

Efficacy of sodium carboxymethyl cellulose massage for cervical dilatation in torsion detorted buffaloes

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Abstract

The efficacy and safety of sodium carboxymethyl cellulose (SCMC) massage on the cervix for cervical dilation was evaluated on water buffaloes after successful detorsion by Sharma's Modified Schaffer's method. For the study, buffaloes (n = 12) suffering from uterine torsion were selected and randomly divided into two groups (n = 6). After detorsion, the cervix was graded based on its physical characteristics. Animals with grade I and grade II cervix were included in the study. The cervical diameter at the time of detorsion/drug administration and parturition was measured for every buffalo using a handmade cervicometer made up of iron rods. Group I buffaloes were administered with dexamethasone (40 mg, I/M), cloprostenol (500 µg, I/M) and calcium magnesium borogluconate (Ca = 1.86 % w/v, Mg = 5 % w/v) (450 mL, slow I/V) after successful detorsion and grading of the cervix. This group was considered as the control group. In group II, cervical massaging with 2% sodium carboxymethyl cellulose was done three times at an interval of 120 minutes along with the drug combination given in the control group. The cervical dilation rate (CDR) of both groups was calculated and compared. The study included signalment, clinical observations, haematological and blood biochemical parameters. Blood samples were collected three times: before detorsion, after treatment and at parturition. The CDR of group II (0.86 ± 0.17 cm/h) varies insignificantly from group I (0.47 ± 0.19 cm/h). There was a significant ($P < 0.05$) increase in SGOT and SGPT levels after massaging with 2% solution of sodium carboxymethyl cellulose. Massaging with 2% solution of sodium carboxymethyl cellulose is not recommended for cervical dilatation purpose.

Key words: Buffaloes, Cervix massage, Sodium carboxymethyl cellulose, Torsion

Highlights

- The cervical dilatation rate was 0.86 ± 0.17 cm/h for the group massaged with sodium carboxymethyl cellulose which varies insignificantly with the control group.
- There was a significant increase in SGOT and SGPT levels after massaging with a 2% SCMC solution.

INTRODUCTION

Incomplete cervical dilation (ICD) is a common complication in buffaloes after detorsion (Yadav *et al.*, 2021). It might be due to fewer cervical rings present in the cervix (Purohit *et al.*, 2011). There may be a complete dilation failure or just a small part of cervical tissue, which is enough to block birth canal (Noakes *et al.*, 2019). ICD can occur spontaneously or may be associated with torsion (Balamurugan *et al.*, 2018; Doddagoudar *et al.*,

2020). ICD can occur due to changes in endocrine profile, enzymatic concentration and inflammatory mechanism (Gahlot *et al.*, 2017). Incomplete dilation after detorsion may force the cesarean section of the animal, which hampers the future fertility and productivity of the buffaloes. Dilation of the cervix depends on the resistance caused by visco-elastic properties of the cervix and the force induced by uterine contractions (Breeveld-Dwarkasing *et al.*, 2003).

The cervix must be completely dilated at the time of parturition to provide enough space to pass the fetus.

Sodium carboxymethyl cellulose (SCMC) is water soluble anionic linear cellulose ether prepared by treating cellulose with aqueous sodium hydroxide followed by a reaction with sodium chloracetate (Dumitriu, 1996). Elkin *et al.* (1984) reported that solutions of SCMC could prevent postoperative intraperitoneal adhesions in rats when test solutions of SCMC were instilled at laparotomy. The combination of SCMC with dexamethasone can prevent adhesion formation (Du *et al.*, 2015). The SCMC gel is a good and effective source of lubrication of the birth canal while dealing with dystocia in large animals. The collagenolytic activity of SCMC breaks collagen fibers of cervical tissue and assists in cervical dilatation (Honparkhe *et al.*, 2009).

Collagen is approximately 70% of the stromal dry weight in the cervix of pregnant animals (Breeveld-Dwarkasing *et al.*, 2003). The cervical Matrix Metallo Proteinases (MMPs) causes denaturation at gradual ripening stage might be due to the activity of the cervical and biochemically characterized by water imbibition (Breeveld-Dwarkasing *et al.*, 2003; Engelen, 2008). Water imbibition make cervical tissue extremely soft, watery and well-distensible character. As a result, cervical tissue can dilate when pressure is exerted by the fetal membranes or the fetus (Engelen, 2008).

