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*Comunidad Educativa al Servicio del Pueblo*

## UNIDAD ACADÉMICA DE POSGRADO

## MAESTRÍA EN MEDICINA VETERINARIA, MENCIÓN CLÍNICA Y CIRUGÍA DE PEQUEÑAS ESPECIES

# VALVULAR MANIFESTATIONS IN TETRALOGY OF FALLOT: CASE REPORT IN A CANINE

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**AUTOR: MVZ. JOSUÉ SANTIAGO SALGADO MORALES**

**TUTOR: DR. EDY PAÚL CASTILLO HIDALGO, PhD.**

**CUENCA - ECUADOR**

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**DIOS, PATRIA, CULTURA Y DESARROLLO**

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El informe de investigación “Valvular manifestations in Tetralogy of Fallot: Case report in a canine de autoría del Sr. “Josué Santiago Salgado Morales” con número de identidad 0105251219, con nacionalidad ecuatoriana, previo a la obtención del Título de Cuarto Nivel o Posgrado correspondiente a Magister en Medicina Veterinaria: Mención clínica y cirugía de pequeñas especies, cumple con la caracterización y estructura (parte protocolaria y parte expositiva) y se sujeta a la normativa pertinente exigida por el Consejo de Educación Superior, CES y la Universidad Católica de Cuenca, en consecuencia se autoriza su presentación para los trámites pertinentes.

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| Asesor Científico | Asesor Metodológico |

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**Josué Santiago Salgado Morales** portador de la cédula de ciudadanía Nº **0105251219**. Declaro ser el autor de la obra: "**Valvular Manifestations in Tetralogy of Fallot: Case report in a canine"**, sobre la cual me hago responsable sobre las opiniones, versiones e ideas expresadas. Declaro que la misma ha sido elaborada respetando los derechos de propiedad intelectual de terceros y eximo a la Universidad Católica de Cuenca sobre cualquier reclamación que pudiera existir al respecto. Declaro finalmente que mi obra ha sido realizada cumpliendo con todos los requisitos legales, éticos y bioéticos de investigación, que la misma no incumple con la normativa nacional e internacional en el área específica de investigación, sobre la que también me responsabilizo y eximo a la Universidad Católica de Cuenca de toda reclamación al respecto.

Cuenca, **04 de diciembre del 2024**

F: ……..

**Josué Santiago Salgado Morales**

C.I. **0105251219**

## Agradecimiento

Primero a Dios, por brindarme fortaleza, sabiduría y perseverancia para poder culminar un escalón más de mi crecimiento profesional y personal.

A mi hermoso hijo Yoshua, porque está en mi ser tu ejemplo de vida para que seas determinado en tus metas y tu proyecto de vida tanto profesional como persona. Fuiste, eres y serás mi mejor inspiración.

A mi querida madre Jeimmy Morales; por heredarnos tu ejemplo de fuerza, valentía, resistencia, perseverancia y darnos la mejor enseñanza de vida de no rendirnos nunca por más difícil que sea la situación y seguir nuestros sueños, gracias a todo ello volaremos alto. Y este título es gracias a ti.

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A todos aquellos familiares y amigos que con su aliento y apoyo me permitieron llegar a cumplir una meta más, profundamente agradecido.

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Josué Santiago Salgado Morales

## Dedicatoria

Este trabajo está dedicado, ante todo, a Dios, quien ha sido mi guía constante a lo largo de este trayecto. A mi amado hijo, cuya presencia me da fuerzas infinitas, a mi madre, a mis dos hermanas y a todas las personas que han sido un pilar inquebrantable en mi vida.

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**Abstract**

Tetralogy of Fallot is a congenital cardiac anomaly that can be associated with other heart diseases, such as atrioventricular valve insufficiencies. To characterize the structural and conduction changes related to valvular insufficiency in patients with Fallot tetralogy in Cuenca, Azuay-Ecuador. This study describes the case of a juvenile female canine who presented syncope episodes and exercise intolerance. The canine was referred to the cardiology service for echocardiography and electrocardiography evaluation. An echocardiogram was performed to evaluate the right and left hemicardium, valves, ejection and shortening fractions, and systolic and diastolic function. An electrocardiogram was performed to assess the heart's electrical activity and detect the presence of cardiac arrhythmias. The echocardiography examination revealed tricuspid and mitral valve insufficiency, along with tetralogy of Fallot. The electrocardiography examination showed the presence of pulmonary P waves, first and second-degree sinoatrial blocks, and a complete third-degree right bundle branch block

