EVALUATION OF BLOOD FLOW IN MIDDLE UTERINE ARTERY BY COLOR DOPPLER ULTRASONOGRAPHY IN UTERINE TORSION BUFFALOES BEFORE AND AFTER DETORSION

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ABSTRACT

The present study was conducted to evaluate the blood flow in middle uterine artery in uterine torsion affected buffaloes before and after detorsion and compare the findings of uterine torsion animals with the normal advance pregnant buffaloes. The study was conducted on twenty clinical cases of uterine torsion and twenty normal advance pregnant buffaloes (control group). Blood flow was measured with the help of color doppler ultrasonography by linear array per-rectal transducer having frequency range between 5.0 to 7.5 MHz. The data collected were statistically analyzed by "one way ANOVA" using computerized SPSS 16.0 software program. Blood flow volume (BFV) in middle uterine artery ipsilateral to uterine torsion (IPUT) were found significantly decreased than normal advance pregnant buffaloes ($P<0.05$). In cases of uterine torsion, BFV in the middle uterine artery IPUT were significantly lesser ($P<0.05$) than middle uterine artery contralateral to uterine torsion (COUT). However, after detorsion of uterus there was significant increase ($P<0.05$) in BFV in middle uterine artery IPUT and non-significant increase ($P>0.05$) in middle uterine artery COUT. Doppler ultrasound measurement of uterine blood flow holds the promise of being helpful for investigation of normal pregnancy and uterine torsion cases in buffaloes and could be useful to assess the alteration in blood flow in middle uterine artery after detorsion of uterine torsion.

Keywords: *Bubalus bubalis*, buffalo, uterine torsion, color doppler, middle uterine artery, detorsion

INTRODUCTION

Torsion of uterus usually occurs in a pregnant uterine horn and is defined as the twisting of the uterus on its longitudinal axis resulting in severe uterine vascular compression in late pregnant animals (Purohit *et al*., 2011). Based on published data it appears that uterine torsion is the single largest cause of dystocia in buffaloes during terminal gestation (Purohit and Gaur, 2011; Jeengar *et al*., 2015). Incidence of uterine torsion in buffaloes were reported 67 to 83% of

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total incidence of dystocia (Ghosh *et al*., 2013). Rotation of uterus compresses middle uterine vein which results in disturbances in circulation and increases carbon dioxide tension in the fetal blood. Consequently, uncomfortable fetus makes vigorous movements that may further increase the degree of uterine torsion. With the increase in degree of torsion, there is compression of middle uterine artery and oxygen going to the fetus is decreased (Schonfelder *et al*., 2005). Factors such as duration of the condition and severity of the torsion have been suggested as determinants of the outcome (Amin *et al*., 2011).

Rolling of dam by Modified Schaffer's method and caesarean section are the two techniques that are frequently employed for relieving the torsion of uterus and delivering the fetus in such cases. However, the success rate with treatments depends upon several factors such as the pre-operative condition of the animal, operative technique and post-operative measures. In Modified Schaffer's method for correction of uterine torsion, theory is to rotate the dam to the same degree and direction to which the uterus has rotated, keeping the fetus fixed by fixing uterus with a plank. Currently, there is apparently no information about effects of rolling on blood flow to middle uterine artery and consequently, the prognostic clinical information of the dam and the fetus were difficult to obtain and other advanced tools like doppler ultrasonography might be useful in solving the problem.

In human medicine, color flow mapping has become a powerful tool to investigate the blood flow of placental circulation in normal pregnancy and to predict retardation of fetal growth and in diagnosis of various diseases (Dickey, 1997). A method for investigating the uterine blood flow using trans-rectal color doppler sonography was applied in cattle (Herzog and Bollwein, 2007) and mare (Bollwein *et al*., 2004).

Color doppler ultrasonography has been used previously for evaluating the uterine blood flow and perfusion during late normal pregnancy and in uterine torsion affected buffaloes (Hussein, 2013) but the blood flow to middle uterine artery has not been assessed after detorsion of uterus. So there is a need to assess the effects of rolling on blood flow to middle uterine artery so that prognostic clinical information of fetus and dam can be obtained before going for further manipulations after detorsion in uterine torsion affected buffaloes. So the objectives of this work were to (1) investigate the blood flow in the middle uterine artery during late normal pregnancy and compare it with uterine torsion in buffaloes; and (2) assess the alterations in blood flow after detorsion of uterus.