The objective of this study was to clinically evaluate the safety and efficacy of sodium carboxymethyl cellulose (SCMC) massage on the cervix for cervical dilation in water buffaloes after successful detorsion by Sharma's Modified Schaffer's method. We hypothesized that SCMC massage would enhance CDR and reduce the duration of the first stage of calving in buffaloes.

MATERIALS AND METHODS

Ethical statement: All animals under study were affected by uterine torsion ($n = 12$), and administration of drug combination to animals was performed with owner consent under ethics approval from the Institutional Animal Ethics

Committee at the College of Veterinary Sciences, LUVAS, Hisar.

Place: The study was conducted on buffaloes suffering from uterine torsion, which were reported to the Veterinary Clinical Complex, the Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar. Hisar is located at 29.09°N 75.43°E in western Haryana, India. It has an average elevation of 215 m (705 ft) above mean sea level.

Animals: A brief history regarding gestation length, lactation, duration of illness, anorexia or inappetence, parity, colic signs, straining, and previous treatments if given, was recorded. At the arrival, animals were subjected to general clinical examinations such as recording of body temperature, pulse rate, heart rate, and mucous membrane examination after restraining the animals in a chute. Diagnosis of uterine torsion was made with careful per-rectal and per-vaginal examinations. Along with determining types of uterine torsion, the degree of uterine torsion was also determined based on vaginal folds constriction and broad ligament status. The buffaloes suffering from uterine torsion, which were detorted successfully via Sharma's Modified Schaffer's method and having cervix soft (grade I) or soft and partially lobulated (grade II), were selected for the study. These buffaloes were subdivided into two groups having six animals in each group ($n=6$).

Experimental design: Detorsion of uterine torsion was followed by per-rectal and per-vaginal examinations of animals, and animals were graded based on the physical characteristics of the cervix. Buffaloes in which the external os of the cervix was soft and smooth, moderately soft and partially lobulated, and hard with lobulated were characterized into grade I, grade II, and grade III, respectively. Grade I and grade II animals were included in the study, and grade III animals were subjected directly to cesarean section. Drugs were administered just after detorsion in all animals according to the experimental protocol. The

cervical diameter was measured per-vaginally with the help of a handmade cervicometer (Fig. 1), which was made up of iron rods and scale at the time of detorsion and parturition. Cervicometer was sterilized with 70% isopropyl alcohol before and after each measurement. In group II, cervical massages for 20 min were carried out with lukewarm sodium carboxymethyl cellulose (2% solution in water), and the procedure was repeated a maximum of 3-times at 120 minutes intervals. In this procedure, about 1 liter of warm SCMC (Carmellose sodium – Carboxymethyl cellulose sodium salt medium viscosity 200-300 cPs I R, SDFCL- Mumbai, India) solution was continuously applied on the cervix along with simultaneous massage with a properly gloved hand in the region of the external os. Common induction protocols used in both groups include dexamethasone (Dexona® Vet Injection-Dexamethasone Sodium Phosphate Injection I.P. (Vet.)- Zydus AHL, Ahmedabad- 382445), cloprostenol (Vetmate™- Cloprostenol Sodium IP (Vet)- Provimi Animal Nutrition India Pvt. Ltd. Bengaluru- 560064) and, calcium magnesium borogluconate (Mifex®- Calcium Magnesium Borogluconate Injection I.P. (Vet.)- Elanco, Bengaluru, India - 562123).

Calculation of rate of cervical dilation: The rate of cervical dilation was calculated by the formulae: Linear rate of cervical dilation = (Cervical dilation at parturition - Cervical dilation at drug administration) / (Duration between drug administration and parturition).

Haematological and biochemical study: Blood samples were collected from jugular venipuncture before detorsion, after treatment (after detorsion and administration of drugs in group I and after completion of massaging in group II) and, after per-vaginal delivery of foetus or at the time when it was confirmed that further dilation of the cervix was not possible and the animal will be subjected to caesarean section. Collected samples were used for haematological and serum biochemical studies. Haematological parameters included, haemoglobin (Hb), packed cell volume (PCV), total leukocyte count (TLC), differential leukocyte count (DLC), monocyte (M), lymphocyte (L), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and mean corpuscular volume (MCV) were estimated in automatic analyzer MS4 (JLS380 Melet Schloesing Laboratoires- 9 Chaussee Jules Cesar- 95520 OSNY, France) after collecting blood samples in



Fig. 1. A handmade cervicometer made up of iron rods and scale

vials containing EDTA.

