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Research Article

ULTRASONOGRAPHIC EVALUATION OF MATERNAL HEART DURING PREGNANCY AND AFTER PARTURITION IN BEETAL GOATS

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ABSTRACT

The present study was conducted on six healthy adult Beetal goats of age 3 to 5 years to evaluate maternal heart during various stages of pregnancy and after kidding by ultrasonography. These healthy does were served to fertile buck and pregnancy was confirmed at day 32 by ultrasonography. Before mating ultrasonography was done in these healthy does and served as control. Echocardiography was performed from 37 days of gestation till three weeks after kidding to evaluate cardiac parameters like left ventricle internal diameter at diastole and systole, inter-ventricle septum thickness at diastole and systole, left ventricle free wall thickness at diastole and systole, Left ventricle end diastolic volume, left ventricle end systolic volume, stroke volume, cardiac output, heart rate and ejection fraction. All these parameters except ejection fraction showed elevation from mid pregnancy onwards and reached maximum at 142 days of pregnancy and remained elevated up to 3 weeks of kidding from control. This study demonstrated that pregnancy cause changes in heart dimensions and functions and might take longer duration to get restored to control values. Additionally, present study provides basic normal pregnancy data of maternal heart to serve as reference for further study.

Keywords: Beetal, Echocardiography, Goat, Heart, Kidding

Pregnancy is a physiological process that affects women's hemodynamics and cardiovascular system more profoundly (Adeyeye *et al.*, 2016). There is fall in systemic vascular resistance due to neurohormonal substances which results in increase in blood volume to meet the demand of mother for foetus growth. During pregnancy, two percent of maternal mortalities are found to occur because of maternal cardiac abnormalities (McAnulty *et al.*, 1990). In goats, structural cardiac abnormalities are rarely diagnosed clinically because this species adapt easily to any stress related to pregnancy and climate. So, it is relatively resistant to cardiac diseases during pregnancy. Despite this, echocardiography has proved to be an interesting tool for diagnosing cardiovascular diseases in goats (Buczinski, 2009). There are few studies available on echocardiography of pregnant goats while several studies have been done on normal goats for reference values (Singh *et al.*, 2017; Tejswani *et al.*, 2018). However, Olsson *et al.* (2001) carried out echocardiography in pregnant Swedish goats and observed no significant change in heart dimensions in pregnancy, lactation and dry period in contrast to other studies shown in different species while, Jordanow *et al.* (2018) reported significant change in heart parameters and a huge rise in cardiac output on different stages of pregnancy but did not observed any change in heart parameters after kidding, therefore, this study was designed to observe deviations in heart parameters in different stages of pregnancy and after kidding.

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MATERIALS AND METHODS

The study was carried out in Goat farm maintained by the Department of Animal Genetics and Breeding, LUVAS, Hisar. Total, six healthy Beetal goats of 3 to 5 years having body weight between 30-35 kg were selected. In these goats echocardiography was done as a control then these goats were mated to fertile buck during estrus and pregnancy was confirmed at day 32 by recording foetal heart rate. From day 37 onwards echocardiography was done in these goats fortnightly till 3 week after kidding. Echocardiography was performed in conscious goats in between 3rd to 5th intercostal space by restraining the animal. For this, hairs were clipped from 3rd to 5th intercostal space on left side of animal over cardiac region, then skin was cleaned with surgical spirit and the ultrasound coupling gel was applied on transducer of frequency 2-5 MHz in ultrasound machine "Sonoscape". By two dimensional and M-mode, various heart parameters i.e. Left ventricle diameter in diastole and systole, interventricle septum diameter in diastole and systole, left ventricle free wall during diastole and systole, left ventricle end diastolic volume and systolic volume were calculated by Teichholz formula (Teichholz *et al.*, 1976) as both left ventricle axis were symmetrical.

Left ventricle end diastolic volume = (7 × LVDd3)/ (2.4 + LVDd)

Left ventricle end systolic volume = (7 ×LVDs3)/ (2.4 + LVDs)

Ejection fraction (%) = Stroke volume/end diastolic volume ×100.

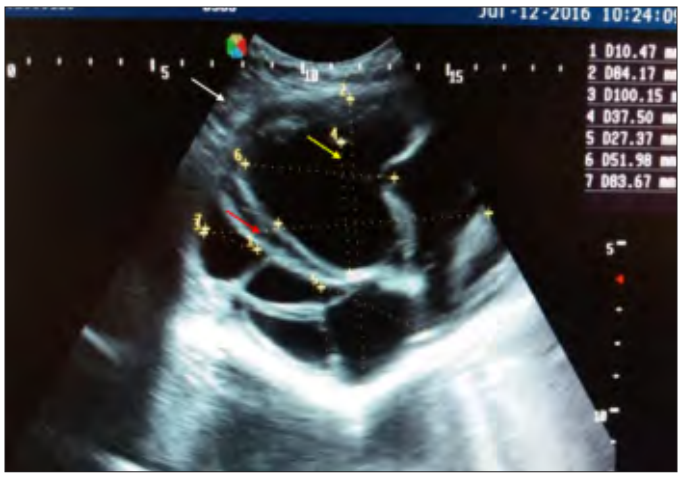

Fig. 1. Ultrasonographic image of heart showing left ventricle diameter (yellow arrow), inter-ventricle septum diameter (red arrow), left ventricle free wall (white arrow) in diastole in pregnant doe.

