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CASE REPORT

Ventricular septal defect and double-chambered right ventricle in an alpaca

Helen Poser, DVM*, Angela Dalla Pria, DVM, PhD, Giulia M. De Benedictis, DVM, PhD, Calogero Stelletta, DVM, PhD, Michele Berlanda, DVM, PhD, Carlo Guglielmini, DVM, PhD

Department of Animal Medicine, Production and Health, University of Padova, Viale dell'Università 16, 35020 Legnaro, PD, Italy

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Abstract A 20-month-old male alpaca was referred for evaluation of a cardiac murmur evident since birth. Echocardiography identified a ventricular septal defect (VSD) and a fibro-muscular band causing a stenosis of the right ventricular outflow tract. Right ventricular catheterization and selective angiography confirmed the diagnosis of VSD and double-chambered right ventricle with bidirectional shunting.

A 20-month-old Huacaya alpaca was presented to the Veterinary Teaching Hospital of the University of Padua because of a cardiac murmur that had been audible since birth. During the first five months of life, the cria grew normally but showed clinical signs suggestive of right-sided congestive heart failure (CHF) including fatigue and mild ascites. These signs resolved without specific treatment. No diagnostic investigations had been performed prior to referral.

On physical examination the alpaca was in good body condition, weighing 49 kg and had a body condition score of 5/9. The mucous membranes

* Corresponding author.
E-mail address: helen.poser@unipd.it (H. Poser).

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Abbreviation

CFD	color flow Doppler
CHF	congestive heart failure
CHM	congenital heart malformation
DCRV	double-chambered right ventricle
DV	dorso-ventral
ECG	electrocardiogram
IVS	inter ventricular septum
LV	left ventricle
LVOT	left ventricular outflow tract
RV	right ventricle
RVOT	right ventricle outflow tract
TTE	transthoracic echocardiography
VSD	ventricular septal defect

were pink with a capillary refill time <2 s. Peripheral femoral arterial pulse was regular and synchronous. Cardiac auscultation revealed a grade 5/6 holosystolic crescendo-decrescendo heart murmur audible over the left and the right hemithorax, with the maximal intensity over the left heart base. Heart rate was 64 bpm. No other abnormalities were detected.

Arterial blood gas analysis showed mild resting hypoxemia with PaO_2 of 75 mmHg (normal range = 90—100 mmHg) and hemoglobin oxygen saturation of 94% (normal range = 95—99%). Complete blood count and serum biochemical tests were within reference ranges. A standing electrocardiogram (ECG) was recorded without sedation using standard limb leads and showed a normal sinus rhythm with a heart rate of 62 beats/min. Wave morphology and duration were within reference ranges.[1]

Right-to-left lateral and dorso-ventral (DV) radiographic views of the thorax were obtained. The cardiac silhouette and the quantitative radiographic parameters were within the normal range, with a vertebral heart scale of 8.9 and 7.1 on lateral and DV views, respectively (normal ranges = 9.36 ± 0.59 and 8.21 ± 0.51, respectively).[2] Cardio-sternal contact, number of intercostal spaces spanned by the heart in lateral view, cardiophrenic contact in DV view and caudal vena cava dimensions all appeared normal.[2]

After shaving the precordial area, transthoracic echocardiography (TTE)[a] was performed without sedation with the cria in lateral recumbency on an echocardiography table. Two-dimensional real-time TTE revealed a 15-mm diameter perimembranous ventricular septal defect (VSD) and a fibro-muscular stenosis in the right ventricular outflow tract (RVOT) (Fig. 1). The proximal right ventricle (RV) appeared hypertrophic (RV wall thickness in diastole = 0.96 cm) and dilated, with an end-diastolic diameter of 2.1 cm measured from the right parasternal short axis view at the level of the chordae tendinae (reference [mean, SD] = 1.12 ± 0.36 cm).[b] The interventricular septum (IVS) was 1.01 cm thick in diastole (reference = 1.24 ± 0.28 cm)[b] and appeared flattened in the right parasternal short-axis view with a paradoxical systolic motion. Neither hypertrophy nor dilation was evident in the distal RV beyond the midventricular obstruction. The pulmonic valve and the proximal pulmonary trunk appeared normal. The aortic root appeared morphologically normal with a diameter of 2.8 cm (reference = 3.04 ± 0.37 cm)[b] and normal leaflet mobility.

Spectral and color flow Doppler (CFD) revealed a high-velocity turbulent flow (Fig. 1B) across the RVOT stenosis (peak velocity = 5.47 m/s, corresponding to a pressure gradient of 120 mmHg between the proximal or apical and the distal or basilar portion of the RVOT). The effective orifice area was calculated by the continuity equation as 1.56 cm^2, corresponding to an RVOT stenosis of 79%.[3] Bidirectional flow was evident across the VSD with left-to-right shunting during diastole and right-to-left shunting during systole (Fig. 2). Maximal systolic velocity across the VSD was 2.12 m/s, corresponding to a pressure gradient of 18 mmHg. Trivial mitral and tricuspid regurgitation were also evident. Right-to-left shunting across the VSD was confirmed with an agitated saline contrast study. Blood flow velocities across the semilunar and atrioventricular valves were normal.

The cria was premedicated with midazolam and general anesthesia was induced with propofol and maintained with propofol and fentanyl administered by constant rate infusion. After intravenous administration of 150 U/kg of heparin, right heart catheterization was performed via right jugular access. Selective angiography confirmed the presence of a stenotic RVOT (Fig. 3) and right-to-left systolic shunting across the VSD. The measured systolic and diastolic right ventricular pressure was 147 mmHg and 6 mmHg, respectively. It was not possible to advance the catheter to the distal RV chamber and pulmonary artery to record post-stenotic pressures. Invasive arterial systolic, diastolic, and mean arterial blood pressures recorded

[a] Logic P5, GE Healthcare, Milan, Italy.

[b] Hallowell GD and Potter TJ. Normal echocardiographic appearance and dimensions in adult alpacas. Proceedings ACVIM 26th Annual Veterinary Medical Forum abstract program. J Vet Intern Med 2008; 22:715.