

DOPPLER EVALUATION OF FOETAL AORTA IN NORMAL GESTATION IN CANINES

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Total 20 pregnant bitches with known history of breeding; irrespective of age, parity belonging to different breeds were classified into two groups (n=10) according to dam's body weight. (Group I, >25kg BW; Group II, <25kg BW). Colour and pulsed wave Doppler was performed in all the bitches between 40-50 and 51-60 days of gestation. The blood flow parameters SPV, EDV, PI and RI of foetal aorta, uteroplacental arteries and umbilical arteries were recorded. The mean systolic peak velocity (SPV) for foetal aorta in group I, II were 47.15 ± 9.01 , 37.43 ± 15.57 cm/sec and 58.88 ± 4.53 , 48.05 ± 16.90 cm/sec respectively, during 40-50 and 51-60 days of gestation. The mean end diastolic velocity (EDV) values for foetal aorta in group I, II were, 3.10 ± 2.83 , 4.48 ± 1.13 cm/sec and 11.14 ± 4.62 , 11.95 ± 1.90 cm/sec respectively, during 40-50 and 51-60 days of gestation. The mean pulsatility index (PI) values for foetal aorta in group I, II were 1.63 ± 0.18 , 1.49 ± 0.21 and 1.43 ± 0.23 , 1.46 ± 0.19 respectively, during 40-50 and 51-60 days of gestation. The mean resistivity index (RI) values for foetal aorta in group I, II were 0.93 ± 0.05 , 0.94 ± 0.05 and 0.81 ± 0.07 , 0.86 ± 0.12 during 40-50 and 51-60 days of gestation.

Keywords: Canines, Doppler evaluation, Foetal Aorta, Normal gestation.

Investigations on the dynamics of maternal and foetal blood flow using Doppler ultrasound have been conducted in different species recently and it is thought that it would be a reliable diagnostic tool in future. (Bollwein *et al.*, 2000, Bollwein *et al.*, 2002, Bollwein *et al.*, 2003, Blanco *et al.*, 2008). Resistance indices of uteroplacental and umbilical arteries, foetal aorta and foetal common carotid arteries progressively decrease throughout normal canine gestation (Nautrup, 1998; Di Salvo *et al.*, 2006; Blanco *et al.*, 2010; Miranda and Domingues, 2010) guaranteeing an appropriate perfusion of the placenta and foetal viscera.

The detection of the umbilical cord is possible via ultrasonography after the days 40-46 of pregnancy in canine (Johnston *et al.*, 2001). The foetal size and the formation of skeleton rapidly increase during last 3 to 4 weeks of gestation in bitches (Johnston *et al.*, 2001). Therefore there is an increase of the amount of nutritional requirements in fetuses which are growing. Researchers reported that the umbilical artery waveform has systolic and diastolic phases after 5th - 6th week of gestation in canines. (Di Salvo *et al.*, 2006). The pulsatility and resistance indices of umbilical artery starts to decrease significantly in this stage and increasing the

foetal blood flow coming from the umbilical cord.

The abnormalities occurred before heart rate decreased, suggesting that Doppler could predict compromised pregnancies and obstetrical diseases. However, scanty information is available on spontaneous canine cases of pathological gestation. Though, Doppler ultrasonography alone is not sufficient for the evaluation of foetal well-being, this technique enables the gynaecologist to diagnose foetal distress earlier than other tests (Fleischer *et al.*, 1994). For the technique to be applicable in canine obstetrics, it is essential to standardise it. Establishment of various landmarks as regards to the blood flow through the uteroplacental and foetal vessels during different stages of gestation, along with standardisation of normal values of doppler indices is essential. It was hypothesised that estimating foetal blood flow parameters utilising Doppler ultrasound technology would result in monitoring the pregnancy in canines.

Materials and methods:

The present study was approved by Institutional Ethical committee, (IEC) Mumbai Veterinary College, Parel, Mumbai-400012. Clinically healthy pregnant bitches,

irrespective of age, weight, parity and breed with known history of breeding were selected in this study. The bitches belonged to different breeds with weights ranging from 3 to 55 kg. The experimental bitches were divided into two groups according to the body weight, each comprising 10 bitches.