Blood samples for analysis of biochemical parameters were collected for estimation of alanine aminotransferase (SGPT), aspartate aminotransferase (SGOT), urea, creatinine, total proteins, albumin, globulin, albumin: globulin, phosphorus, and calcium. The serum was harvested by centrifugation at 3000 rpm for 20 min. and then stored at -20°C. Biochemical parameters were analyzed with EM 200™ (Automated random access clinical chemistry analyzer, Erba Mannheim, Germany) analyzer using commercially available Transasia XL (M/S Transasia Biomedical Limited, Mumbai, India) system pack kits.

Statistical analysis: Data expressed as mean $\pm$ standard error of the mean (SEM) was analyzed using the General linear model (SPSS software (IBM Inc, USA). All haematological, biochemical and CDR results were considered statistically significant at the 95% confidence level ($P < 0.05$). The significant differences between groups for targeted parameters were determined by post hoc Duncan's multiple comparison tests.

RESULTS

All the animals included in the study were female buffaloes of first to third parity. Most buffaloes belonged to age groups 5-7 years ($n = 7$) and second parity ($n = 6$). Ten were not having a history of wallowing, and two animals were wallowing in the last trimester. All animals

were in the advanced stage of gestation (Table 1). Eleven animals were affected with uterine torsion of the right side. The most common site of occurrence of uterine torsion was post cervical ($n = 11$). The degree of uterine torsion was moderate in most of the animals ($n = 8$), followed by mild degree ($n = 2$) and high degree ($n = 2$). Most of the animals were detorted in one ($n = 5$) and two rollings ($n = 5$) followed by three rollings ($n = 2$). After examination of the cervix per-vaginally, the cervix was classified into grade 1 ($n = 7$) and grade II ($n = 5$).

The rates of cervical dilation were insignificant ($P < 0.05$) between control (group I) (0.47 ± 0.19 cm/h) and SCMC, group II (0.86 ± 0.17 cm/h). The time (Mean $\pm$ S.E.) taken for parturition after treatment was 20.63 ± 1.96 hours in group I and 21.19 ± 3.36 hours in group II.

No significant difference in any of the haematological parameters was observed in groups at different time intervals during the entire period of observation (Table 2). There was a significant increase ($P < 0.05$) in the mean serum calcium levels after treatment in both groups compared with calcium levels before detorsion and at parturition (Table 3). The cervical massage of the cervix with sodium carboxymethyl cellulose resulted in a significant ($P < 0.05$) increase in the SGOT and SGPT levels at parturition. No significant difference in any other biochemical parameters was observed in groups at different time intervals during the

Table 1. Signalment and clinical observation recorded in buffaloes under study

Groups	Gestation length (days) (Mean $\pm$ S.E.)	Parity	Site of uterine torsion	Direction of uterine torsion	Degree of uterine torsion	Rollings for detorsion	Grading of cervix
Group I ($n = 6$)	305.2 $\pm$ 4.99	1 st ($n=4$)	Post-cervical ($n=5$)	Right ($n=5$)	Mild ($n=1$)	One ($n=3$)	Grade I ($n=4$)
		2 nd ($n=1$)	Pre-cervical ($n=1$)	Left ($n=1$)	Moderate ($n=4$)	Two ($n=2$)	Grade II ($n=2$)
		3 rd ($n=1$)			High ($n=1$)	Three ($n=1$)	
Group II ($n = 6$)	299.5 $\pm$ 2.64	2 nd ($n=5$)	Post-cervical ($n=6$)	Right ($n=6$)	Mild ($n=1$)	One ($n=2$)	Grade I ($n=3$)
		3 rd ($n=1$)			Moderate ($n=4$)	Two ($n=3$)	Grade II ($n=3$)
					High ($n=1$)	Three ($n=1$)	

Table 2. Haematological profiles (Mean $\pm$ SE) of female buffaloes under study at different time intervals

