominal contractions were not evident, whereas the transducer detected and recorded the initial pressure changes arising from the uterus which was classified as first stage labour. During stage II of parturition, the contraction graph went high in mmHg with increased strength and frequency and the abdominal contractions become evident externally at the same time. This phase (stage II) was classified as progressive and expulsive uterine contractions.

The mean baseline and peak of initial, progressive and expulsive contractions is summarised in Table 1. Similarly, the time interval between contractions, number of peaks per 10 min (frequency) and the change of amplitude were also recorded in the present study. The mean time interval between contractions, number of peaks per 10 min and change of amplitude for initial, progressive and expulsive contractions are summarised in Table 2.

Figure 3 shows the initial phase of contractions defined as the phase where there will be cervical dilatation and initiation of uterine contraction. The mean initial baseline uterine contraction during queening was 13.08 ± 1.02 mmHg which ranged from 7 mmHg to 20 mmHg. This baseline contractions raised to a mean initial peak uterine contraction of 28.18 ± 1.63 mmHg with a range of 15 mmHg to 36.5 mmHg.

The phase of uterine contractions where there will be entry, movement and positioning of the foetus in the birth canal is the progressive contraction phase (Fig. 4). The mean baseline progressive uterine contraction was 24.10 ± 1.51 mmHg with a range from minimum and maximum pressure of 15 mmHg to 32.5 mmHg, respectively. The mean peak progressive uterine contraction was 46.55 ± 3.09 mmHg which ranged from 24 mmHg to 62.3 mmHg.

The phase of uterine contractions where there will be a maximum strength and frequency with the expulsion of foetus is the expulsive contraction phase (Fig. 5). The mean expulsive uterine contractions were with a baseline and peak of 37.02 ± 2.80 mmHg and 67.97 ± 5.36 mmHg pressure, respectively. The baseline expulsive uterine contractions ranged from 20 mmHg to 55 mmHg.

Table 1: Characterization of uterine contractions of queens

No.	Phase of contractions	Baseline contractions (mmHg) (mean±SE)	Peak contractions (mmHg) (mean±SE)
1	Initial (n=12)	13.08 ± 1.02 (7-20)	28.18 ± 1.63 (15-36.5)
2	Progressive (n=54)	24.10 ± 1.51 (15-32.5)	46.55 ± 3.09 (24-62.3)
3	Expulsive (n=54)	37.02 ± 2.80 (20-55)	67.97 ± 5.36 (30-89.2)

Table 2: Time interval, frequency and change of amplitude (mean±SE) of uterine contractions of queens in different phases

No.	Phase of contractions	Time interval (min)	No. of peaks/10 min	Change of amplitude (mmHg)
1	Initial (n=12)	5.53 ± 0.27 (3.5-7.5)	1.91 ± 0.10 (1.33-2.86)	15.35 ± 0.98 (8-24)
2	Progressive (n=54)	2.82 ± 0.21 (1.8-5)	3.88 ± 0.24 (2-5.56)	25.21 ± 2.11 (3-47.5)
3	Expulsive (n=54)	1.91 ± 0.02 (1.8-2.2)	5.25 ± 0.06 (4.55-5.56)	33.87 ± 2.58 (10-52)