Group I (n=10): It included the canine females with normal gestation, weighing more than 25 kg.



Fig. 1. Colour flow pattern of foetal aorta

Two dimensional ultrasonography in combination with colour Doppler and pulsed wave Doppler was performed in all bitches for two times i.e. during 40 to 50 and 51 to 60 days of gestation. The blood flow parameters like SPV, EDV, PI and RI were recorded for evaluation of uteroplacental arteries, umbilical arteries, and foetal aorta. The foetal aorta was traced from the heart and evaluated as the foetal descending aorta. The aorta was visible as an anechoic tube coming out of the heart; bifurcating and then continuing as the foetal ascending and descending aorta (Plate 1). A colour-flow confirmed the presence of the aorta and then a pulsed-wave Doppler was performed to obtain the waveform and the parameters were recorded.

Table 1 Blood flow parameters of the foetal aorta in group I

Sr. No	Parameter	40 to 50 days (n=10)	51 to 60 days (n=10)	't' Cal	't' Table
1	SPV (cm/sec)	47.15 ± 9.01 ^a	58.88 ± 4.53 ^b	3.67	2.101

Group II (n=10): It included the canine females with normal gestation, weighing less than 25 kg.

The caudal-most foetus in either horn was examined using pulsed-wave Doppler ultrasonography after locating the gravid uterus. Imaging the aorta was easier at this stage. On 2D mode, the aorta was feebly visible. The aortic arch along with the descending aorta could be appreciated in colour Doppler mode (Plate 2). The aorta was pulsatile.



Fig.2. Colour Doppler and pulsed wave image of foetal aorta during 40 to 50 days of gestation

Results and discussions:

During 51 to 60 days of gestation, the whole aorta, right from its origin in the heart to the aortic arch to the descending aorta could be imaged. The colour intensity was brighter indicating increased blood flow, and the aorta appeared thicker. Blood flow parameters of the foetal aorta in both the groups were evaluated by measuring the velocities viz SPV and EDV and the Doppler indices viz. RI and PI during 40 to 50 and 51 to 60 days of gestation. The data was statistically analysed using the t-test and means of the same are presented in Table 1 and table 2.

2	EDV (cm/sec)	03.10 ± 2.83 ^a	11.14 ± 4.62 ^b	4.69	
3	Tamax (cm/sec)	27.10 ± 3.92 ^a	34.06 ± 6.04 ^b	3.05	
4	PI	01.63 ± 0.18	01.43 ± 0.23	2.09	
5	RI	00.93 ± 0.05 ^a	00.81 ± 0.07 ^b	4.07	
6	A:B ratio	36.03 ± 29.50 ^a	06.29 ± 2.53 ^b	3.17	

[Different superscripts within same row denote significant differences (p < 0.05)]

Table 2 Blood flow parameters of the foetal aorta in group II

Sr. No	Parameter	40 to 50 days (n=10)	51 to 60 days (n=10)	't' Cal	't' Table
1	SPV (cm/sec)	37.43 ± 15.57	48.05 ± 16.90	1.46	2.101
2	EDV (cm/sec)	04.48 ± 1.13 ^a	11.95 ± 1.90 ^b	2.59	
3	Tamax (cm/sec)	23.01 ± 7.26	28.90 ± 11.28	1.38	
4	PI	01.49 ± 0.21	01.46 ± 0.19	0.32	
5	RI	00.94 ± 0.05	00.86 ± 0.12	1.87	2.26
6	A:B ratio	11.00 ± 2.87 ^a	04.54 ± 0.88 ^b	4.90	2.22

[Different superscripts within same row denote significant differences (p < 0.05)]

The mean SPV values for foetal aorta in group I, II were 47.15 ± 9.01, 37.43 ± 15.57 cm/sec and 58.88 ± 4.53, 48.05 ± 16.90 cm/sec respectively, during 40-50 and 51-60 days of gestation. A significant increment was observed in the SPV of foetal aorta between 51-60 days than 40-50 days of gestation in group I. The similar significant increase in SPV of foetal aorta was reported by Di Salvo *et al.* (2006) and Ghaisas (2012) in canines and Scotti *et al.* (2008) in felines. Feliciano *et al.* (2014) reported gradual increase in SPV of foetal aorta in canines. Pereira *et al.* (2012) and Ribeiro (2017) reported gradual increase in SPV of foetal aorta in felines.

