



*Original Research*

## **Pulmonary to Systemic Flow Ratio (Qp/Qs) in Dilated Cardiomyopathy, Mitral Valve Disease and Patent Ductus Arteriosus Affected Dogs**

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### **Abstract**

The study was designed to determine pulmonary to systemic flow ratio (Qp/Qs) by Doppler echocardiography in Dilated cardiomyopathy (DCM), Mitral valve disease (MVD) and Patent ductus arteriosus (PDA) affected dogs. Dilated cardiomyopathy, mitral valve disease and Patent ductus arteriosus were diagnosed by Doppler echocardiography and in these affected dogs pulmonary artery diameter, peak pulmonary artery velocity, pulmonary velocity time interval, aortic diameter, peak aortic flow, aortic velocity time interval were recorded. The mean values of Qp/Qs ratio in DCM and MVD were  $1.16 \pm 0.21$  and  $0.72 \pm 0.31$  respectively. The mean values of Qp, Qs and Qp/Qs ratio was  $25.62 \pm 4.47$ ,  $14.99 \pm 5.02$  and  $1.2 \pm 0.16$  respectively in PDA affected dogs. Increase in Qp may be observed due to pulmonary over circulation, these leading to an increase in Qp/Qs ratio. Left to right shunting associated with intracardiac shunts in PDA leads to above mentioned condition. The combination of pulmonary to systemic flow ratio (Qp/Qs) with Doppler parameters, offers a striking approach for the assessment of intra cardiac shunt severity in dogs. Further, the present method is rapid, easy and non-invasive and aids in early diagnosis.

**Key words:** Dilated Cardiomyopathy, Dog, Mitral Valve Disease, Patent Ductus Arteriosus, Pulmonary to Systemic Flow Ratio

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### **Introduction**

In normal canine heart, without any septal defects or any other congenital defect in heart, there will be equal output from the right and left ventricles. Blood leaves the right ventricle will circulate through the lungs, then return to the left heart to be ejected to the body. In this event, the systemic blood flow (Qs) is equal to the pulmonary blood flow (Qp). Therefore, the Qp:Qs ratio is 1:1. In dogs with patent ductus arteriosus, blood passes from the aorta to the pulmonary artery. Thus, the left atrium, left ventricle and pulmonary



artery realize a volume overload, but the right atrium and right ventricle do not. The magnitude of a left-to-right shunt can be expressed in terms of the ratio of the volume of pulmonary flow ( $Q_p$ ) and systemic flow ( $Q_s$ ). In normal dogs this ratio is one because, in normal dogs the volume of blood that is pumped to the lungs ( $Q_p$ ) is equal to the volume of blood that is pumped to the body ( $Q_s$ ). In dogs with left-to-right shunts, the  $Q_p$ - $Q_s$  ratio is greater than one. In general, if  $Q_p$ - $Q_s$  ratio is 1.5 or less it is considered a small shunt; a  $Q_p$ - $Q_s$  ratio of 1.5 to 2.0 is considered a moderate shunt; and a  $Q_p$ - $Q_s$  ratio of more than 2.0 is considered a large shunt.

Both in human patients (Sabry *et al.*, 1995) and in experimental canine models (Valdes-Cruz *et al.*, 1983; Valdes-Cruz *et al.*, 1984; Meijboom *et al.*, 1983) the assessment of  $Q_p/Q_s$  using Doppler echocardiography has been validated. Serres *et al.*, 2009 assessed  $Q_p/Q_s$  by the Doppler echocardiographic method in healthy dogs and he reported  $Q_p/Q_s$  offers an attractive approach for the assessment of ICS severity in dogs, because of its non-invasive aspect. However, Serres *et al.*, 2009 opined, for clinical relevance, longitudinal studies has to be conducted in dogs. With this background the study was designed to determine  $Q_p/Q_s$  by Doppler echocardiography in Dilated cardiomyopathy (DCM), Mitral valve disease (MVD) and Patent ductus arteriosus (PDA) affected dogs.

## Materials and Methods

Dogs presented to the cardiology service of the Veterinary Teaching Hospital, Veterinary College Bangalore eligible for entry into the study. Dilated cardiomyopathy (37 cases), Mitral valve disease (26 cases) and Patent ductus arteriosus (8 cases) were diagnosed by Doppler echocardiography and these affected dogs were subjected to following assessment.

### Doppler Assessment of Left Ventricular Systolic Function

#### Aortic Outflow

In left apical five chamber view Aortic outflow was recorded (Fig. 1) and following measurement were carried out-

- a) Peak velocity of aortic flow
- b) Velocity time integral (VTI) - The aortic outflow spectrum was traced, and the area under its curve determined.
- c) Ejection time (ET) - the duration of the aortic outflow spectrum (Boon, 2011).

#### Pulmonic Outflow

In the right cranial short axis views, optimizing the pulmonary trunk Pulmonic outflow was recorded (Fig.