MATERIALS AND METHODS

Study area

The study was conducted in the Teaching Veterinary Clinical Complex (TVCC) with the collaboration of the Department of Livestock Production and Management, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), Hisar (Haryana).

Animals

The study was conducted on twenty clinical cases of uterine torsion and twenty normal advance pregnant buffaloes (control group). The animals were admitted to the TVCC with the history of no progress in the parturition process or because of a general medical problem like colic, straining, reduced feed intake in late pregnant buffaloes (mostly between 8^{th} and 10^{th} month of pregnancy).

Methodology

The case history for each animal was recorded in history sheet which included the age of the animal, parity, stage of gestation, duration of the condition, and previous intervention and its nature. Diagnosis of uterine torsion was done after careful rectal and vaginal examinations after checking the broad ligament status. Uterine torsion having degree ≤180 were classified as light degree and the one having degree greater than 180 were classified as high degree uterine torsion arbitrarily, solely on the basis of manual judgement. After ascertaining the side and degree of uterine torsion, the uterine torsion affected (n = 20) buffaloes were subjected to detorsion by Sharma's Modified Schaffer's method. A high quality ultrasound machine (Figure 1; SonoScape S6/S6Pro/S6BW; Portable Digital Color Doppler Ultrasound) equipped with linear array trans-rectal transducer (Figure 2) having switchable frequency between 5.0 to 7.5 MHz designed for per-rectal approach was used for assessment of blood flow to middle uterine arteries.

Doppler examination of blood flow

The uterine artery was identified within the mesometrium near its origin at the rudimentary umbilical artery and near the external iliac artery. At this location uterine blood flow waveforms were obtained by activating the pulsed doppler function and placing the doppler gate over the uterine artery, adjusted to the diameter of the vessel. After that "CDI" and "update" buttons were pressed to get color Doppler images of blood flow to middle uterine artery.

Middle uterine artery perfusion was quantified by the blood flow volume (BFV) using the following formula (Bollwein *et al*., 2002):

$$\text{BFV (ml/sec)} = \text{TAMV (cm/sec)} \times \pi \times (\text{DI} \times 0.1/2)^2$$

Where, TAMV is the time-averaged maximum velocity of blood flow in the uterine artery and DI (mm) is the diameter of the uterine artery. The TAMV was calculated from the time-averaged maximum frequency shift (TAMF), using the formula:

$$\text{TAMV (cm/sec)} = \frac{(\text{TAMF} \times c)}{2F \cos \alpha}$$

Where, "c" is the ultrasound propagation speed, "F" is the transmitted wave frequency, and "α" is the angle between the ultrasound beam and the blood flow direction. The TAMV values of two uniform consecutive pulse waves were averaged. For determination of the diameters of the uterine arteries, the mean of three measurements of vessel diameter per examination was calculated from a frozen, two-dimensional, grey-scale image. The previous indices were recorded in the uterine artery ipsilateral (IPUT) and contralateral (COUT) to uterine torsion. Then the changes in the previous parameters were compared between normal pregnancy and uterine torsion. Moreover, ultrasonography was performed after detorsion to assess changes in blood flow to middle uterine artery. Changes in blood flow to uterus after detorsion were compared with blood flow to uterus before detorsion.

Statistical analysis

The ultrasound images recorded in the machine were reviewed in the scanner itself to re-examine the images in detail. The data collected were statistically analyzed for finding out average mean and standard error. One way ANOVA was employed using computerized SPSS 16.0 software program. Differences at $P<0.05$ were considered to be statistically significant.

RESULTS AND DISCUSSION

Color doppler images were obtained in normal advance pregnant (Figure 5) and uterine torsion affected buffaloes (Figure 6 and Figure 7). These images were further evaluated for blood flow characteristics in middle uterine artery (Figure 3 and Figure 4). Color doppler pattern of blood flow to uterus showed both the systolic and diastolic peaks. In normal advance pregnant buffaloes, BFV (Table 1) in the middle uterine arteries, IPUT and COUT, did not differ significantly ($P>0.05$). In cases of uterine torsion, mean ± SE value of BFV in middle uterine artery IPUT were significantly shorter and lesser ($P<0.05$) than in COUT (Table 1). BFV in uterine torsion cases in middle uterine artery ipsilateral to uterine torsion (Table 1) were found significantly decreased than in normal advance pregnant buffaloes ($P<0.05$).

