Indian Journal of Animal Sciences **94** (9): 782–785, September 2024/Short communication
https://doi.org/10.56093/ijans.v94i9.151846

Haemodynamic characteristics of middle uterine artery in crossbred cows with uterine torsion

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Received: 21 May 2024; Accepted: 19 July 2024

Keywords: Colour doppler indices, Crossbred cow, Middle uterine artery, Uterine torsion

Livestock sector, with special reference to dairy cattle, plays a key role in the rural economy of any developing country. Sustained dairy production is dependent on the calf crop at regular intervals. Thus, successful dairying relies on the reproductive efficiency of the animal. Normal calving process is an important event in reproduction and vital determinant of future fertility. Any compromises in this process like dystocia, result in massive stress to the dam and affects the animal physiologically which in turn have a negative impact on the economy of the dairy farmer (Funnell and Hilton 2016).

Dystocia due to uterine torsion is a common problem encountered in cattle. It is defined as the twisting of uterus on its longitudinal axis which results in severe uterine vascular compression in late pregnant animals and found to be life threatening to the fetus (Purohit *et al.* 2011). In uterine torsion, the middle uterine artery (MUA) is reported to be compressed which leads to decreased oxygen and increased carbon dioxide in fetal circulation. As a sequel, struggling of fetus for oxygen further exaggerates the degree of torsion and leads to death of fetus (Ghuman 2010). Thus, it was hypothesized that the assessment of uterine blood flow status in the cattle diagnosed for uterine torsion could determine the prognostic status of the fetal viability (Schonfelder *et al.* 2005, Hussein 2013). Transrectal Doppler ultrasound is reported to be an effective method to assess the uterine blood flow in cattle (Panarace *et al.* 2006) and buffaloes (Varughese *et al.* 2013). Hence, the present study was conducted to assess the blood flow characteristics in MUA of uterine torsion affected cows in relation to the fetal viability.

Crossbred cows which were brought to the Obstetrics Unit of Veterinary Clinical Complex, Veterinary College and Research Institute, Namakkal, Tamil Nadu, India with the history of full-term gestation and straining for parturition (>8-10 h) were utilized for the study. A total of six crossbred cows were randomly selected and individual case history and vital parameters of the animals were recorded. Vaginal and rectal examinations were performed and the torsion was diagnosed and categorized for degree (90°, 90 - 180°, >180°), direction (right or left) and site (post cervical or pre cervical) (Roberts 1986).

Blood flow characteristics of MUA: Colour Doppler ultrasound machine (Sonoray) equipped with transrectal linear transducer (5-7.5 MHz) was utilized for studying the blood flow characteristics of ipsilateral and contralateral MUA before and after detorsion (Singh *et al.* 2019). Colour mode was used to locate the middle uterine artery. The image was frozen and diameter (DI) of the blood vessel was obtained. Then, the probe was switched over to pulse-wave mode to obtain spectral waves. At least three cardiac cycles were measured to arrive at the velocity parameters and Doppler indices (Figs. 1-3) such as peak systolic velocity (PSV; cm/sec), end diastolic velocity (EDV; cm/sec), time averaged velocity (TAV; cm/sec), resistance index (RI) and pulsatility index (PI) as described. Based on the obtained spectral doppler values, the MUA perfusion characteristics were quantified (Bollwein *et al.* 2002):

$$\text{Blood flow volume (BFV; ml/min)} = TAV \times \pi \times (DI \times 0.1/2)^2$$

$$\text{Time-averaged peak velocity over the cardiac cycle (TAP)} = (PSV\text{-}EDV) / PI$$

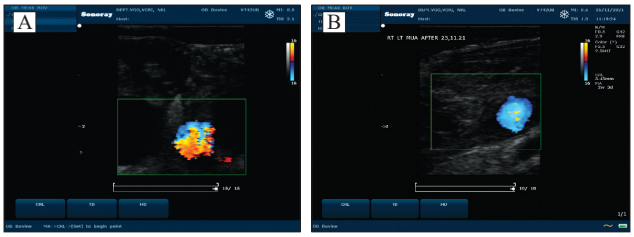

Fig. 1. Colour doppler images: (A) Right middle uterine artery before detorsion; (B) Doppler image of left middle uterine artery after detorsion.