2). The following measurement were carried out-

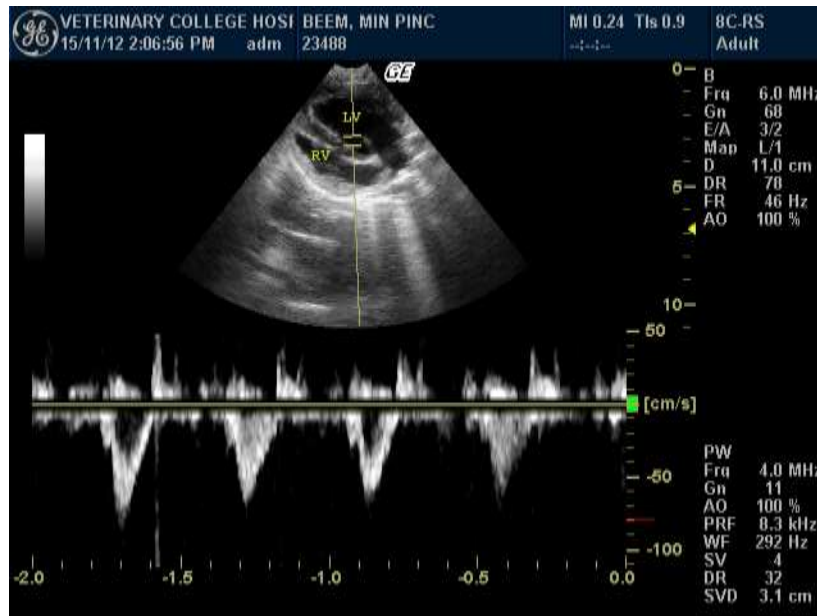
- a) Peak velocity of pulmonic outflow
- b) Velocity time integral (VTI) - The pulmonic outflow spectrum was traced, and the area under its curve determined.

c) Ejection time (ET) - the duration of the pulmonic outflow spectrum (Boon, 2011).

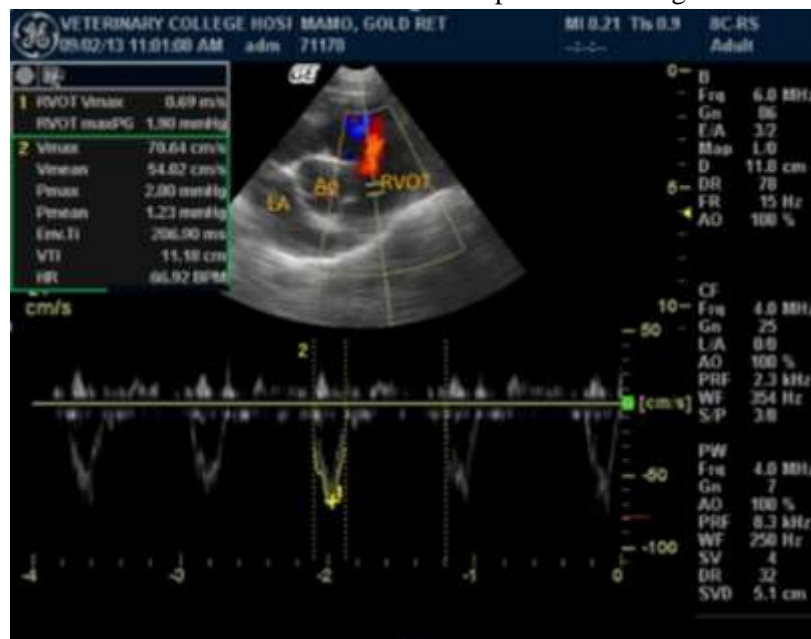
### Pulmonary to Systemic Flow Ratio (Qp/Qs)

Qp (Pulmonary flow ml) =  $(3.14 \times (\text{mpa}/2)^2 \times \text{VTI}_{\text{pul}}$

Qs (Systemic flow ml) =  $(3.14 \times (\text{Ao}/2)^2 \times \text{VTI}_{\text{sys}}$  (Serres *et al.*, 2009; Boon, 2011)



**Fig. 1:** Pulsed wave Doppler sample volume placed within the aorta, just beyond the aortic valves, to record aortic flow profiles in a dog



**Fig. 2:** Pulsed wave Doppler sample volume is placed just beyond the pulmonic valves to record pulmonic outflow profile in a dog

### Statistical Analysis

Data were recorded as percent, Mean  $\pm$  SE. The data obtained were subjected to statistical analysis using SPSS 17 software. Data between DCM, MVD and PDA were analysed by one-way analysis of variance.

### Results and Discussion

The assessment of pulmonary to systemic flow ratio (Qp/Qs) in DCM and MVD affected dog were represented in Table 1. The assessment of Qp/Qs in PDA affected dog were represented in Table 2. Pulmonary to systemic flow ratio in DCM, MVD and PDA affected dogs were represented in Table 3.

