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Case Report

Percutaneous balloon valvuloplasty for management of pulmonic stenosis in four dogs: First experience in Veterinary Medicine in Romania

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Abstract: Pulmonic stenosis (PS) is one of the most common congenital heart diseases (CHD) in dogs, accounting for approximately 32% of all congenital cardiac defects diagnosed in this species [9]. If severe and left undiagnosed or untreated, PS can lead to signs of right-sided congestive heart failure (R-CHF) and, ultimately, death [7]. This paper describes aspects of the palliative management of PS using percutaneous balloon valvuloplasty (BVP) in four dogs, which, to the authors' knowledge, has not been previously performed in Romania. The minimally invasive procedures were performed between December 2021 and February 2023, at the first Interventional Veterinary Radiology Laboratory in Romania., specialized and optimised for Interventional Veterinary Cardiology (Doctor's Vet Univers Clinic, Bucharest). All patients were referred for signs of exercise intolerance or syncope due to haemodinamic effects of PS. The population included 2 females and 2 males aged between 18 and 72 months. Three dogs who underwent BVP showed a reduction in pressure gradient between 28 and 50 percent and a positive outcome. In one dog, the BPV failed to reduce the pressure gradient, and the patient subsequently suffered a sudden cardiac death (SCD). These findings are comparable with previously reported data in the literature and support the use of BVP as an effective palliative option for managing PS in dogs. Although the learning curve is important for improving outcomes, continued experience remains crucial for achieving consistent success.

Keywords: BVP, minimally invasive, catheterisation, Veterinary Interventional Cardiology

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1. Introduction

Pulmonic stenosis is a congenital heart disease, characterized by an obstruction localized at the level of the right ventricular outflow tract. Pulmonic stenosis is the most commonly diagnosed congenital malformation in dogs [2,8,9], accounting for up to 32% of all congenital conditions. In some studies it surpasses subaortic stenosis and patent ductus arteriosus. It can affect both sexes equally and is more commonly described in certain breeds: Boxer, Mongrel, English Bulldog, French Bulldog, Pincher, German Shepherd, Beagle, West Highland White Terrier. [4]

Depending on the location of the stenotic lesion, PS can be classified as subvalvular, valvular and supravalvular. The most common of these is the valvular form and its classified itself into 3 types. Type A is characterized by a normal annulus, but fusion of the cusps with a dome-like appearance during systole. Type B includes valves with thickened cusps and reduced mobility and annulus hypoplasia. The mixed/intermediate type is used to describe condition that have common characters of both types A and B [8,7,4]

The clinical signs observed in dogs with PS are usually related to their severity. In mild forms, clinical signs may be absent, while in moderate to severe forms exercise intollerance, syncope, and signs of R-CHF, such as ascites, pleural effusion and subcutaneous oedema are frequently detected. In most severe cases with marked ventricular hypertrophy leading to myocardial hypoxia, arrhythmias as well as sudden cardiac death may occur [10].

The diagnosis and assessment of the severity of stenosis is achieved by echocardiography, based on morphologic changes of the valve and pressure gradient at this level, in conjunction with other associated changes (right ventricular concentric hypertrophy due to pressure overload, right atrial dilatation frequently associated with tricuspid valve regurgitation and/or post-stenotic dilatation of the pulmonary trunk [10,2]