Variable	Group	Time point		
		Before detorsion	After treatment	At parturition
Haemoglobin (g/dL)	I	10.40 $\pm$ 0.89	10.52 $\pm$ 0.63	9.53 $\pm$ 0.62
	II	13.23 $\pm$ 0.36	12.32 $\pm$ 0.26	13.02 $\pm$ 0.25
Packed cell volume (%)	I	33.80 $\pm$ 2.73	33.15 $\pm$ 2.02	29.67 $\pm$ 2.02
	II	44.70 $\pm$ 3.76	41.58 $\pm$ 3.17	42.57 $\pm$ 2.45
Total erythrocyte count (X10 ⁶ /mm ³)	I	4.95 $\pm$ 0.50	4.81 $\pm$ 0.31	4.55 $\pm$ 0.47
	II	6.40 $\pm$ 0.43	6.04 $\pm$ 0.38	6.12 $\pm$ 0.30
Total leukocyte count (X10 ³ /mm ³)	I	8.33 $\pm$ 1.22	7.99 $\pm$ 1.26	8.75 $\pm$ 1.38
	II	7.36 $\pm$ 1.17	7.77 $\pm$ 1.26	6.85 $\pm$ 0.78
Granulocyte (%)	I	68.28 $\pm$ 5.07	73.77 $\pm$ 3.74	75.05 $\pm$ 1.81
	II	74.77 $\pm$ 2.69	77.37 $\pm$ 2.50	78.70 $\pm$ 3.46
Lymphocyte (%)	I	29.60 $\pm$ 4.33	26.10 $\pm$ 2.41	23.40 $\pm$ 1.80
	II	23.55 $\pm$ 2.52	20.93 $\pm$ 2.35	19.77 $\pm$ 3.20
Monocyte (%)	I	2.12 $\pm$ 0.79	1.80 $\pm$ 0.65	1.50 $\pm$ 0.32
	II	1.68 $\pm$ 0.39	1.77 $\pm$ 0.46	1.53 $\pm$ 0.35
Mean corpuscular haemoglobin (pg/cell)	I	19.82 $\pm$ 1.25	20.23 $\pm$ 1.11	20.33 $\pm$ 1.12
	II	20.62 $\pm$ 0.72	20.53 $\pm$ 0.65	20.65 $\pm$ 0.66
Mean corpuscular haemoglobin concentration (g/dL)	I	31.35 $\pm$ 0.80	31.83 $\pm$ 0.71	32.40 $\pm$ 0.54
	II	29.83 $\pm$ 1.23	29.88 $\pm$ 0.97	29.70 $\pm$ 0.83
Mean corpuscular volume (fL)	I	69.25 $\pm$ 2.38	68.57 $\pm$ 2.49	67.77 $\pm$ 2.32
	II	69.68 $\pm$ 2.03	69.47 $\pm$ 2.40	69.87 $\pm$ 2.18

entire period of observation (Table 3).

DISCUSSION

For a veterinary obstetrician, nothing is more disturbing than prolonged parturition due to delay in the first stage of parturition. This protracted parturition leads to exhaustion to the dam and stress to both the fetus and the dam. Complete cervical dilation is one of the effective results of straining forces of parturition. In this study, SCMC (0.86 $\pm$ 0.17 cm/h) has a non-significant effect ($P < 0.05$) on CDR when compared to the control group (0.47 $\pm$ 0.19 cm/h). The time (Mean $\pm$ S.E.) taken for parturition after treatment was 20.63 $\pm$ 1.96 hours in the control group and 21.19 $\pm$ 3.36 hours in the SCMC group, which is very similar. In this study, it was observed that 2% SCMC is a good lubricant for the birth canal of buffaloes but does not enhance CDR significantly. It resulted

in the lubrication of the birth canal and obstetrician's gloves, subjectively reducing the friction during mutation. Honparkhe *et al.* (2009) used SCMC for cervical dilation in detorted buffaloes. They found that, out of 19 buffaloes subjected to cervical massage, complete cervical dilation was achieved in 15 buffaloes. Literature suggested that all mechanical modities applied for achieving cervical dilatation has a similar mechanism. The mechanical pressure applied by massaging on the cervix results in the stimulation of release of PGF2 α , which leads to uterine contractions, functional changes in the cervix and dilatation of the cervix (Tenore, 2003). Marginal differences in clinical studies on haematology have been reported in torsion-affected buffaloes (Singla *et al.*, 1992; Karthick *et al.*, 2016). There are various reports that uterine torsion-affected buffaloes suffer from normocytic

Table 3. Serum biochemical profiles (Mean $\pm$ SE) of female buffaloes under study at different time intervals