Stroke volume is the difference in between left ventricle end diastolic volume and end systolic volume and the cardiac output are the product of heart rate and stroke volume. The maternal heart rate was taken by Color Doppler imaging (Fig. 1).

Statistical analysis

Data were analyzed using statistical software SPSS 20 with one-way ANOVA and means were compared with Duncan Multiple Range Test. All the values were expressed as mean ± standard error of mean (SEM). Significance level was calculated at 0.05.

RESULTS AND DISCUSSION

Out of six goats, two goats delivered twins and four goats delivered single foetus. Echocardiography at 142 day was conducted 2 days before kidding one goat, 3 days before in two goats, 4 days before in two goats and 5 days before in one goat.

The cardiac parameters are shown in Table 1 and Table 2. The Left ventricle diameter during diastole (LVDd) and systole (LVDs), inter-ventricle septum diameter during diastole (IVSd) and systole (IVSs), left ventricle free wall diameter during diastole (LVFWd) and systole (LVFWs), left ventricle end diastolic volume (LVEDV) and left ventricle end systolic volume (LVESV) increased significantly ($P<0.05$) from mid pregnancy onwards and reached maximum on 142 days of pregnancy (Table1 and Table 2). Similarly, heart rate (HR) and cardiac output (CO) also rose significantly ($P<0.05$) from mid pregnancy while stroke volume (SV) increased significantly ($P<0.05$) from advanced stage of pregnancy as shown in Table 2. All these heart parameters remained elevated 3 weeks after kidding significantly ($P<0.05$) from control except Ejection Fraction (EF), percentage of which did not show any significant ($P<0.05$) change throughout pregnancy and after kidding from control.

Echocardiography was found to be very valuable practical technique in goats and useful in assessing the status of pathophysiological conditions of heart (Singh *et al.*, 2017). During pregnancy, it has been reported that there is fall in systemic vascular resistance due to vasomotor substances, inducing compensatory sodium and water retention which increases blood volume that further reduce hematocrit and blood viscosity (Olga *et al.*, 2018).

Since heart is very important vital organ and has been shown to be affected in other species i.e. Dog (Blanco *et al.*, 2012); Goat (Olsson *et al.*, 2001), Human (Adeyeye *et al.*, 2016). Therefore, in present study twelve parameters were studied to know the effect of pregnancy on heart.

This study revealed that pregnancy results in increase in diameter of left ventricle, interventricle

Table 1

Heart parameters on different stages of pregnancy, after kidding and their comparison with control

Days of pregnancy	LVDd (mm)	LVDs (mm)	IVSd (mm)	IVSs (mm)	LVFWd (mm)	LVFWs (mm)
Control	40.8±0.50^{a}	24.42±1.31^{a}	7.41±0.33^{a}	10.72±0.65^{a}	9.01±0.29^{a}	12.56±0.63^{a}
37	40.59±0.52^{a}	23.26±1.24^{a}	7.07±0.33^{a}	10.67±0.71^{a}	8.39±0.49^{a}	12.58±0.90^{a}
52	41.86±0.92^{ab}	24.76±1.38^{ab}	7.89±0.27^{ab}	11.52±0.61^{ab}	8.75±0.40^{a}	12.83±1.05^{a}
67	43.20±0.63^{bc}	25.39±0.89^{ab}	8.06±0.15^{abc}	10.78±0.50^{a}	9.27±0.57^{ab}	12.73±0.67^{a}
82	44.80±0.85^{c}	28.83±1.05^{cd}	9.07±0.31^{cd}	12.13±0.45^{ab}	10.84±0.76^{bc}	12.58±0.71^{a}
97	43.42±0.74^{bc}	27.63±1.02^{bc}	8.84±0.32^{bc}	11.82±0.38^{ab}	10.84±0.60^{bc}	12.13±0.67^{a}
112	45.10±0.72^{c}	29.72±1.05^{cd}	9.97±0.34^{de}	12.31±0.46^{ab}	11.94±0.61^{cd}	13.23±0.60^{a}
127	47.83±0.51^{d}	30.80±0.66^{cd}	10.41±0.39^{e}	12.64±0.57^{b}	12.49±0.64^{d}	13.54±0.75^{a}
142	50.01±0.71^{d}	31.24±1.41^{d}	10.69±0.33^{e}	12.71±0.33^{b}	12.80±0.49^{d}	14.46±0.60^{a}
1 week after kidding	50.00±0.51^{d}	30.33±0.49^{cd}	10.24±0.50^{e}	12.65±0.48^{b}	12.65±0.60^{d}	14.19±0.56^{a}
3, week after kidding	49.17±0.71^{d}	29.82±0.63^{cd}	10.03±0.56^{e}	12.65±0.48^{b}	12.11±0.57^{cd}	13.78±0.56^{a}