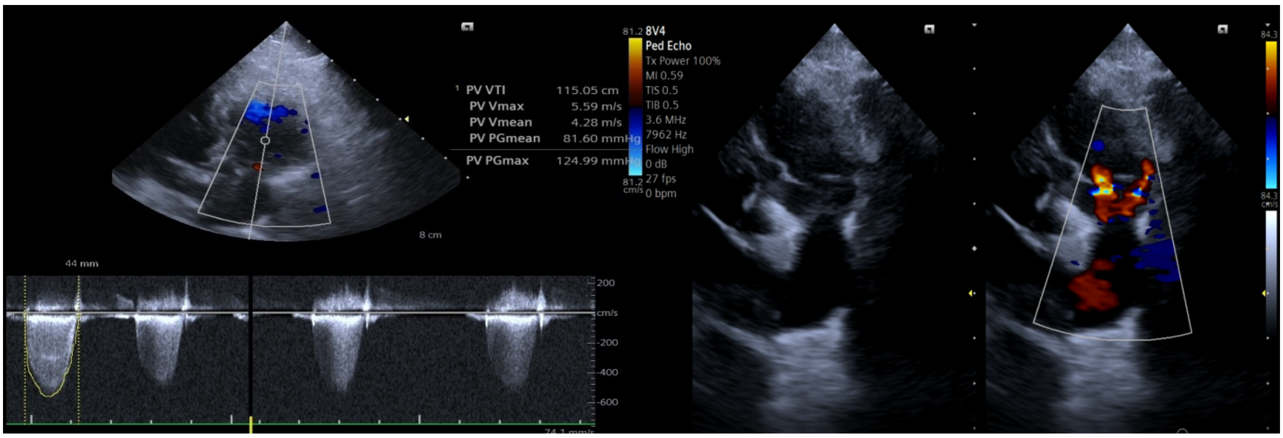
The most widely used guidelines for classifying the severity of PS were established by Bussadori et al. in 2000. These guidelines define three severity categories based on the maximum pressure gradient measured across the pulmonary valve: mild stenosis corresponds to a peak pressure gradient between 20–49 mmHg, moderate stenosis is defined by a gradient of 50–80 mmHg, and severe stenosis is diagnosed when the pressure gradient exceeds 80 mmHg [4].

Currently, in veterinary medicine, two types of procedures are relatively commonly performed to palliate or alleviate PS: balloon valvuloplasty using different types of catheters, including cutting and high-pressure balloons and transpulmonary stent implantation. Other minimally invasive techniques described in dogs include pulmonary valve implantation, such as the Melody valve. In addition to interventional approaches, some cardiologists employ beta-blocker therapy with the aim of improving diastolic function, reducing right ventricular inotropism and the transvalvular pressure gradient, and thereby decreasing myocardial oxygen consumption [1,3,5,6].

2. Cases

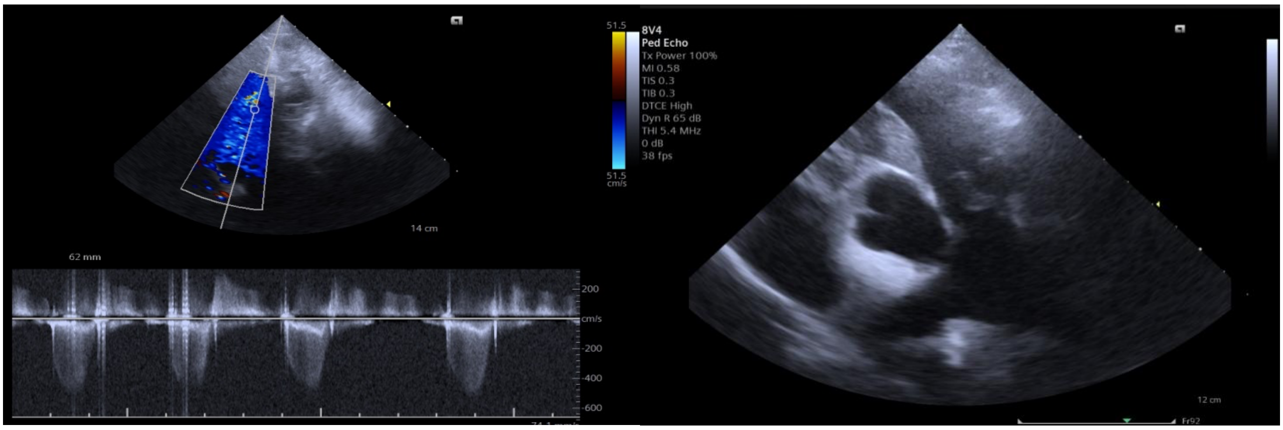
2.1 Case description

Four dogs aged between 18 and 72 months, two males and two females, from three different breeds (one German Shepherd, two West Highland White Terriers and one Lagotto Romagnolo), were included in the present case study. They were diagnosed with valvular pulmonary stenosis type A. Three of them showed syncope on physical efforts at the time of diagnosis.