Variable	Group	Time point		
		Before detorsion	After treatment	At parturition
Aspartate amino transferase (U/L)	I	144.38 $\pm$ 10.87	132.65 $\pm$ 9.41	156.62 $\pm$ 15.90
	II	132.58 $\pm$ 6.27 ^A	132.35 $\pm$ 6.33 ^A	153.58 $\pm$ 3.07 ^B
Phosphorous (mg/dL)	I	4.13 $\pm$ 0.28	3.97 $\pm$ 0.28	4.69 $\pm$ 1.04
	II	3.87 $\pm$ 0.38	3.81 $\pm$ 0.32	4.77 $\pm$ 0.59
Urea (mg/dL)	I	24.30 $\pm$ 3.88	23.80 $\pm$ 4.20	24.87 $\pm$ 4.72
	II	19.62 $\pm$ 2.83	22.23 $\pm$ 2.18	25.23 $\pm$ 3.86
Creatinine (mg/dL)	I	1.49 $\pm$ 0.13	1.55 $\pm$ 0.16	1.63 $\pm$ 0.18
	II	1.96 $\pm$ 0.26	2.09 $\pm$ 0.35	2.19 $\pm$ 0.43
Calcium (mg/dL)	I	8.92 $\pm$ 0.30 ^A	16.27 $\pm$ 1.03 ^B	10.48 $\pm$ 0.46 ^A
	II	9.10 $\pm$ 0.32 ^A	17.17 $\pm$ 2.07 ^B	10.77 $\pm$ 0.56 ^A
Total protein (g/dL)	I	6.51 $\pm$ 0.26	5.82 $\pm$ 0.29	6.50 $\pm$ 0.23
	II	5.14 $\pm$ 0.31	5.67 $\pm$ 0.36	5.67 $\pm$ 0.25
Albumin (g/dL)	I	2.31 $\pm$ 0.09	2.01 $\pm$ 0.10	2.16 $\pm$ 0.11
	II	1.72 $\pm$ 0.13	1.80 $\pm$ 0.14	1.79 $\pm$ 0.08
Globulin (g/dL)	I	4.20 $\pm$ 0.26	3.82 $\pm$ 0.24	4.35 $\pm$ 0.15
	II	3.43 $\pm$ 0.19	3.87 $\pm$ 0.23	3.88 $\pm$ 0.20
Albumin: Globulin ratio	I	0.56 $\pm$ 0.05	0.53 $\pm$ 0.04	0.50 $\pm$ 0.02
	II	0.50 $\pm$ 0.02	0.46 $\pm$ 0.02	0.46 $\pm$ 0.02
Alanine aminotransferase (U/L)	I	66.18 $\pm$ 2.79	60.68 $\pm$ 2.70	66.73 $\pm$ 3.98
	II	61.30 $\pm$ 2.04 ^A	64.40 $\pm$ 1.64 ^{AB}	67.20 $\pm$ 1.15 ^B

Means with different superscripts (A/B) in a row show significant differences within groups (P<0.05)

normochromic anaemia, which may be due to the relatively massive loss of blood during abnormal parturition and accumulation of metabolic waste products (Amer and Hashem, 2007). The leukogram of torsion-affected buffaloes revealed lymphocytopenia, neutrophilia, and monocytosis in association with eosinopenia (Amer and Hashem, 2007; Nagaraju, 2018).

The increased calcium level after treatment in the present study was due to the administration of calcium borogluconate. Calcium borogluconate is recommended for a slow intravenous route only as increased calcium levels may cause cardiac arrhythmia and instant death of the animal. Hypo-proteinemia in torsion affected animals has been reported earlier (Arora *et al.*, 2013). BUN and creatinine levels are comparable to previous

studies (Amer *et al.*, 2008; Satish *et al.*, 2018). Cervical massage with SCMC might have caused cervical muscle damage, which is indicated by a higher level of SGOT. However, there was no significant increase in SGOT level observed in the case of the control group. The significant increases in levels of SGPT in the SCMC group also indicate muscle damage. Due to lack of parallel studies, data could not be compared.

It can be concluded that the cervical massaging with 2% SCMC for cervical dilatation in detorted buffaloes has an insignificant effect on CDR. The detorted animals may be treated with dexamethasone and calcium magnesium borogluconate.

Conflict of interest: Authors have no conflict of interest in this study.

