UTERINE BLOOD FLOW DURING PERIPARTUM PERIOD IN BUFFALO AND ITS ASSOCIATION WITH SHEDDING OF PLACENTA

N. SINGH[1]*, V.K. GANDOTRA[2], S.P.S. GHUMAN[3], S.S. DHINDSA[4] AND P.S. BRAR[5]

Department of Veterinary Gynaecology and Obstetrics
Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana - 141 004

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ABSTRACT

Twenty-three normal calving buffalo were subjected to trans-rectal doppler sonography to assess the blood flow in ipsilateral (IpsiUA, side of pregnant horn) and contralateral (ContUA) uterine artery in relation to shedding of placenta within 6 h post-calving (n=18) or later (n=5). Doppler parameters viz. time average peak velocity (TAP), blood flow volume (BFV), and resistive (RI) and pulsatility index (PI) were measured immediately before the start of calving process, and at 30 min and 6 h post-calving. The values of TAP and BFV in the uterine artery recorded at the start of calving process invariably exhibited a decreasing trend by 30 min post-calving which continued till 6 h post-calving ($p<0.05$). The values of RI and PI in uterine artery ipsilateral to side of pregnancy increased consistently till 6 h post-calving as compared to pre-calving values ($p<0.05$). At 6 h post-calving, both in IpsiUA as well as ContUA, the values of TAP and BFV were higher ($p<0.05$), and RI and PI were lower ($p<0.05$) in buffalo that failed to shed placenta within 6 h post-calving in comparison to their counterparts taking >6 h after calving for shedding placenta. In conclusion, the reference values for doppler indices for uterine artery during peripartal period were generated and it was observed that the decrease observed in blood flow in uterine artery was slow in buffalo with delayed shedding of placenta.

Keywords: Buffalo, Calving, Doppler, Placenta, Uterine artery

INTRODUCTION

The delivery of fetus results in a sudden decrease in blood flow through the placenta and subsequent shrinking of the villi (Laven and Peters, 1996). During postpartum period, the shedding of placenta is initial process of involution and is completed in majority of the farm animals within 6 h after delivery (Van-Werven *et al.,* 2012). Doppler sonographic assessment of blood flow to uterus was done several times in women under different conditions (Jaffa *et al*., 1996 and Nakai *et al.,* 1997). For investigating perfusion of blood to uterus in cattle, arterial blood flow was examined during the estrous cycle (Bollwein *et al.,* 2000), pregnancy (Bollwein *et al*., 2002) and during the puerperium (Krueger *et al.,* 2009 and Heppelmann *et al*., 2013). In buffalo, a limited number of studies during late gestation were conducted (Hussein, 2013 and Varughese *et al.,* 2013), however, there is no literature on uterine blood supply during postpartum period in buffalo. Certain peripartum complications like uterine torsion temporarily hinder the uterine blood flow (Ghuman, 2010 and Hussein, 2013). Hence, the present study was planned to evaluate the uterine blood flow during peripartum period in normal calving buffalo and to assess any association of peripartum uterine blood flow indices with shedding of placenta.

MATERIALS AND METHODS

Twenty-three multiparous buffalo housed in semi-intensive housing systems with complete gestation period and no history of difficult calving in previous gestations were selected for the study. The doppler sonography of uterine blood flow was carried out through transrectal approach to measure the uterine artery doppler indices using a portable color doppler ultrasound system equipped with a 5.0-7.5 MHz linear

[1]Ph.D. Scholar, [2]Professor, [5]Professor cum Head; [3]Professor cum Head, Department of Teaching Veterinary Clinical complex; [4]Assistant Animal Scientist, Department of Animal Genetics and Breeding; *navdeep1987@gmail.com

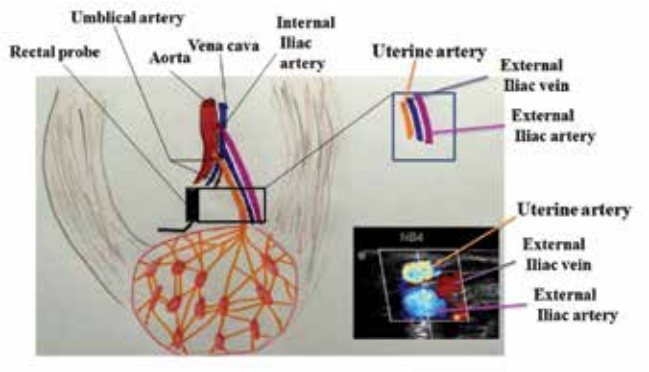

Figure 1: The location of middle uterine artery and the placement of rectal probe