**Resumen**

La Tetralogía de Fallot es una anomalía cardíaca congénita que puede presentarse con otras cardiopatías, como las insuficiencias valvulares auriculoventriculares. Caracterizar los cambios estructurales y de conducción en relación con la insuficiencia valvular en pacientes con tetralogía de Fallot en la ciudad de Cuenca, Azuay-Ecuador. Este studio describe el caso de una paciente canina juvenil que acude a consulta general por presentar episodios de síncope e intolerancia al ejercicio. La paciente es remitida al servicio de cardiología para una evaluación de ecocardiografía y electrocardiografía. Se realizó un ecocardiograma para evaluar el hemicardio derecho e izquierdo, las válvulas, fracciones de eyección y acortamiento, así como la función sistólica y diastólica. También se utilizó un electrocardiograma para valorar la actividad eléctrica del corazón y detectar la presencia de arritmias cardíacas. El estudio ecocardiográfico reveló insuficiencia valvular tricuspídea y mitral, junto con la tetralogía de Fallot. El electrocardiograma mostró la presencia onda P pulmonale, bloqueos sinoauriculares de primer y segundo grado, así como un bloqueo completo de la rama derecha de tercer grado.

## Índice de Contenido

Tetralogy of Fallot is a congenital heart disease characterized by the combination of a ventricular septal defect, right ventricular hypertrophy, aortic extraposition and pulmonary stenosis (Chetboul et al., 2016; Veen et al., 2022). Its prevalence in dogs varies between 0.5% and 5.1% (Kim et al., 2022; Sarikan, 2022; Veen et al., 2022). Clinically, it manifests with cyanosis, hypoxia and an intense cardiac murmur (Malcolm & Saunders, 2024; Veen et al., 2022) and is associated with a high mortality rate.

Genetic studies have identified isolated conotruncal defects, with hypotheses that include genetic interference or chromosomal microdeletions. The expression of these defects often requires the presence of alleles at locus pairs (Birincioglu et al., 2020; Petra et al., 2005).

Tetralogy of Fallot has been documented in several species, including canines, felines, rats, bovines, camelids and beavers (Emerson et al., 2017; Laniesse et al., 2014; Pazzi et al., 2014). Research has shown that the average lifespan in dogs and cats with this pathology is 23.4 months. A survival rate mean of 3.4 months has been observed in those without a cardiac murmur, in contrast to 16.4 months in those with a cardiac murmur (Chetboul et al., 2016).

A comprehensive analysis of the clinical history (Birincioglu et al., 2020; Durham, 2019) along with complementary tests (Karissara et al., 2021; Weder et al., 2016) and other relevant factors, will facilitate the evaluation of the predisposition to develop cardiac comorbidities and their interaction with the tetralogy of Fallot.

This study is classified as a clinical case. The patient was referred to the veterinary cardiology service CARDIOMEDICC in Cuenca. The diagnosis was made by clinical evaluation and complementary tests.

**Clinical evaluation:** A mixed-breed female dog, aged one year and four months, weighing 10.2 kg, was evaluated. The patient showed exercise intolerance and episodes of syncope and heart murmur. A heart murmur with an intensity of 5/6 was identified during the evaluation. Despite the presence of the murmur, cardiological studies did not reveal significant alterations indicating the need for pharmacological treatment. However, surgery was recommended to correct the tetralogy of Fallot. A year later, the patient's death was confirmed.

**Electrocardiographic Evaluation:** An electrocardiogram was performed using the INcardio ICXV1.0 veterinary device, which provides 12 derivatives with a recording duration of 5 minutes. The electrocardiographic analysis revealed the presence of frequent sinoatrial blocks, with an irregular presentation and second-degree sinoatrial blocks. It was observed that the supraventricular electrical axis remained within average values, although a P wave voltage, consistent with P pulmonale, was detected. A severe right axis deviation was identified in the ventricular electrical axis, evidenced by an S-type QRS complex in lead DII and a prominent negative deflection in leads DI, DII, DIII, aVF and precordial V2 to V6. Additionally, findings included P pulmonale, first- and second-degree sinoatrial blocks, and a complete third-degree right bundle branch block (Fig. 1).