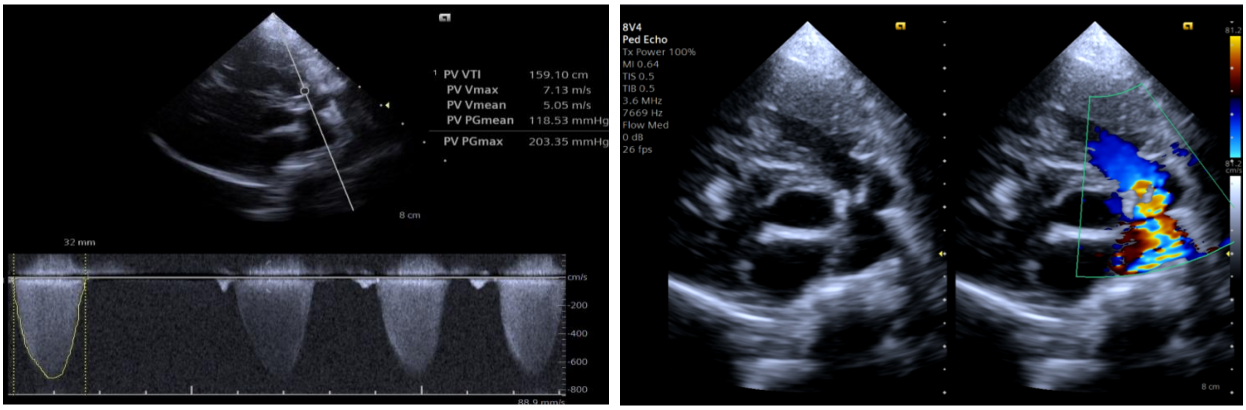
(a) (b)

Fig 1. (Case 1): (a) Right parasternal, short axis view, Continuous wave Doppler at the pulmonary valve level, showing high pressure gradient, suggestive pulmonic stenosis; (b) Right parasternal, short axis view, 2D image and color Doppler during ventricular diastole, showing the presence two pulmonary regurgitation jets and the thickened and fused appearance of the sigmoids.



(a) (b)

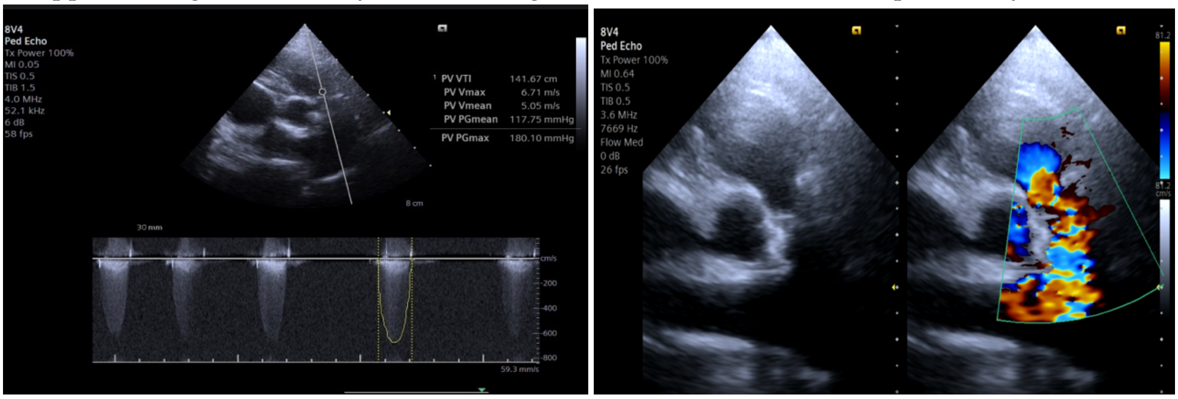
Fig 2. (Case 2): (a) Right parasternal, short axis view, Continuous wave Doppler at the pulmonary



valve level, showing high pressure gradient; (b) Left parasternal, short axis view, 2D image and during ventricular diastole, showing thickened valve sigmoids.

(a) (b)

Fig 3. (Case 3): (a) Right parasternal, short axis view, Continuous wave Doppler at the pulmonary valve level, showing the increased pressure gradient; (b) Right parasternal, short axis view, 2D image and color Doppler during ventricular systole, showing the turbulent flow across the pulmonary valve.