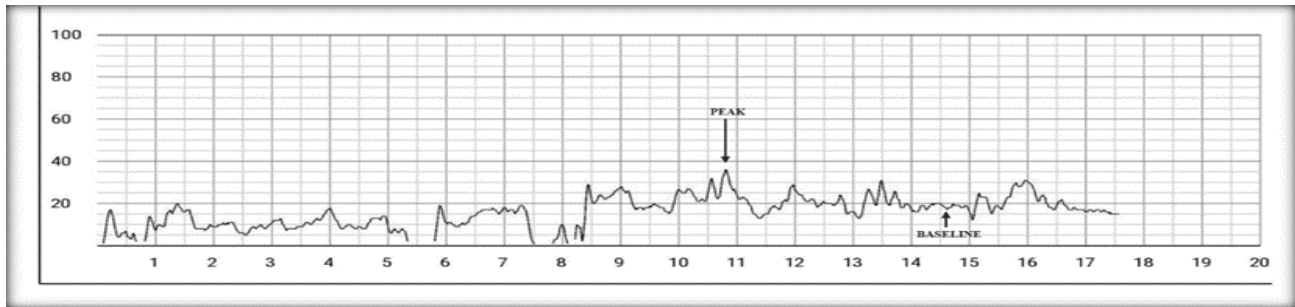


Fig. 3: Representative graph of uterine contractions of queens in initial phase

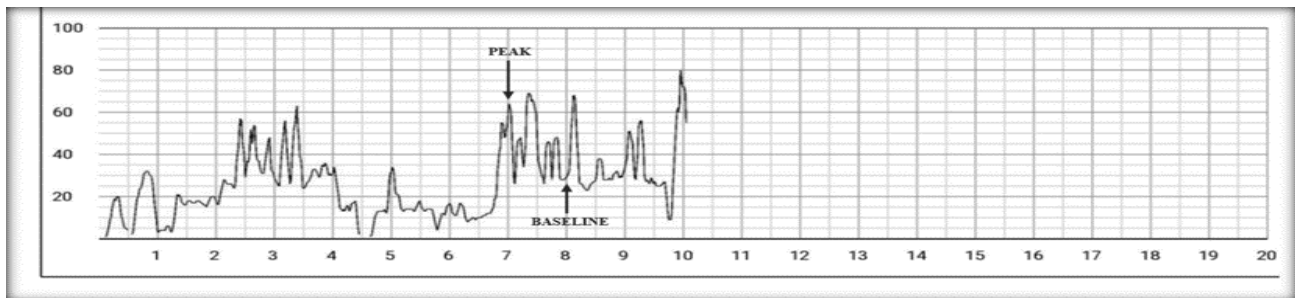


Fig. 4: Representative graph of uterine contractions of queens in progressive phase

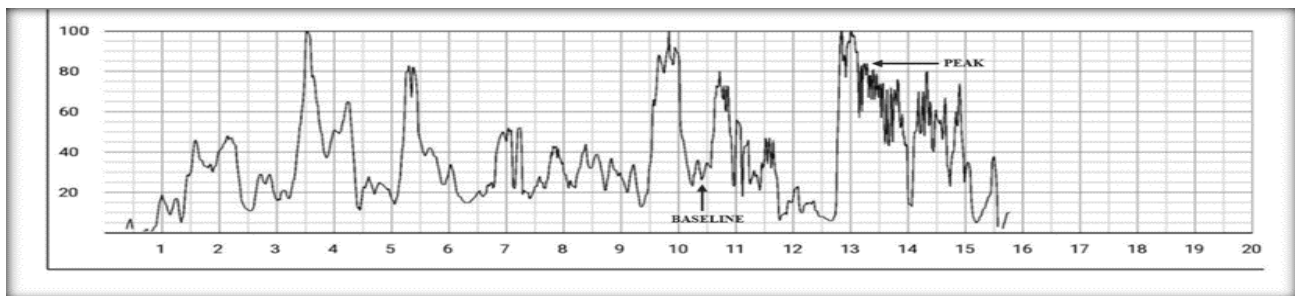


Fig. 5: Representative graph of uterine contractions of queens in expulsive phase

Whereas, the peak expulsive uterine contractions ranged from 30 mmHg to 89.2 mmHg.

The mean time interval between initial contractions was 5.53 ± 0.27 min with a frequency of 1.91 ± 0.10 peaks per 10 min. The time interval and frequency ranged from 3.5 to 7.5 min and 1.33 to 2.86 peaks, respectively, for the same. The mean change of amplitude for initial contraction was 15.35 ± 0.98 mmHg with a range of 8 to 24 mmHg.

For the progressive contractions, the mean time interval between progressive contractions was 2.82 ± 0.21 min with a frequency of 3.88 ± 0.24 peaks per 10 min. The time interval and frequency ranged from 1.8 to 5 min and 2 to 5.56 peaks, respectively, for the same. The change of amplitude for progressive contractions ranged from 3 to 47.5 mmHg with a mean of 25.21 ± 2.11 mmHg.

The time interval between expulsive contractions ranged from 1.8 to 2.2 min with a mean of 1.91 ± 0.02 min and the frequency ranged from 4.55 to 5.56 peaks per 10 min with a mean of 5.25 ± 0.06 peaks. The mean change of amplitude for expulsive contractions was 33.87 ± 2.58 mmHg with a range of 10 to 52 mmHg.

Signs exhibited by queens and corresponding uterine contractions

The various signs exhibited by queens before and during parturition were compared with uterine contraction recordings. Table 3, depicts the comparison of the approaching signs of queening and signs during queening (stage I and stage II) with the corresponding uterine contractions. It was observed that there was no uterine activity in terms of baseline and peak contractions, when the queens exhibited the signs of approaching parturition. Although hiding behaviour, restlessness or nervousness, enlarged mammary gland with milk, licking vulval region, inappetence, and pacing were exhibited by most of the queens in the present study, there was no evidence of external abdominal or tocodynamometer contraction either during this period.