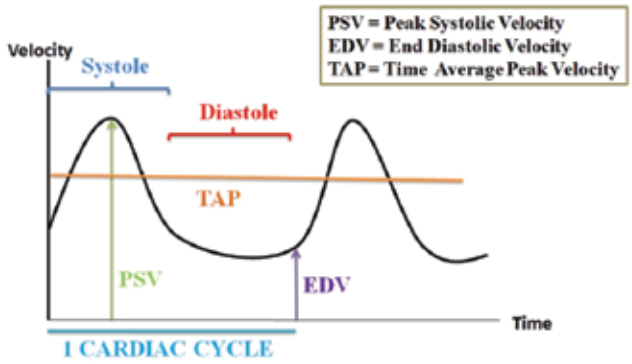

Figure 2: Spectral waveform (a cardiac cycle) of middle uterine artery

transducer (M-Turbo, SonoSite Inc., Bothell, USA). The buffalo were subjected to sonography at the start of initiation of calving (relaxation of pelvic ligaments and milk letdown), and subsequently at 30 min and 6 h after the delivery of fetus. The ipsilateral (IpsiUA, side of pregnant horn) and contralateral (ContUA) medial uterine artery were examined for measuring doppler indices (Bollwein *et al*., 2000). The uterine artery was recognized within the mesometrium near to its origin at the rudimentary umbilical artery and close to the external iliac artery (Figure 1). Various doppler indices over the cardiac cycle like pulsatility index (PI), resistive index (RI), time-average peak velocity (TAP) and blood flow volume flow (BFV) were calculated (Bollwein *et al.,* 2002). To increase the accuracy of results of doppler indices, at least three wave form measurements were taken for each parameter and the mean of at least two to three cardiac cycle of each wave form were used (Figure 2 and 3). The data (Mean±SE) was analyzed using IBM SPSS version 21 and the differences with $p<0.05$ were considered statistically significant. One-way ANOVA was used to compare doppler indices at different time-points and between different groups at same time-point.

RESULTS AND DISCUSSION

All the buffalo calved without any assistance and placenta was shed within 6 h in 18 buffalo and the remaining five buffalo shed their placenta few hours later. The values of time average peak velocity (TAP) and blood flow volume (BFV) in the uterine artery recorded at the start of calving process invariably exhibited a decreasing trend by 30 min post-calving which continued till 6 h post-calving ($p<0.05$, Table 1). This decrease in TAP and BFV can be attributed to an abrupt decline in blood flow through placenta and subsequent shrinking of villi after the delivery of fetus (Laven and Peters, 1996).

The other doppler indices viz. resistive index relates to negative relation with vascular perfusion and increasing resistance indicates decrease in vascular perfusion (Bollwein *et al*., 2000). Pulsatility index demonstrates the resistance in the vascular bed distal to the site of measurement. In the present study, the values of RI and PI in the uterine artery ipsilateral to side of pregnancy increased consistently till 6 h post-calving as compared to pre-calving values ($p<0.05$, Table 1), thus indicating the vasoconstriction of caruncular blood vessels during post-delivery period (Krueger *et al.,* 2009).

Nevertheless, at 6 h post-calving, the TAP and BFV values of IpsiUA as well as ContUA were higher ($p<0.05$), as well as RI and PI values of IpsiUA as well as ContUA were lower ($p<0.05$) in buffalo that failed to shed placenta within 6 h post-calving in comparison to their counterparts taking >6 h for shedding placenta after calving (Table 1). This is due to the fact that the