**Echocardiographic Evaluation:** A veterinary echocardiography, Esaote Bissosound My Lab 30, was used for the evaluation. Left Heart Chambers: A decrease in the left ventricular chamber's internal dimension and moderate interventricular septum hypertrophy were observed. Right Heart Chambers: Evaluation revealed mild to moderate dilatation of the right heart chambers, with moderate to severe thickening of the ventricular wall and a moderate increase in the internal dimension of the chamber (Fig. 2). Mitral Valve: Valvular thickening was detected, confirming mild mitral valve insufficiency (Fig. 3). Tricuspid Valve: Mild to moderate tricuspid insufficiency was evidenced (Fig. 2). Interventricular Septum: A loss of continuity was identified in the septum proximal to the aortic valve, with turbulent right-to-left flow and an approximate pressure gradient of 19.6 mmHg (Fig. 4), consistent with a perimembranous interventricular septal defect (Fig. 5). Aortic Valve: The aortic valve presented a bicuspid morphology, and along with the aorta, was shifted to the right (Fig. 6). Anterograde flow was laminar. Pulmonary Valve: Severe hypoplasia of the pulmonary valve ring was observed. Doppler evaluation revealed systolic turbulent flow with an approximate gradient of 128.3 mmHg, consistent with severe type B pulmonary stenosis (Fig. 7). The echocardiographic evaluation confirmed the presence of tetralogy of Fallot, with mild to moderate tricuspid valve insufficiency and mild mitral valve insufficiency.

Congenital heart disease affects approximately 3% of the canine population. The incidence of Tetralogy of Fallot ranges from 0.6% to 6.9% (Kim et al., 2022; Patterson, 1968; Veen et al., 2022). This condition is significantly more prevalent in purebred dogs,

with an incidence of 0.89%, compared to mixed-breed dogs, which present an incidence of 0.26% (Hoffman & Kaplan, 2002).

In dogs, Tetralogy of Fallot has been reported in a variety of breeds, including Akita, Poodle (Patterson, 1968), German Shepherd (Lucina et al., 2021; Malcolm & Saunders, 2024), Maltese (Chetboul et al., 2016; Park et al., 2020), Alaska Malamute, Bulldog (Chetboul et al., 2016; Sarikan, 2022; Veen et al., 2022), Keeshond (Patterson et al., 1974, 1993; Patterson, 1968; Petra et al., 2005; Sarikan, 2022), Terrier mongrel (Tou et al., 2011), Pomeranian mongrel (Chung et al., 2018; Patterson, 1968), Chihuahua (Chetboul et al., 2016; Patterson, 1968; Weder et al., 2016), Labrador retriever (Fukushima et al., 2013), Sussex Spaniel (Brockman et al., 2007), Beagle (Paslawska et al., 2013; Patterson, 1968; Weder et al., 2016), Jack Russell Terrier, Border Terrier, Boxer (Chetboul et al., 2016; Patterson, 1968), Cane Corso (Chetboul et al., 2016), Dachshund, Shiba Inu, Bernese Mountain Hound, Bavarian Mountain Hound, Airedale Terrier, Havanese (Paslawska et al., 2013), Bull Dog Frances (Patterson, 1968) and mixed-breed dogs without breed lineage (Case Reported).

The association of tetralogy of Fallot with other congenital or acquired malformations has been documented (Lucina et al., 2021). In the case presented, tetralogy of Fallot was observed concomitant with tricuspid valve insufficiency and mitral valve insufficiency. These findings are congruent with previous studies that reported the following prevalence of associated malformations: subvalvular stenosis in 32%, valvular stenosis in 29%, supravalvular stenosis in 29%, and combinations of subvalvular and valvular stenosis in 14%, subvalvular and supravalvular in 4%, and a combination of the three forms in 18%. In addition, hypoplasia of the pulmonary trunk was present in 36% of the reported cases (Chetboul et al., 2016).

In approximately 76% of patients with Tetralogy of Fallot, normal physiological rhythms are observed (Lucina et al., 2021). However, several electrocardiographic abnormalities were documented in this case, including sinus tachycardia, mitral and pulmonary P waves, left ventricular hypertrophy, and a third-degree incomplete right bundle branch block. Significant electrocardiographic changes were also evidenced, such as a pronounced increase in R-wave amplitude, deep Q-waves in leads I and III, and ST-segment elevation, indicative of myocardial hypoxia (Sindhu et al., 2022). On the other hand, the literature has reported the presence of sinus tachycardia and, in advanced stages,

right ventricular wall hypertrophy. In these cases, an increase in the S wave amplitude in leads I, II and III and an apparent rightward shift of the cardiac axis were observed (Paslawska et al., 2013).