(a) (b)

Fig 4. (Case 4): (a) Right parasternal, short axis view, Continuous wave Doppler at the pulmonary valve level, showing the increased pressure gradient; (b) Right parasternal, short axis view, 2D image and color Doppler during ventricular systole, showing the turbulent flow across the pulmonary valve.

2.2 Procedure description

The vascular access was performed using the surgical cut-down technique, exposing the right external jugular vein, under general anesthesia, with the patient positioned in left lateral recumbency. Using the modified Seldinger technique or venotomy (the vein is exposed and the temporary haemostasis is obtained by placing two - cranially and caudally - umbilical tapes, silk or sterile rubber band in a single loop technique), an introducer sheath is placed and an angiography catheter was inserted through in order to perform angiography, aiming to localize the stenosis and to exclude coronary malformations. Either a diagnostic catheter or a hydrophilic guidewire (inserted through the lumen of the catheter) was advanced to the pulmonary trunk. The hydrophilic guidewire was then replaced with a rigid Rosen guidewire or a rigid guidewire was inserted through the diagnostic catheter into the pulmonary arteries. Subsequently (after removal of the angiography catheter, if necessary) the pressure balloon was inserted "over the wire". The balloon was selected individually according to the diastolic diameter of the stenosis (using the ratio Balloon/ring diameter = 1.2 or 1.3 and taking into account the size of the access port required for the balloon in relation to the patient's size). After positioning the pressure balloon at the stenosis level, the balloon inflation procedure followed. In each case the balloon was inflated 5 times successively, aiming for the "waist" appearance of the balloon to completely disappear during the last series of dilations. Finally, after the final emptying of the contrast solution from the balloon, the balloon and guidewire were withdrawn from the heart and then from the blood vessel, followed by the removal of the access port, ligation of the blood vessel or venoplasty and suture of the skin.

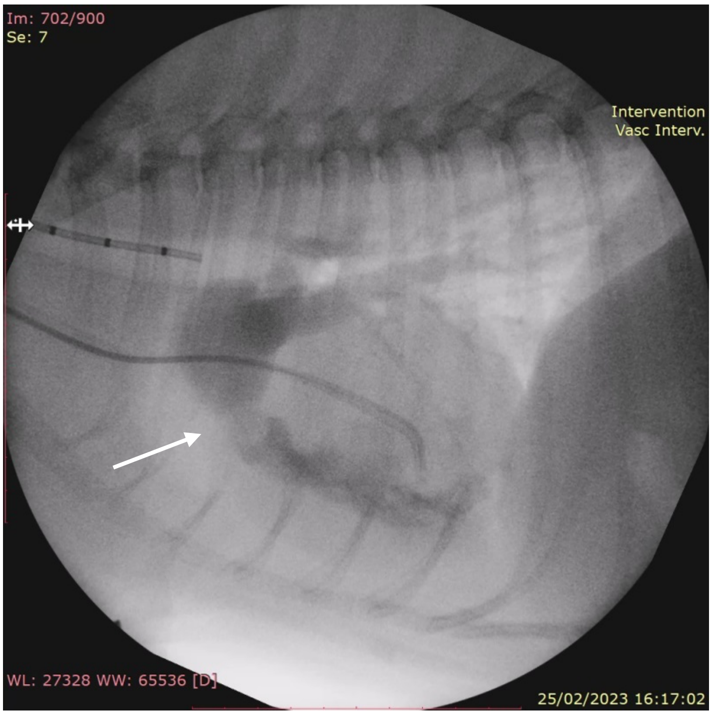


Fig. 5: Fluoroscopic image showing the angiogram taken during the procedure. The stenosis is indicated by an arrow (original)