The mean EDV values for foetal aorta in group I, II were, 3.10 ± 2.83, 4.48 ± 1.13 cm/sec and 11.14 ± 4.62, 11.95 ± 1.90 cm/sec respectively, during 40-50 and 51-60 days of gestation. A significant increment was observed in the EDV of foetal aorta between 51-60 days than 40-50 days of gestation in group I. The similar significant increase in EDV of foetal aorta was reported by Di Salvo *et al.* (2006) and Ghaisas (2012) in canines. Feliciano *et al.* (2014) reported gradual increase in EDV of foetal aorta in canines. Scotti *et al.* (2008) and Pereira *et al.* (2012) reported gradual increase in EDV of foetal aorta in felines. However, Ribeiro (2017) reported that mean EDV of the aorta

was constant (0.00 cm/sec) between 40-60 days of gestation in felines.

The mean PI values for foetal aorta in group I, II were 1.63 ± 0.18, 1.49 ± 0.21 and 1.43 ± 0.23, 1.46 ± 0.19 respectively, during 40-50 and 51-60 days of gestation, which decreased non-significantly as gestation progressed. Similarly Ghaisas (2012) also reported non-significant decrease in the PI of aorta with the advancement of gestation in canines and Feliciano *et al.* (2014) also reported progressive decrease in PI of foetal aorta between 5th to 8th weeks of gestation in canines and also Di Salvo *et al.* (2006) reported significant decrease in the PI of the foetal aorta during the same time periods in canines. Scotti *et al.* (2008) reported a significant decrease in the PI of the foetal aorta during the same time periods in felines while Ribeiro (2017) reported progressive decrease in PI of foetal aorta in felines during 40 to 50 and 51 to 60 days of gestation which are similar to the present findings. Pereira *et al.* (2012) reported almost constant values of PI for the foetal aorta throughout gestation in felines.

The mean RI values for foetal aorta in group I, II were 0.93 ± 0.05, 0.94 ± 0.05 and 0.81 ± 0.07, 0.86 ± 0.12 during 40-50 and 51-60 days of gestation, which decreased significantly (P<0.01) between the two time periods. Similar findings to the present study

regarding significant decrease in RI of foetal aorta with advancement of gestation in canines were reported by Di Salvo *et al.* (2006), Serin and Tarimcilar (2011) and Ghaisas (2012). Scottiet *al.* (2008) and Ribeiro (2017) reported constant values of RI for foetal aorta during the same time periods in felines. Pereira *et al.* (2012) reported constant resistivity index until day 42 which declined on day 49, and thereafter it was stable. Feliciano *et al.* (2014) also reported constant RI of foetal aorta between 5th to 8th weeks of gestation in canines.

The results of the analysis revealed that the blood flow parameters viz. SPV, EDV, PI and RI in group I and II did not differ significantly ($p < 0.05$) during 40 to 50 and 51 to 60 days of gestation. It indicates that in normal gestation body weight has no significant effect on blood flow parameters of foetal aorta during 40 to 50 and 51 to 60 days of gestation in canines.

The blood flow velocities of the foetal aorta increased with advancement of the gestation. There was significant increase in SPV and EDV of foetal aorta during 51 to 60 days of gestation. The blood flow index RI values were decreased significantly with advancement of gestation from 40 to 50 to 51 to 60 days. The PI value decreased non-significantly with advancement of gestation. The indices were positively correlated with each other ($p < 0.05$) and RI was negatively correlated with the EVD ($p < 0.05$) during 40 to 50 and 51 to 60 days.

It can be concluded that the blood flow velocities of the foetal aorta increased with advancement of the gestation. The blood flow parameters viz. SPV and EDV of foetal aorta increased significantly, while, the blood flow index RI values decreased significantly with advancement of gestation from 40 to 50 to 51 to 60 days. The PI value decreased non-significantly with advancement of gestation in canines.



Fig.3. Colour Doppler and pulsed wave image of foetal aorta during 51 to 60 days of gestation

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