It has been reported that 68% of patients with tetralogy of Fallot do not require medical treatment due to the absence of significant functional alterations, which is consistent with the evaluation of untreated patients (Chetboul et al., 2016). Similarly, in our case, no significant functional changes were observed to justify medical intervention.

Regarding surgical approaches, various techniques have been employed, such as the modified Blalock-Taussig shunt (mBT), Potts anastomosis and Waterston anastomosis (Chung et al., 2018). Reports suggest a significant improvement in the clinical status of patients between 24 and 36 months after surgical correction of the defects (Meca et al., 2020; Weder et al., 2016). The modified Blalock-Taussig shunt (mBT) has demonstrated prolonged survival in patients for up to 6 years (Brockman et al., 2007; Meca et al., 2020; Weder et al., 2016), although challenges have also been reported in patients with meagre body weight.

The average survival interval from birth to death in patients with tetralogy of Fallot is estimated to be approximately 23.4 months, with variations between species. It has been observed that animals without or with low-grade murmurs have shorter survival, averaging 3.4 months, compared to those with more noticeable murmurs, who have an average survival of 16.4 months. Consistent with these findings, our patient survived for 12 months (Chetboul et al., 2016).

Tetralogy of Fallot is a congenital heart disease that can be associated with other anomalies, primarily valvular defects such as stenosis and insufficiencies, which contribute to significant structural, hemodynamic and electrical alterations. Clinically, it manifests with exercise intolerance and cyanosis, with heart murmur being a prevalent distinguishing sign. The treatment for this condition is surgical correction by a modified Blalock-Taussig shunt, which has proven effective in improving the affected patients' prognosis and quality of life.

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**Conflict of Interest**

The authors declared no conflicts of interest.

**Ethical Statement**

This study does not present any ethical concerns.

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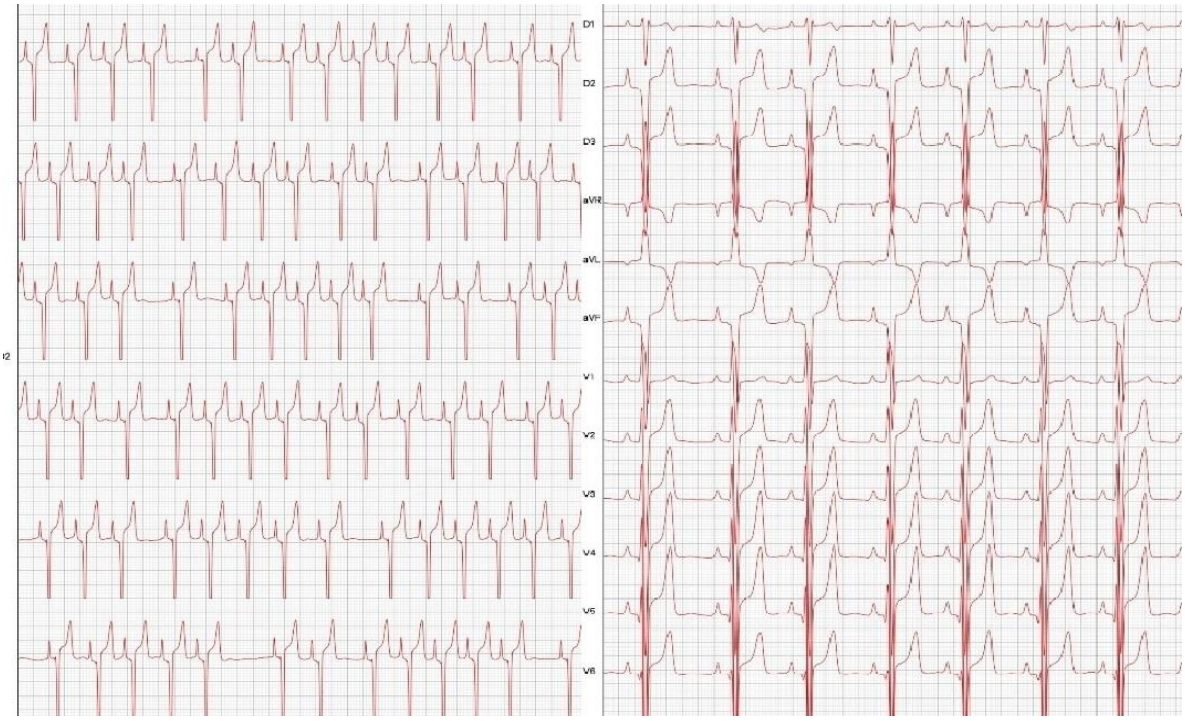