Values in columns with different superscript are significantly different ($P<0.05$)

Table 2

Heart parameters on different stages of pregnancy, after kidding and their comparison with control

Days of Pregnancy	LVEDV (ml)	LVESV (ml)	SV (ml)	CO (L/min)	HR (bpm)	EF (%)
Control	72.50±2.31^{a}	21.08±2.46^{ab}	51.42±3.99^{a}	3.59±0.22^{a}	70.33±1.35^{a}	70.56±3.36^{a}
37	71.23±2.41^{a}	18.65±2.23^{a}	52.59±3.74^{a}	3.70±0.24^{a}	70.67±1.14^{a}	73.49±3.22^{a}
52	77.56±3.94^{a}	22.08±2.83^{ab}	55.48±5.89^{a}	4.07±0.32^{a}	74.33±1.85^{ab}	70.75±3.8^{a}
67	82.83±3.07^{ab}	22.98±1.92^{ab}	59.86±3.25^{ab}	4.47±0.21^{ab}	74.83±1.40^{ab}	72.16±2.11^{a}
82	89.96±3.99^{b}	31.43±2.54^{cd}	58.53±5.44^{ab}	4.56±0.41^{ab}	78±1.71^{b}	64.46±3.51^{a}
97	83.05±3.22^{ab}	28.21±2.45^{bc}	54.84±5.23^{a}	4.32±0.39^{ab}	81±1.88^{b}	65.36±1.44^{a}
112	92.07±3.39^{b}	33.84±2.74^{cd}	58.23±5.48^{ab}	5.51±0.46^{bc}	93.33±2.96^{c}	62.65±3.63^{a}
127	104.64±2.54^{c}	37.20±1.96^{d}	66.19±4.57^{b}	6.17±0.55^{cd}	92.83±2.65^{c}	62.99±2.99^{a}
142	118.62±5.85^{d}	38.46±2.87^{d}	81.42±5.14^{c}	8.03±0.53^{e}	98.33±1.89^{c}	68.63±2.21^{a}
1 week after kidding	117.67±3.85^{d}	36.03±1.43^{d}	81.67±6.21^{c}	7.75±0.56^{e}	93.67±3.47^{c}	69.40±1.9^{a}
3weeks after kidding	113.21±5.10^{cd}	34.01±1.62^{cd}	79.20±5.12^{c}	7.21±0.53^{de}	91.33±3.85^{c}	69.7± 1.69^{a}

Values in columns with different superscript are significantly different (P<0.05)

septum, left ventricle free wall during diastole and systole from mid pregnancy onwards. This might be due to volume overload. The left ventricle end diastolic volume and systolic volume increased in pregnancy might be due to changes in aldosterone and oestrogen hormones that leads to increase blood volume during pregnancy (Zenter *et al.*, 2009). In present study, cardiac output increased to maximum at last stage of gestation. Similarly, Jordanow *et al.* (2018) observed a very high level of cardiac output in dairy goats that seems to be due to higher heart rate. In other breeds of goats there were comparable increases in cardiac output. It was 53% in Swedish goat (Olsson *et al.*, 2001) and 76% in Pygmy goat (Hosenpud *et al.*, 1986). These changes in cardiac output in pregnancy have been attributed to increasing blood flow including flow to placenta and foetus (Robson *et al.*, 1989).

In this study increased in heart rate might be due to combination of heavy body weight and excitement during measurement (Olsson *et al.*, 2001) that could be results of epinephrine release. Similarly, Olsson *et al.*, (2003) observed significant increase in heart rate in beagle dogs from 3 week of gestation till delivery that decreased at 4 weeks after delivery but values were still higher than control values. Ejection fraction percentage did not show any significant change throughout pregnancy in present study similar, results were observed by Savu *et al.* (2012).

In current study, all heart parameters remained elevated up to 3 weeks after kidding in comparison with control. This might be associated with more blood flow to mammary glands for lactation that may influence circulatory system (Zarifi *et al.*, 2012), while, Olsson *et al.* (2001) did not find any significant change in heart parameters during pregnancy, lactation and dry period in Swedish goats that may be because of breed difference. There were no comparable studies of change in heart dimensions and functions after kidding in goat.

CONCLUSION

From present study, it is concluded that pregnancy causes changes in heart dimensions and functions and these changes remained elevated up to 3 weeks of kidding. These changes might take longer time to return back to control value.

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