It was observed that there was significant increase ($P<0.05$) in BFV (Figure 7) in middle uterine artery IPUT after detorsion of uterus (after rolling with Modified Schaffer's method) and non-significant change in BFV ($P>0.05$) in middle uterine artery COUT.

Vascular doppler ultrasound is based on the doppler effect resulting from the scattering and reflection of ultrasound beams originating from the probe (Piezo-crystals) and moving to the target reflecting object (red blood cells within the blood vessels), when the object reflecting ultrasound waves is moving. A positive frequency is usually created when this object is moving toward the probe and vice versa. The difference in frequency between the released and returned signals is described as doppler shift, which depends on the speed of the moving object. The processing of this doppler shift can produce either a color flow display or a doppler sonogram.

Martinoli *et al.* (1998) reported the next advance in doppler development was color doppler sonography (color doppler imaging), which has the ability to visually assess blood flow velocities and perfusion in B-mode gray images. Color imaging doppler means that the instruments can impose color signals of blood flow on a gray-scale image (B-mode), the first two (continuous wave and pulsed wave) known as spectral doppler.

In the current study, in all cases of uterine torsions a dramatic decrease in blood flow in middle uterine artery ipsilateral to uterine torsion was recorded, that might be attributed possibly to the compression of the blood vessels. It was observed that there is high systolic flow and absence of

Table 1. Measurement of blood flow to uterus (mean ± SE) in control and uterine torsion affected buffaloes (before and after detorsion).

Groups	BFV (IPUT) ml/sec	BFV (COUT) ml/sec
Control group	7.42 ± 0.25^{a}	6.73 ± 0.21^{a}
Uterine torsion (before detorsion)	3.47 ± 0.24^{c}	6.42 ± 0.16^{a}
Uterine torsion (after detorsion)	5.19 ± 0.25^{b}	6.45 ± 0.16^{a}

Means with different superscript in columns are showing significant level at $P<0.05$.

Figure 1. SonoScape S 6 portable digital color doppler ultrasound machine.

Figure 2. Linear array trans-rectal transducer.

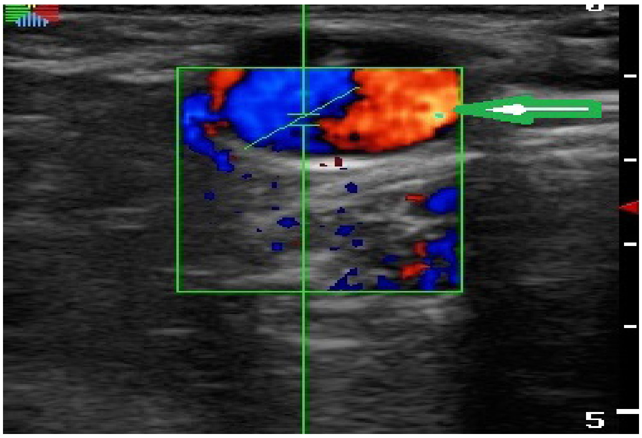

Figure 3. Color doppler image of middle uterine artery (cross-section) in buffaloes affected with uterine torsion.

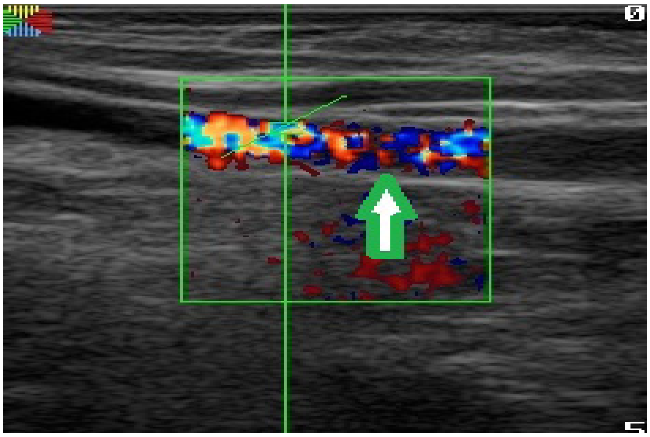

Figure 4. Color doppler image of middle uterine artery (longitudinal-section) in buffaloes affected with uterine torsion.