**Figure 1. The electrocardiography study evidenced the presence of a pulmonary P wave, first— and second-degree sinoatrial blocks, and a second-degree right bundle branch block.**

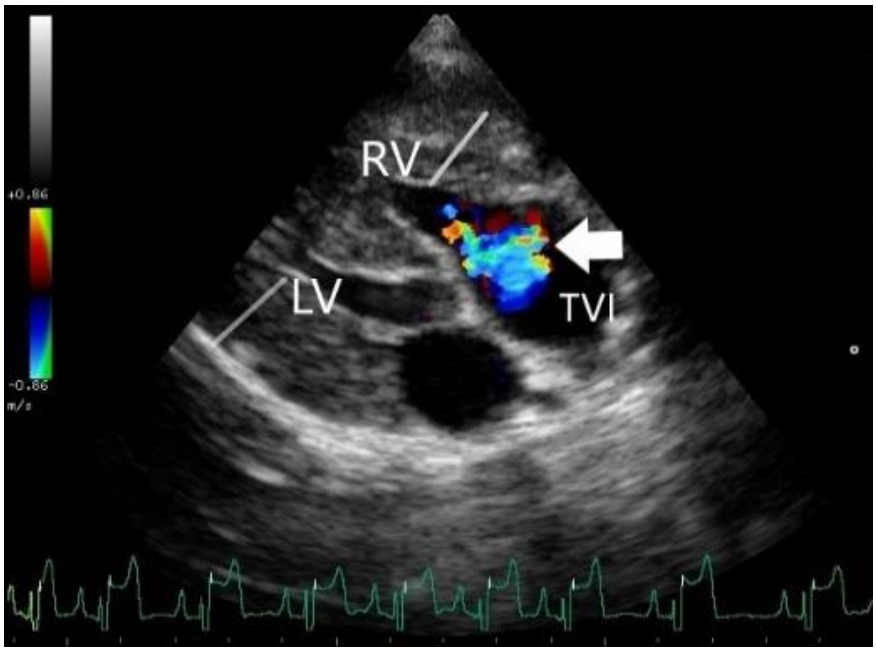


**Figure 2. Right parasternal longitudinal four-chamber view**.
There is evidence of right ventricular hypertrophy and mild to moderate tricuspid valve insufficiency. RV: Right Ventricle; LV: Left Ventricle; TVI: Tricuspid Valve Insufficiency.

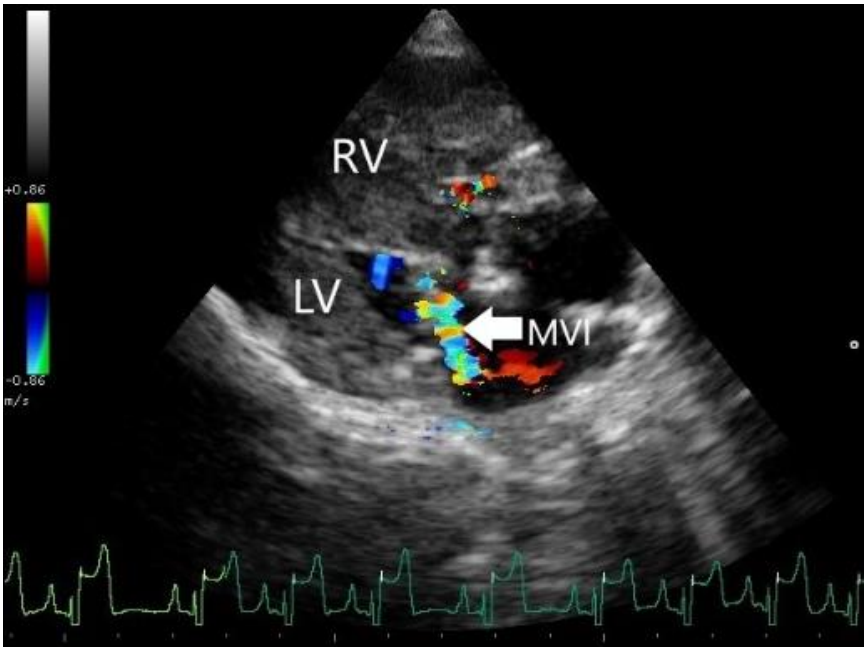


**Figure 3. Right parasternal longitudinal four-chamber view.**
Mild mitral valve insufficiency is evidenced. RV: Right Ventricle, LV: Left Ventricle, MVI: Mitral Valve Insufficiency.