Author's contribution: RY, GS: Concept and design; PD, RY, PY: Acquisition of data; RY, PY: Performed statistical analysis of data and interpretation of result

REFERENCES

- Amer HA and Hashem MA, 2007. Relationship between clinical and biochemical picture of uterine torsion in Egyptian buffaloes (*Bubalus bubalis*). *Int J Vet Med*, 4(1): 1-11, doi: 10.5580/1157
- Amer HA, Hashem MA and Bader A, 2008. Uterine twisting during pregnancy in buffaloes; relationship between clinical finding and biochemical indices. *J Appl Biol Sci*, 2: 31-39
- Arora N, Luthra RA, Pandey AK and Singh G, 2013. Profiles of some biochemical constituents in periparturient and uterine torsion affected buffaloes. *Hariyana Vet*, 52: 69-70
- Balamurugan B, Kharayat N, Lavanya M, Kumar A, Ramamoorthy M *et al.*, 2018. Dystocia due to incomplete cervical dilation concurrent with cervico-vaginal prolapse in cattle: A case report. *J Entomol Zool Stud*, 6(6): 544-545
- Breeveld-Dwarkasing VN, Koppele JM, Bank RA, Van Der Weijden GC, Taverne MA *et al.*, 2003. Changes in water content, collagen degradation, collagen content, and concentration in repeated biopsies of the cervix of pregnant cows. *Biol Reprod*, 69: 1608-1614, doi: 10.1095/biolreprod.102.012534
- Doddagoudar V, Gond M, Pasha M, Jambigi A and Jakkali N, 2020. Post cervical right side uterine torsion in non-descript buffalo: A case report. *Int J Livest Res*, 10(3): 209-211, doi: 10.5455/ijlr.20191214071611
- Du XH, Liu JQ, Xin K and Liu GH, 2015. Dexamethasone and sodium carboxymethyl cellulose prevent postoperative intraperitoneal adhesions in rats. *Braz J Med Biol Res*, 48(4): 344-348, doi: 10.1590/1414-431X20144211
- Dumitriu S, 1996. Polysaccharides in Medicinal Applications. Marcel Dekker Inc. USA, pp 102
- Elkins TE, Bury RJ, Ritter JL, Ling FW, Ahokas RA *et al.*, 1984. Adhesion prevention by solutions of sodium carboxymethylcellulose in the rat, *I. Fertil Steril*, 41: 926-928, doi: 10.1016/s0015-0282(16)47909-4
- Engelen EV, 2008. Smooth muscle cells in bovine

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- cervical ripening and dilatation contractility, degrading enzymes and inflammation. Doctoral thesis, Utrecht University, Netherland
- Gahlot SC, Kumaresan A, Kumar S, Yadav S, Saraf KK *et al.*, 2017. A review: Incomplete cervical dilation in animals. *Int J Sci Environ Technol*, 6(2): 1036-1048
- Honparkhe M, Ghuman SPS, Kumar A, Gupta K, Sood NK *et al.*, 2009. Cervical massage with sodium carboxy methyl cellulose for achieving complete cervical dilatation in successfully detorted uterine torsion affected buffaloes. *Indian J Anim Sci*, 79(1): 26-29
- Karthick C, Selvaraju, Napoleon RE and Doraisamy KA, 2016. Haematological changes during uterine torsion and detorsion in buffaloes. *Indian Vet J*, 93(10): 22-25
- Nagaraju O, 2018. Clinical and haemato-biochemical parameters in uterine torsion affected graded Murrah buffaloes (*Bubalus bubalis*) (Master's Thesis). Sri Venkateswara Veterinary University, Gannavaram, Andhra Pradesh, India
- Noakes DE, Parkinson TJ and England, GC, 2019. *Veterinary Reproduction and Obstetrics*. WB Saunders, pp 229-244
- Purohit GN, Barolia Y, Shekher C and Kumar P, 2011. Diagnosis and correction of uterine torsion in cattle and buffaloes. *Raksha Tech Rev*, 2: 11-17
- Satish, Gaur M, Jhamb D, Saraswat C, Sharma S *et al.*, 2018. Studies on the prognostic test for uterine torsion in Surti buffaloes (*Bubalus bubalis*). *J Entomol Zool Stud*, 6(6): 1074-1077
- Singla VK, Sharma RD, Gandotra VK and Prabhakar S, 1992. Changes in certain serum biochemical constituents in buffaloes with uterine torsion. *Indian Vet J*, 69: 805-807
- Tenore JL, 2003. Methods for cervical ripening and induction of labor. *Am Fam Physician*, 67(10): 2123-2128
- Yadav R, Singh G, Yadav P, Pandey AK, Dutt R *et al.*, 2021. Uterine torsion in Murrah buffaloes: A study of one year. *Ruminant Sci*, 10(1): 225-228

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