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## Cyanotic congenital heart disease in a foal with large subaortic ventricular septal defect

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### Abstract

Ventricular septal defects are the most common congenital cardiac defects reported in horses. A 50 days old foal (Nukra) was presented to the large animal clinics, GADVASU, Ludhiana with a primary complaint of exercise intolerance and shortness of breath. Physical examination, revealed normal vital parameters but the mucus membrane appeared slightly cyanotic. Clinical examination revealed tachypnoea and tachycardia with a thoracic thrill over the left side of the chest. Lung sounds were normal upon lung auscultation. In the right parasternal short axis view, a large subaortic VSD was observed which was seen overriding the RV more than 80%. Color Doppler ultrasound revealed blood flow pattern through the patent ductus arteriosus. The presence of a loud murmur, tachycardia/tachypnoea along with cyanotic mucus membranes in a neonatal foal should always warrant a thorough cardiac evaluation for any congenital cardiac defects.

**Keywords:** Ventricular septal defects (VSD), congenital cardiac defects, horses

### Introduction

Ventricular septal defects (VSDs) have been described in both humans and animals. VSDs are normally classified on the basis of its location (Schwarzwald 2008) [8]. It is the most common congenital cardiac defect reported in horses (Scansen 2019) [7]. It may occur as an isolated defect or as a part of complex congenital abnormalities (Michlik *et al* 2014) [6]. Congenital heart defects occur secondary to errors during cardiac development and their consequences depend on the extent of the defect leading to variable clinical signs (Scansen, 2019) [7]. Echocardiography has been described as a reference non-invasive technique for the diagnosis of congenital heart defects in horses. The present case report describes the clinical and echocardiographic features in a young foal with subaortic ventricular septal defect.

### Case Presentation

A 50 days old foal (Nukra) was presented to the large animal clinics, GADVASU, Ludhiana with a primary complaint of exercise intolerance and shortness of breath. Owner also complained about fever (104 °F) and reduced appetite from last one week. Upon physical examination, animal was alert with a BCS of 2, rectal temperature was 102.4 °F, color of the mucus membrane was slightly cyanotic (Fig) and CRT was <2 sec. Clinical examination revealed tachypnoea and tachycardia with a respiration rate of 34 breaths per minute and a heart rate of 111 bpm. Upon cardiac auscultation, a thoracic thrill was evident over the left side of the chest. For further diagnosis, the foal was sent for thoracic radiographs for evaluating the chest cavity. Mild interstitial pattern was observed in caudal lung lobes. Under cardiac investigation, electrocardiography and echocardiography was conducted. The electrocardiographic findings were widening of the QRS complex and RA enlargement. An echocardiographic examination was then carried out according to a previously established protocol (Boon, 2011) using the ultrasound machine. The right parasternal long axis view revealed gross dilatation of the right atrium (RA) and right ventricle (RV). The size of the right side chambers was observed to be more than the left atrium and left ventricle. Further, it was observed that the main pulmonary artery was atectic and the right pulmonary artery was small sized which was retrogradely being filled by patent ductus arteriosus (PDA) (Fig. 1) The size of the PDA was 0.508 cm.

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In the right parasternal short axis view, a large subaortic VSD was observed which was seen overriding the RV more than 80% (Fig 2). The interventricular septum had a deficiency in the superior part, measuring about 2.3 cm. Color Doppler revealed severe aortic regurgitation (Fig 3). M-mode measurements were done in right parasternal short axis view. The measurement were as follows: LVIDd- 4.87 cm, LVIDs-

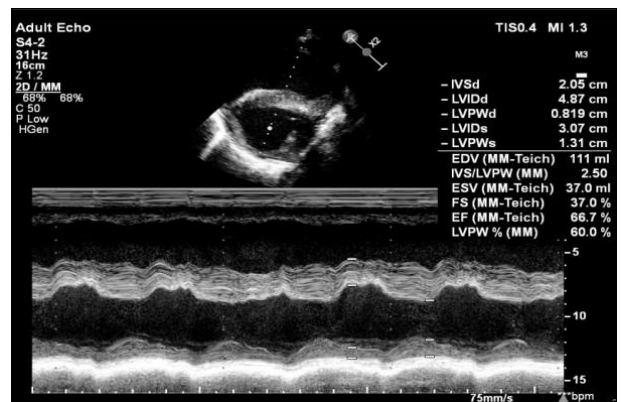
3.07 cm, LVPWd- 0.82 cm, LVPWs- 1.31 cm, EDV-111 ml, ESV- 37 ml, FS%-37% and EF%=66.7% (Fig 4). In the left parasternal apical four chamber view, there was severe mitral regurgitation and severe tricuspid regurgitation (Fig 5). The interatrial septum was showing restrictive PFO due to high pressure in the atrium. Regurgitation was also seen at the interatrial septum.