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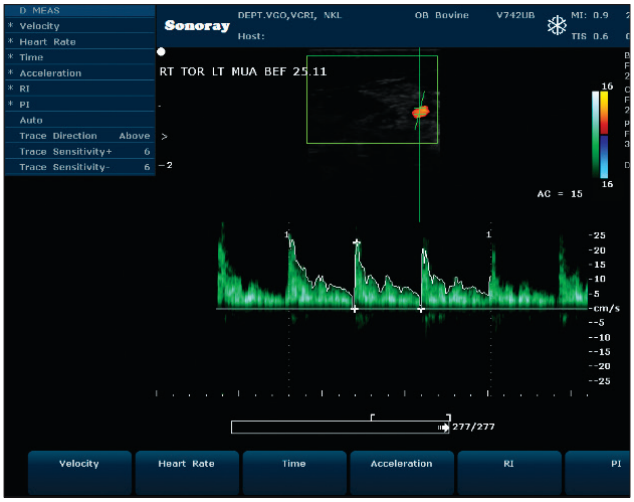

Fig. 2. Spectral doppler image of left middle uterine artery before detorsion.

Fig. 3. Spectral doppler image of left middle uterine artery after detorsion.

Haematological and biochemical parameters: Blood samples were collected with EDTA and serum vacutainer from all the animals before attempting for detorsion. Serum was separated and subjected to haematological and biochemical analysis (Blood urea nitrogen, creatinine, calcium, phosphorous, albumin and total protein) using autoanalyzer UV-VIS spectrophotometer (Selectra ProX, ELITech Group SAS France) with a photometric range of -0.1 to 3.0 absorbance.

Cows with uterine torsion were subjected to detorsion as per the Schaffers method. After rolling of dam, vaginal examination revealed patent birth canal with varying degrees of cervical relaxation. Per vaginal delivery of viable calves (n=2) and dead fetuses (n=4) were performed with standard obstetrical procedures within the range of 30 min to 2 h, depending on the degree of cervical relaxation.

All the animals were followed for three months post-partum for resumption of cyclicity based on expression of oestrus signs. The observed data were statistically analyzed using one way ANOVA by SPSS (SPSS®) 29.0 Software package.

Clinical investigation of torsion affected cows revealed that all the six animals (100%) had right sided, post-cervical torsion, of which two (33.33%), one (16.67%) and three (50.00%) animals had 90°, 90-180° and >180° torsion, respectively. During rolling of dam, single roll and two rolls were required for complete detorsion in two and four animals, respectively.

The MUA doppler parameters of the torsion affected cows are given in Table 1. The BFV of contralateral MUA was found to be significantly ($P<0.05$) decreased when compared to ipsilateral artery, prior to detorsion. Before detorsion, the PI value was non-significantly ($P>0.05$) higher in ipsilateral MUA torsion and significant decrease could be observed after detorsion. No significant differences ($P>0.05$) were observed in RI and TAP values before and after detorsion in both ipsilateral and contralateral MUA.

In relation to viability of calf, the BFV values prior to detorsion were significantly higher ($P<0.05$) in animals which delivered a live calf (743.72±252.92 ml/min) than that had a dead calf (300.43±88.07 ml/min). Perusal of the data also revealed that PI values were significantly ($P<0.05$) higher in animals with delivery of dead fetuses than live fetuses. However, RI values were similar between live and dead calvers.

The haematology and serum biochemical values of the torsion affected cows are represented in Table 2. Haematological and serum biochemical values were within the reference values and no significant observation could be made out of this in torsion affected cows. However, significant differences in leukogram and serum biochemical value such as glucose, creatinine, calcium and phosphorous was reported in torsion affected buffaloes (Karthick 2015).

In the present study, all the animals were found to be affected with right sided post-cervical uterine torsion, which was higher than the observations (72.34%) in cows (Selvaraju and Karthick 2020). Increased incidence of right-side torsion was supported by the anatomical fact that increased space availability in abdominal cavity due to the

Table 1. Haemodynamic parameters (Mean±SE) of the middle uterine artery in cows before and after detorsion

CDI	Before detorsion		After detorsion	
	Ipsilateral	Contralateral	Ipsilateral	Contralateral
PI	2.00±0.10[a]	1.55±0.04[b]	1.75±0.19[a]	1.80±0.07[b]
RI	0.91±0.02	0.81±0.04	0.90±0.03	0.94±0.02
TAP (cm/s)	12.09±1.5	15.65±1.2	14.61±1.4	15.00±0.7
BVD (mm)	8.53±1.9	5.47±1.7	8.5±1.2	7.86±1.6
BFV (ml/min)	448.19±126[a]	233.47±53.19[b]	563.02±177.1[a]	450.62±89.7[a]

Values within the row with different superscripts differ significantly $P<0.05$.