**Table 1:** Assessment of Pulmonary to systemic flow ratio (Qp/Qs) in cardiac disease in dogs

Echocardiographic Variables	DCM (N= 37)	MVD (N= 26)	Total	P value
Pulmonary artery diameter (cm)	2.23 $\pm$ 0.16	1.54 $\pm$ 0.14	1.91 $\pm$ 0.14	0.009**
Aortic diameter (cm)	1.93 $\pm$ 0.27	1.61 $\pm$ 0.22	1.76 $\pm$ 0.16	0.544 <sup>ns</sup>
Peak PA velocity (m/s)	0.77 $\pm$ 0.07	2.81 $\pm$ 2.11	1.91 $\pm$ 1.17	0.423 <sup>ns</sup>
Pulmonary VTI (cm)	6.66 $\pm$ 1.45	7.2 $\pm$ 1.11	6.35 $\pm$ 0.97	0.168 <sup>ns</sup>
Peak aortic flow (m/s)	0.75 $\pm$ 0.06	0.97 $\pm$ 0.06	0.85 $\pm$ 0.04	0.016*
Aortic VTI (cm)	6.96 $\pm$ 0.85	8.83 $\pm$ 1.1	7.86 $\pm$ 0.7	0.186 <sup>ns</sup>
QP	34.54 $\pm$ 10.77	13.44 $\pm$ 2.74	20.64 $\pm$ 5.73	0.102+
QS	20.82 $\pm$ 3.6	18.63 $\pm$ 4.08	19.72 $\pm$ 2.67	0.691 <sup>ns</sup>
QP:QS	1.16 $\pm$ 0.21	0.72 $\pm$ 0.31	1.24 $\pm$ 0.24	0.114 <sup>ns</sup>

Results are in Mean  $\pm$  SE; \*\*: Significant ( $P \leq 0.01$ ); \*: Significant ( $P \leq 0.05$ ); + significant ( $P \leq 0.10$ ); <sup>ns</sup>: Non-significant

**Table 2:** Assessment of Pulmonary to systemic flow ratio (Qp/Qs) in PDA (N=8)

Echocardiographic Variables	Values
Pulmonary artery diameter (cm)	1.99 $\pm$ 0.17
Aortic diameter (cm)	1.66 $\pm$ 0.11
Peak PA velocity (m/s)	0.67 $\pm$ 0.08
Pulmonary VTI (cm)	8.97 $\pm$ 1.26
Peak aortic flow (m/s)	0.67 $\pm$ 0.06
Aortic VTI (cm)	6.31 $\pm$ 1.21
Qp	25.62 $\pm$ 4.47
Qs	14.99 $\pm$ 5.02
QP:QS	1.2 $\pm$ 0.16

Results are in Mean  $\pm$  SE

**Table 3:** Pulmonary to systemic flow ratio (Qp/Qs) in DCM, MVD and PDA affected dogs

Echocardiographic Variables	DCM	MVD	PDA	Total	P value
QP	34.54 $\pm$ 10.77	13.44 $\pm$ 2.74	25.62 $\pm$ 4.47	23.52 $\pm$ 4.5	0.199
QS	20.82 $\pm$ 3.6	18.63 $\pm$ 4.08	14.99 $\pm$ 5.02	18.89 $\pm$ 2.37	0.698
QP:QS	1.16 $\pm$ 0.21	0.72 $\pm$ 0.31	1.2 $\pm$ 0.16	1.34 $\pm$ 0.15	0.934

The mean Qp and Qs value in DCM affected dog were 34.54 $\pm$ 10.77 and 20.82 $\pm$ 3.6 respectively. The mean Qp and Qs value in MVD affected dog were 13.44 $\pm$ 2.74 and 18.63 $\pm$ 4.08 respectively. The mean values of Qp/Qs ratio in DCM and MVD were 1.16 $\pm$ 0.21 and 0.72 $\pm$ 0.31 respectively. There was no significant

difference between these groups. The normal range of Qp/Qs flow ratio was 0.71-1.29 (Serres *et al.*, 2009). In the present study Qp/Qs ratio was normal in DCM and MVD affected dogs, which is in agreement with the results of earlier workers (Serres *et al.*, 2009). In the case of left to right shunting associated with intracardiac shunts, an increase in Qp may be observed due to pulmonary over circulation, and thus leading to an increase in Qp/Qs ratio. The mean values of Qp, Qs and Qp/Qs ratio was  $25.62 \pm 4.47$ ,  $14.99 \pm 5.02$  and  $1.2 \pm 0.16$  respectively in PDA affected dogs. Increase in Qp may be observed due to pulmonary over circulation, these leading to an increase in Qp/Qs ratio. Left to right shunting associated with intracardiac shunts in PDA leads to above mentioned condition. These findings are in agreement with earlier observations of Serres *et al.* (2009).

### Conclusion

The combination of pulmonary to systemic flow ratio (Qp/Qs) with Doppler parameters, offers a striking approach for the assessment of intra cardiac shunt severity in dogs. Further, the present method is rapid, easy and non-invasive and aids in early diagnosis.

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