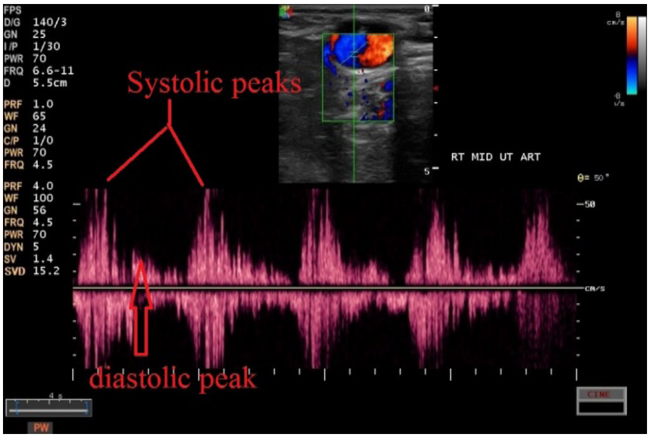

Figure 5. Color doppler image of blood flow in middle uterine artery ipsilateral to pregnant horn in normal advance pregnant buffalo.

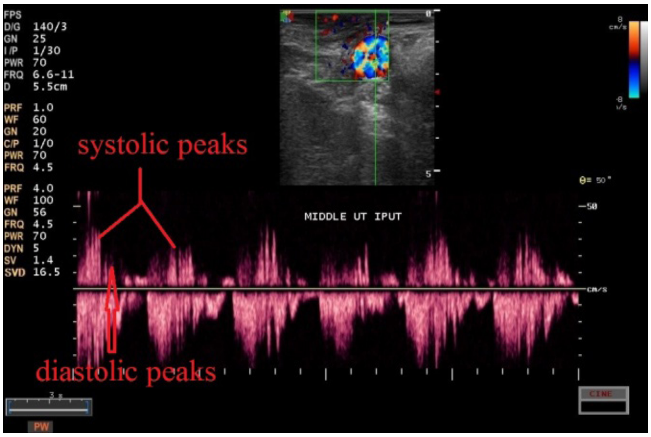

Figure 6. Color doppler image of blood flow in middle uterine artery ipsilateral to uterine torsion (before detorsion) in full term buffalo having right side post cervical uterine torsion.

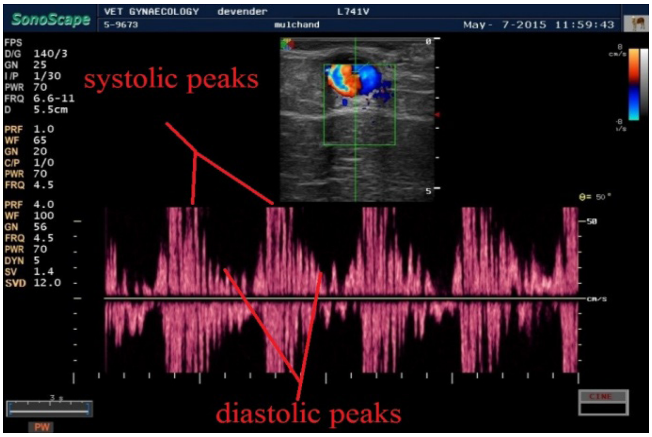

Figure 7. Color doppler image of blood flow in middle uterine artery ipsilateral to uterine torsion (after detorsion) in full term buffalo having right side post cervical uterine torsion (greater than 180 degree).

early diastolic flow in uterine torsion in buffaloes. It was also observed that after detorsion blood flow in middle uterine artery ipsilateral to uterine torsion increased again which might be attributed to removal of vascular compression. One possible reason for the observed alterations in uterine blood flow could be the alteration in the circulatory system during detorsion. So the findings of blood flow to uterus were comparable to Hussein (2013), who had previously reported the reduction in blood flow to uterus in uterine torsion affected buffaloes. Also, findings were comparable to study by Panarace *et al.* (2006) who performed doppler ultrasound scanning (triplex doppler system) once weekly from 30 to 270 days of gestation in cows to assess blood-flow parameters of both median uterine arteries and found that blood flow volume indices were significantly higher in the median uterine artery ipsilateral versus contralateral to the fetus.

Doppler ultrasound measurement of uterine blood flow holds the promise of being helpful for investigation of normal pregnancy and uterine torsion cases in buffaloes and could be useful to assess the alteration in blood flow in middle uterine artery after detorsion. This finding could be useful for dam and fetus before further manipulations in uterine torsion cases for better prognosis. In conclusion, the present study could be a valuable tool to ascertain hemodynamic changes in complicated pregnancy (e.g. abnormalities in uterine blood flow/placenta/fetus) and its extent of deviation from normal.

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