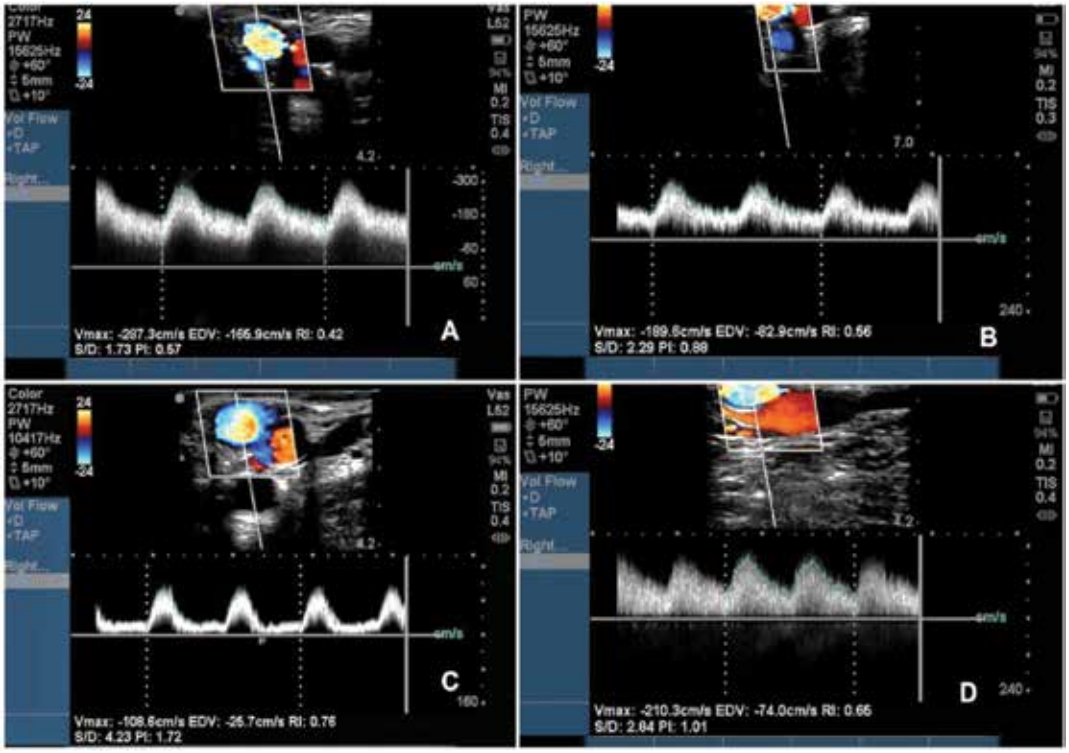

Figure 3: Doppler sonograph showing spectral waveform of middle uterine artery in buffalo during peripartal period. A) Immediately before the start of parturition process, B) 30 min post-delivery, C) 6 h post-delivery (placenta shedding <6 h post-delivery), D) 6 h post-delivery (placenta shedding >6 h post-delivery). Resistive and pulsatility index increased with the passage of time (from A to C), however, with lower values in D as compared to C because of the presence of placenta inside uterus.

presence of non-separated placenta in uterus hinders the reduction in blood flow to uterus as observed in cases of retained fetal membranes (Heppelmann *et al.,* 2013). Moreover, the RI and PI values were reported to be lower in cases of uterine sub-involution, delayed placental separation or impaired wound healing after caesarean section (Nakai *et al.,* 1997; Nijman *et al.,* 2002; Ajlana *et al.,* 2009 and Heppelmann *et al.,* 2013).

In brief, the present study provided reference values of doppler indices for uterine artery during peripartal period and further suggested that doppler indices can be used to assess the uterine artery blood flow in relation to shedding of placenta.

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Table 1: Doppler indices of middle uterine artery in buffalo (n=23) **during peripartal period.** Blood flow volume, BFV; Time averaged peak velocity, TAP; Resistive index, RI; Pulsatility index, PI; IpsiUA, Ipsilateral and ContUA; Contralateral uterine artery.

Doppler indices, Mean±SE		**At start of calving**	**At 30 min post-calving**	**At 6 h post-calving**	
				Placenta shedding <6 h post-calving (n=18)	**Placenta shedding >6 h post-calving** (n=5)
IpsiUA	**TAP**, cm/s	202.9±7.2^{a}	197.8±24^{a}	64.7±4.32^{b}	116.2±8.03^{c}
	BFV, ml/min	10638±297^{a}	9602±346^{b}	2462±112^{c}	6969±190^{d}
	RI, Index	0.48±0.01^{a}	0.55±0.01^{b}	0.71±0.01^{c}	0.63±0.02^{d}
	PI, Index	0.67±0.02^{a}	0.84±0.2^{b}	1.37±0.04^{c}	1.01±0.08^{d}
ContUA	**TAP**	140±6.9^{a}	112±4.3^{b}	60±2.8^{c}	97±7.4^{b}
	BFV	6294±284^{a}	5436±198^{b}	1878±64^{c}	5485±48^{a,b}
	RI	0.57±0.01^{a}	0.58±0.01^{a}	0.72±0.01^{b}	0.69±0.03^{b}
	PI	0.94±0.04^{a}	0.98±0.04^{a,ab}	1.55±0.06^{b}	1.13±0.04^{c,ab}

*Values with different superscripts within a row differ at p<0.05

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