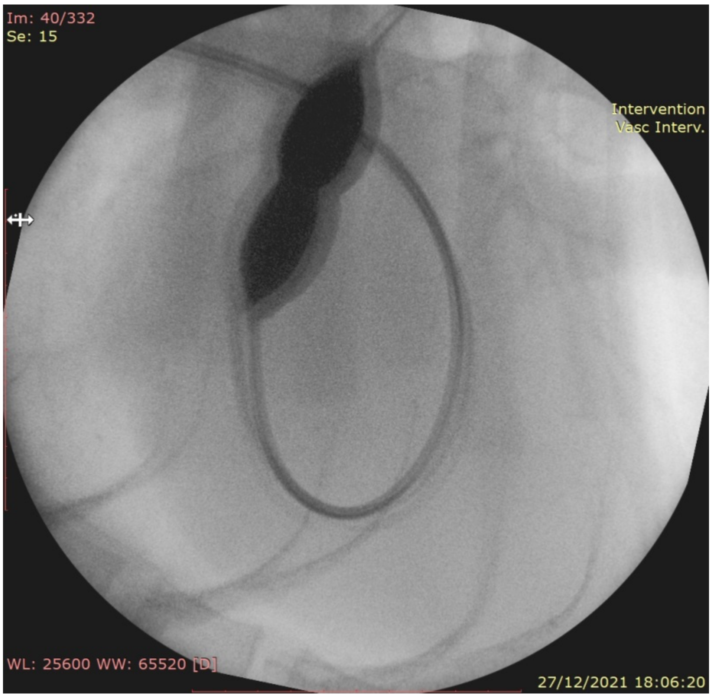


Fig. 6: Fluroscopic image showing the "waist" aspect of the pressure balloon when inflated at the level of the stenotic valve (original)

3. Results

Table 1. Echocardiographic values of each case, measured before and after the procedure

	Pulmonic valve peak pressure gradient before balloon valvuloplasty	Pulmonic valve peak velocity before balloon valvuloplasty	Pulmonic valve peak pressure gradient after balloon valvuloplasty	Pulmonic valve peak velocity after balloon valvuloplasty	Pressure peak gradient reduction percentage
Case 1	130,42 mmHg	5,71 m/s	82,81 mmHg	4,55 m/s	36,50 %
Case 2	123,21 mmHg	5,55 m/s	88,36 mmHg	4,7 m/s	28,28 %
Case 3	212,58 mmHg	7,29 m/s	194,88 mmHg	6,98 m/s	8,32%
Case 4	172,11 mmHg	6,56 m/s	85,75 mmHg	4,63 m/s	50,17 %

Three patients who underwent balloon valvuloplasty showed a reduction in pressure gradient between 28 and 50 percent. This reduction was also associated with an improvement in clinical signs, in 2 of these patients the symptomatology completely resolved, while another patient continued to show episodes of lipotimia/syncope with onset triggered by hyperadrenergic episodes.

For the other patient, balloon valvuloplasty did not reduce significantly the pressure gradient of the stenotic valve. The patient continued to present clinical signs of syncope/lipothymia and cardiac medication was maintained.

Discussions

Balloon valvuloplasty, while generally considered safe, is not without risks. Although complications were rare in our group, it is important to recognize that balloon valvuloplasty carries risks, such as arrhythmias or valvular rupture.

Ventricular premature complexes (VPCs) were commonly observed during right heart catheterization. In one case, however, a severe bradycardia occurred immediately after balloon dilatation.

The patient exhibited a favorable response to atropine, and anesthesia recovery proceeded uneventfully, with no subsequent complications."

A key post-procedural pitfall was the difficulty in ensuring timely ultrasound follow-ups, not necessarily due to lack of compliance, but rather due to the considerable distance that owners were required to travel.

The outcome of the procedure depends on many factors. As regards clinical evolution, it is necessary to take into consideration: age of the subject, degree of right ventricular hypertrophy, presence of fibrosis, possible concomitant tricuspid regurgitation.

As far as the dilation of the stenotic valve and the reduction of the transvalvular peak velocity are concerned, it is necessary to consider the type of stenosis (A. B or mixed form), the level of fibrosis of the valvular leaflets and any dynamic components of the stenosis as well as the concomitant presence of stenosing elements above or below the valve.

As regards the balloons used, it is important to evaluate the balloon diameter/valve diameter ratio. The use of compliant or non-compliant balloons, inflation of the balloon manually or with an inflator device and pressure reached inside the balloon are critical factors that influence procedural success and the possible risk of complications such as balloon rupture.

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