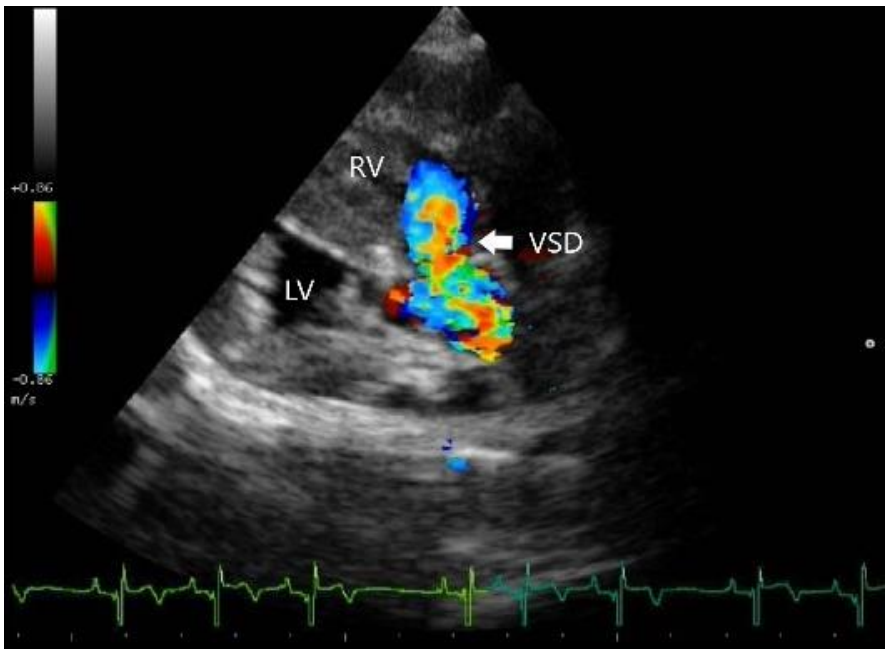


**Figure 4. Right parasternal longitudinal five-chamber view.**
Turbulent reflux with Doppler through the ventricular septal defect. RV: Right Ventricle, LV: Left Ventricle, VSD: Ventricular Septal Defect.

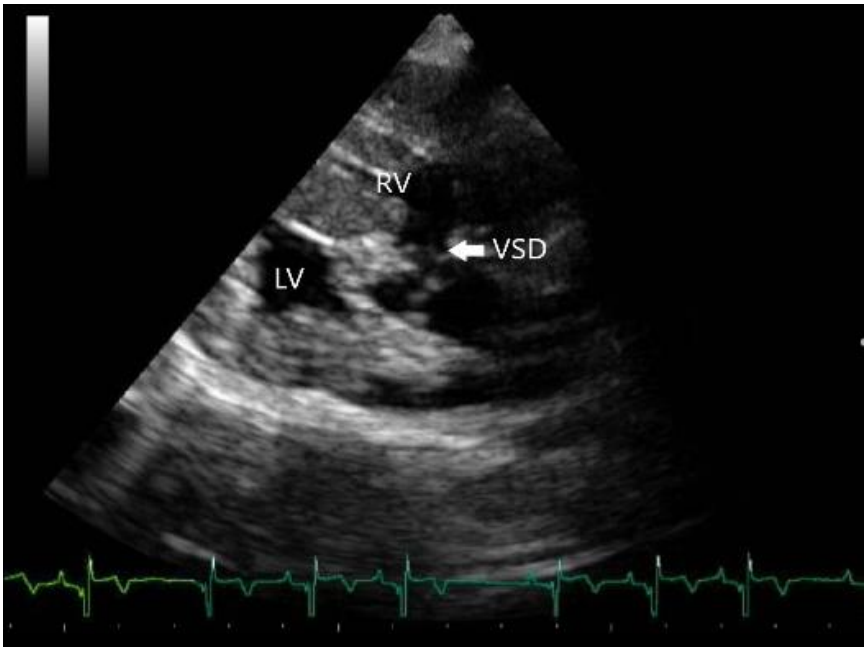


**Figure 5. Right parasternal longitudinal five-chamber view**.
The interventricular septal defect is evidenced. RV: Right Ventricle, LV: Left Ventricle, VSD: Ventricular Septal Defect.