Once the queening progressed to stage I, signs like opaque vulvo-vaginal discharge from the ruptured allantoic sac, rapid breathing, licking or washing herself, restlessness and pacing in circles were exhibited by the queens with corresponding uterine contractions recorded by the tocodynamometer. When the stage I signs with visible mild abdominal contractions were exhibited by the queens, the initial uterine contractions were recorded

Table 3: Signs exhibited and corresponding uterine contractions of queens in different stages of parturition

No.	Signs exhibited by queens	Percentage (n=12)	Stage of parturition	Uterine contraction (baseline and peak)		
1	Hiding behaviour	100%	Signs of approaching parturition (8-12 h before parturition)	No external or tocodynamometer contractions		
2	Restlessness	100%				
3	Enlarged mammary gland with milk	100%				
4	Licking vulval region	100%				
5	Inappetence	91.67%				
6	Pacing	83.33%				
7	Swollen and soften vulva	75%				
8	Parenting kittens of other litter	75%				
9	More attachments	66.67%				
10	Panting	66.67%				
11	Purring	58.33%				
12	Licking her body	50%				
13	Whitish mucous discharge	33.33%				
14	Digging	16.67%				
15	Vulvo-vaginal discharge	100%	Stage I	Initial Baseline: 7-20 mmHg Peak: 15-36.5 mmHg		
16	Rapid breathing	100%				
17	Grooming herself	100%				
18	Restlessness	100%				
19	Pacing in circles	75%				
20	Vocalisation/cat cry	50%				
21	Rearranging bedding	41.67%				
22	Grooming herself	100%			Stage II	a) Progressive Baseline: 15-32.5 mmHg Peak: 24-62.3 mmHg b) Expulsive Baseline: 20-55 mmHg Peak: 30-89.2 mmHg
23	Vulvo-vaginal discharge	100%				
24	Lying on one side	66.67%				
25	Licking/washing her kittens/parenting	66.67%				
26	Vocalisation/cat cry	50%				
27	Semi-squatting stance	33.33%				

with a baseline range of 7-20 mmHg and a peak range of 15-36.5 mmHg.

The progressive and expulsive uterine contractions were recorded when the queening progressed from stage I to stage II with a baseline of 15-32.5 mmHg and peak of 24-62.3 mmHg for progressive contraction, and a baseline of 20-55 mmHg and peak of 30-89.2 mmHg for expulsive contractions. Grooming herself, vulvo-vaginal discharge, lying on one side, parenting her kittens, vocalisation, and semi-squatting stance were exhibited by queens along with visible stronger abdominal contractions during stage II with the corresponding progressive and expulsive uterine contractions.

The parenting of kittens was seen in 66.67% of queens during stage II of parturition. Some queens did not show licking or grooming her kittens etc, immediately after delivery until completion of kitting. The parenting of kittens improved and was seen in all the queens once the parturition completed. In these queens, neonatal care like clearing away amniotic membranes, clearing the airways, massage using a dry towel and warming of the kittens were done manually until completion of parturition.

Discussion

Approaching signs of parturition in queens are not evident that of canines, since most pregnant queens try to hide during parturition. However, there are some behavioural changes that are exhibited by queens before parturition. von Heimendahl and Cariou (2009) mentioned that queens become more restless in the last two days before parturition, may stop eating, and begin

looking for a secluded place to give birth, which was in agreement with the observations of the present study.

Inappetence was observed 8 to 12 h before parturition in the present study which is almost in accordance with von Heimendahl and Cariou (2009), who observed it 24 h before initiation of parturition. Pacing and purring were shown by 83.33% and 58.33% of the queens, respectively, as a sign of approaching parturition, which was in disagreement with Johnston *et al.* (2001), who observed pacing and purring only when uterine contractions began. This could be due to variations in breed, environmental conditions and individual variations.

Since there were very few available literature regarding the monitoring of uterine contractions using tocodynamometer, the results of the present study were discussed by comparing the results with literatures available for canines. The rise in baseline and peak contraction pressures from initial to progressive and from progressive to expulsive were in close agreement with that observed by Chavan (2021). However, the mean baseline and peak contractions obtained in the present study were towards the lower end of what observed in canines by Chavan (2021).

The range of the time interval between contractions was similar to that recorded by Chavan (2021), whose intervals ranged from 3 to 10, 3 to 10 and 1 to 6 min for initial, progressive and expulsive contractions, respectively. The frequency of the contractions was slightly higher when compared with the observations of the previously mentioned investigator. This could be due to differences in the species and individual variations.

The results of the present study were similar to the observations of Davidson and Elits (2006), who

mentioned a frequency range of 0 to 12 contractions with a strength ranging from 15 to 60 mmHg during parturition in canines. Groppetti *et al.* (2010) observed uterine contractions of more than 10 mmHg, 4 to 12 contractions per hour frequency with 2 to 5 min duration of contractions in canines, which was in accordance with the present study.

The strength, frequency and duration of contractions in the present study were in good agreement with Jayakumar (2015) and Chethana *et al.* (2018), who recorded contractions of 30-40% strength, which increased to 80-90% during expulsive phase at a frequency and duration of 2 to 4 contraction per 30 min and 2 to 5 min in canines, respectively.