Table 2. Haematology and serum biochemical values of the torsion affected cows

Parameter	Viable foetus	Dead foetus	Significance (P >0.05)	Overall
Haemoglobin (g/dl)	12.15	11.03	NS	11.40
Haematocrit (%)	35.00	34.25	NS	34.50
RBC ($\times 10^6$ /cmm^3)	7.95	6.55	NS	7.02
WBC ($\times 10^3$ /mm^3)	9.20	8.36	NS	8.64
Total protein (g %)	6.60	6.26	NS	6.37
Albumin (g %)	3.35	3.23	NS	3.27
Calcium (mg %)	9.75	8.82	NS	9.13
Phosphorus (mg %)	6.60	5.27	NS	5.71
BUN (mg/dl)	26.50	25.23	NS	25.65
Creatinine (mg/dl)	2.30	2.14	NS	2.20

NS, Non-significant.

presence of partially filled or unfilled rumen on left side predisposes to the torsion of unstable pregnant uterus to the right side (Ghuman 2010).

Significant changes in the blood flow characteristics of MUA could be observed in torsion affected cows. The BFV of ipsilateral MUA was found to be significantly ($P<0.05$) higher when compared to contralateral artery. In uterine torsion, the ipsilateral MUA was running down due to uterine rotation which might have favoured the blood flow due to gravity, even though it experienced resistance, as evidenced by high PI and RI values. On the other hand, the contralateral MUA stretched over the uterus from the opposite side which caused compression of blood vessels and blood pressure against the gravity, thus resulting in decreased BFV. After detorsion, both the ipsilateral and contralateral MUAs relieved from compression and the blood flow to the uterus returned to the normal with least resistance, which was evident from the increased BFV after detorsion.

Post-detorsion values of RI seemed to be similar when compared to pre-detorsion values, which could be attributed to the compensatory mechanism by the receptors of blood vessel to adjust for the external pressure and alter the velocity in order to safeguard the blood vessel from rupturing (Hussein 2013). But it depends on the immune and inflammatory status of the animal to respond during course of time. It could be assumed that the animal presented to the clinics had a history of exhibition of clinical signs for parturition straining for more than 8-10 h in all the cases, which indicated that the torsion would have occurred much earlier. Based on the occurrence and duration of torsion the PI and RI values might rise initially and subsequently declined. In addition to that, PI value of the individual animal had a variation in the contralateral side after detorsion which supported for the delivery of viable calf.

Perusal of the MUA blood flow parameters prior to detorsion in relation to fetal viability revealed that the BFV values were significantly higher and PI values were significantly lower in animals that delivered a live fetus and vice versa for dead fetus. However, RI values were similar between live and dead calvers suggesting PI is more preferable than RI (Singh *et al.* 2019). Thus, increased BFV and decreased PI ensured better MUA vascularity and fetal viability thereon in torsion affected cows. Hence, assessment of BFV and PI at the time of presentation of torsion case could provide a better prognostic status of the individual cases.

In reference to postpartum resumption of ovarian cyclicity, only two (33.33%) out of six cows exhibited oestrus signs within three months of calving. Inflammation of the uterus due to torsion might have affected the normal involution of uterus and extended the period for resumption of ovarian activity (Rao *et al.* 2020).

From the findings, it could be concluded that MUA blood flow characteristics are important determinant factors of fetal viability in torsion affected cows. Early presentation of the case and early diagnosis of the condition could yield positive results due to undeterred vascularity.

SUMMARY

The aim of the present study was to evaluate the haemodynamics of uterine blood flow in uterine torsion and record the period of resumption of ovarian cyclicity in cattle with uterine torsion. Crossbred cows with term gestation and straining for parturition due to post-cervical uterine torsion were selected for the study. Transrectal ultrasonographic assessment for measuring the doppler indices of middle uterine artery for both ipsilateral and contralateral side before and after detorsion was studied. Haemodynamic parameters such as blood flow volume (BFV), time-averaged peak velocity (TAP), resistance index (RI) and pulsatility index (PI) were assessed by using minimum three cardiac cycles. Blood samples were collected for haematological and biochemical assessment. Before detorsion, the PI value was high in ipsilateral side of uterine torsion and significant decrease could be observed after detorsion. However, BFV significantly increased after detorsion in both ipsilateral and contralateral side of uterine torsion when compared to the pre-detorsion values. Haematological and serum biochemical values were within the reference values and no significant observation could be made out of this in torsion affected cows. Two out of six animals (33.33%) exhibited the heat signs within three months of calving. In conclusion the blood flow volume was evidently increased after detorsion; however, the viability of the fetus was decided by the occurrence, duration and degree of uterine torsion.

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