**Table 1:** The measured M-mode left ventricular dimensions and normal M-mode values in foal

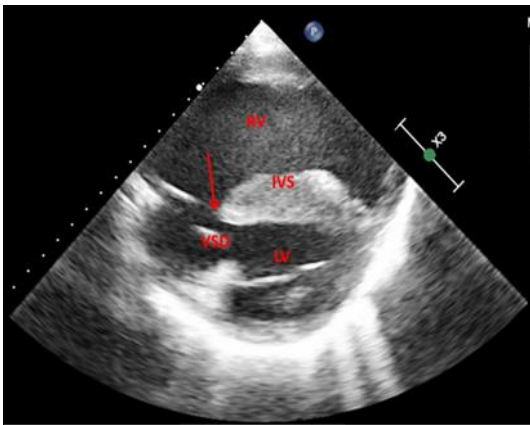
Variable	Measured M-mode values in patient	Reference values (cm) (Matur and Gur, 2011)
Interventricular septal thickness at end-diastole (cm)	2.05	2.22±0.25 (1.60-2.6)
Interventricular septal thickness at end-systole (cm)	2.25	3.05±0.34 (2.28-3.7)
Left ventricular internal diameter at end-diastole (cm)	4.87	5.78±0.63 (5.78-7.98)
Left ventricular internal diameter at end-systole (cm)	3.07	4.79±0.62 (3.72-5.78)
Left ventricular free wall thickness at end-diastole (cm)	0.82	1.29±0.22 (0.84-1.75)
Left ventricular free wall thickness at end-systole (cm)	1.31	2.26±0.38 (1.75-3.27)
End diastolic volume (ml)	111	Not available
End systolic volume (ml)	37	Not available
Fractional shortening (%)	37	31.6±4.7 (25-41)
Ejection fraction (%)	66.7	60.8±6.9 (47-73)



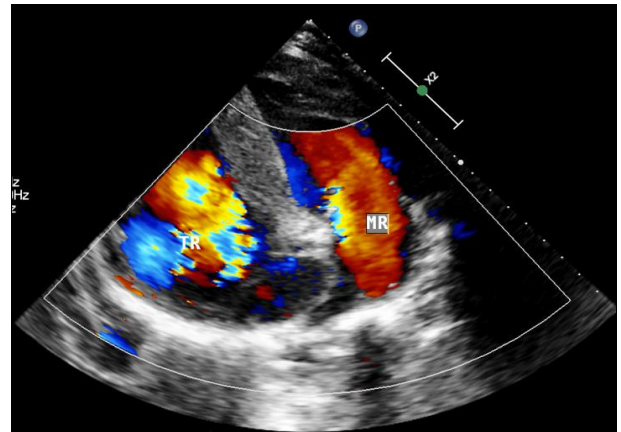
**Fig 1:** 2D image showing atretic man pulmonary and the right pulmonary artery being retrogradely filled by patent ductus arteriosus (PDA)



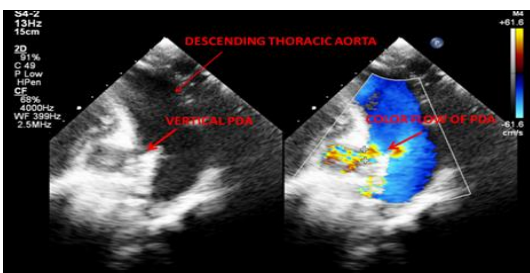
**Fig 4:** M-mode image of heart at right parasternal short axis view



**Fig 2:** Right parasternal long axis view showing a large ventricular septal defect that's seen overriding the right ventricle



**Fig 5:** Left parasternal apical four chamber view showing severe mitral and tricuspid regurgitation



**Fig 3:** Color flow Doppler at right parasternal apical four chamber view showing severe aortic regurgitation and vertical PDA

**Discussion**

Congenital cardiac defects are quite common in horses, of which ventricular septal defects are most common (Hall *et al* 2010) [2]. In a decade long study, it was observed that 6% of the foals were younger than 1 month and 89% were more than 6 months (Lange *et al* 2021) [3]. PDA has been identified in 50% of the foals with congenital defects as reported by Hall *et al* (2010) [2]. The standard method for diagnosis of ventricular septal defect alone or combined with other congenital cardiac defects is echocardiography (Michlik *et al* 2014) [6]. In line with our findings Hall *et al* (2010) [2], has also reported tachycardia and tachypnoea in majority of the presented foals

in their study. Cyanosis of the mucus membranes has also been reported possibly due to the right to left shunting of blood, similar to the present case being discussed. Some of the researchers have also reported nasal discharge, cough, tachypnea, dyspnea, fever, mild colic, exercise intolerance, ventral edema, and pulsation of jugular vein as signs of complicated ventricular septal defects (Lange *et al* 2021) [3]. It has been described in the literature that ventricular septal defects are the commonest congenital cardiac defect in horses and may be diagnosed up to six times more frequently than any other congenital cardiac defect (Marr, 2010) [5]. The possibility of getting a VSD solely is quite less as it is mostly associated with other kind of congenital defects (Hall *et al* 2010) [2]. Similar to the current case, the mean width of ventricular septal defect has been measured as  $2.80 \pm 0.75$  cm (Lange *et al* 2021) [3]. Persistent flow of blood through the ductus arteriosus beyond the age of one week is labeled as patent ductus arteriosus (Lange *et al* 2022) [4]. In foals, both PDA and VSD can be present together (Lange *et al* 2021) [3]. Such defects could have a profound impact on foals through altered growth rate, exercise intolerance, respiratory distress, and death. As such, it is important to recognize the clinical findings associated with such defects early in the course of medical evaluation of neonatal foals, as the presence of a defect can alter the prognosis and course of treatment. Longitudinal follow up studies are required in neonatal foals to access the occurrence of various congenital cardiac defects.

### Conclusion

This case report highlights the presence of a large subaortic ventricular septal defect (VSD) in a 50-day-old foal, accompanied by significant clinical signs such as exercise intolerance, tachycardia, tachypnoea, and cyanotic mucus membranes. The echocardiographic findings demonstrated a substantial defect, overriding the right ventricle, and revealed associated conditions including a patent ductus arteriosus and severe regurgitation in both the mitral and tricuspid valves. Given the high prevalence of congenital cardiac defects in foals, it is crucial for veterinary practitioners to conduct comprehensive cardiac evaluations when presented with similar clinical signs. Early diagnosis and understanding of the implications of such defects are vital for determining appropriate treatment strategies and improving prognostic outcomes. Continued research and monitoring of congenital heart defects in equine populations are essential for enhancing clinical management and care in affected animals.

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