Tamminen (2020) recorded 10 to 30% and 20 to 45% changes in amplitude during the first and second stages of parturition in canines, which was in accordance with the present study. This author documented 0.9 and 1.1 contractions per 10 min during stages I and II, which was lower than the observations of the present study, which could be due to the differences in species, breed and sample size, where the author studied the cardiocography in various breed of canines.

von Heimendahl and Cariou (2009) observed semi-squatting stance and stronger abdominal contractions during stage II of parturition in queens which was in accordance with the present study. Zambelli (2012) mentioned initial weak uterine contractions during stage I and stronger regular uterine contractions during stage II of queening which was in close agreement with the observation of the present study and is normal. Vocalisation, rapid breathing, frequent licking, restlessness, and pacing in circles during stage I of queening were similar to the observations recorded by Purohit and Gaur (2004), von Heimendahl and Cariou (2009), and Smith (2012). Lying on one side and semi-squatting stance during stage II of queening was similar to the observations recorded by Purohit and Gaur (2004).

In conclusion, though there are variations in signs of approaching parturition exhibited by queens, hiding behaviour, restlessness/nervousness, licking vulval region, enlarged mammary gland with milk, inappetence, and pacing were seen in all to almost all queens of the present study which can be considered as the classical signs of approaching queening. The pressure, time interval, frequency and the change of amplitude of uterine contractions, as observed in the present study, might be used for monitoring parturition in queens.

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Conflict of interest

None of the authors had a financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of the paper.

References

- Chavan, AA** (2021). Monitoring uterine contractile pattern during whelping by tocodynamometer with foetal doppler. MVSc Thesis, Maharashtra Animal and Fisheries Sciences University, Nagpur.
- Chethana, H; Krishnaswamy, A and Sudha, G** (2018). Comparative studies on uterine tocodynamometry in cases of primary complete uterine inertia and spontaneous whelping dogs. *Int. J. Liv. Res.*, 8: 162-166.
- Davidson, AP** (2001). Uterine and foetal monitoring in the bitch. *Vet. Clin. Small Anim. Pract.*, 31: 305-313.
- Davidson, AP and Elits, B** (2006). Advanced small animal reproductive techniques. *J. Am. Anim. Hosp. Assoc.*, 42: 10-17.
- Groppetti, D; Pecile, A; Del Carro, AP; Copley, K; Minero, M and Cremonesi, F** (2010). Evaluation of newborn canine viability by means of umbilical vein lactate measurement, Apgar score and uterine tocodynamometry. *Theriogenology*. 74: 1187-1196.
- Jayakumar, C** (2015). Evaluation of neonatal viability following complicated delivery in dogs. Doctoral Dissertation, Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar. PP: 89-91.
- Johnston, SD; Kustritz, MVR and Olson, PN** (2001). *Canine and feline theriogenology*. 1st Edn., Philadelphia, W.B. Saunders. PP: 421-424.
- Kustritz, MVR** (2006). Clinical management of pregnancy in cats. *Theriogenology*. 66: 145-150.
- Maul, H; Maner, WL; Saade, GR and Garfield, RE** (2003). The physiology of uterine contractions. *Clin. Perinatol.*, 30: 665-676.
- Michel, E; Sporri, M and Ohlerth, S** (2011). Prediction of parturition date in the bitch and queen. *Reprod. in Dom. Anim.*, 46: 926-932.
- Owmya, K; Anusha, DG and Vijaya, SR** (2018). Evaluation of cardiocography (Ctg) monitoring for intrapartum foetal surveillance and its correlation with Apgar score. *IOSR J. Den. Med. Sci.*, 17: 42-50.
- Purohit, GN and Gaur, M** (2004). Dystocia and its management in the bitch and queen: a review. *J. Can. Dev. Res.*, 4: 90-100.
- Schmeltzer, LE** (2012). *Nursing the feline patient*. 1st Edn., Wiley-Blackwell. PP: 21-23.
- Smith, FO** (2012). Guide to emergency interception during parturition in the dog and cat. *Vet. Clin. Small Anim. Pract.*, 42: 489-499.
- Tamminen, T** (2020). Canine dystocia: oxytocin receptors, uterine inertia, and cardiocography. Doctoral Thesis, University of Helsinki. Helsingin yliopisto. <http://hdl.handle.net/10138/321945>.
- von Heimendahl, A and Cariou, M** (2009). Normal parturition and management of dystocia in dogs and cats. In *Practice*. 31: 254-261.
- Zambelli, D** (2012). *Management of pregnant and neonatal dogs, cats, and exotic pets*. 1st Edn., Wiley-Blackwell. PP: 43-54.