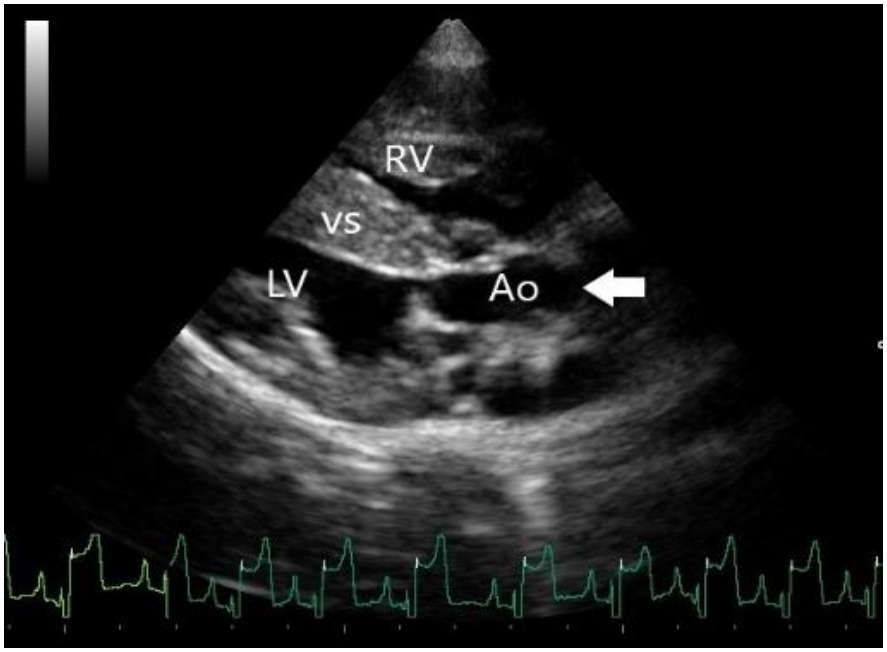


**Figure 6. Right parasternal longitudinal five-chamber view.**
The extraposition of the aorta is evident. RV: Right Ventricle; LV: Left Ventricle; Ao: Aorta; VS: Ventricular Septum.

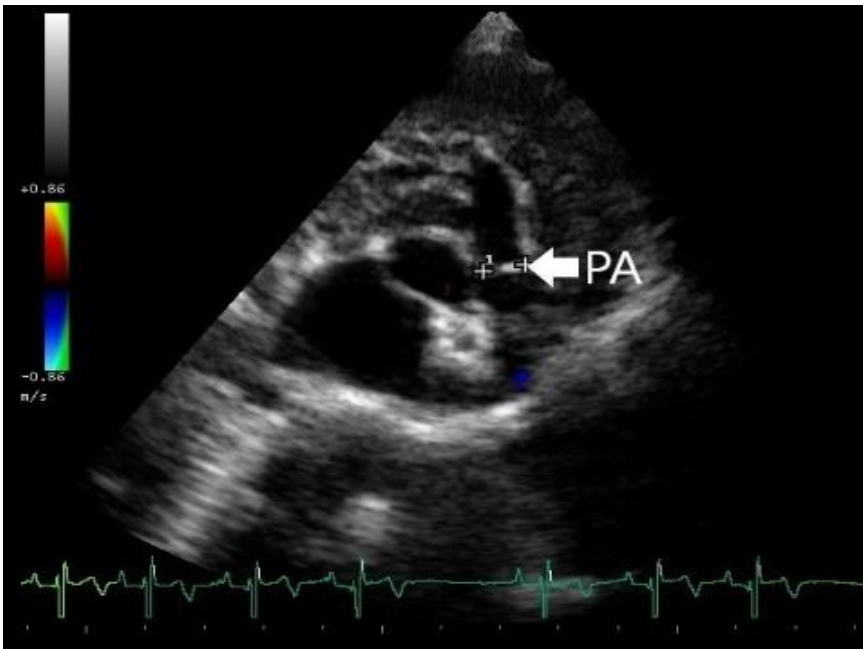


**Figure 7. Transverse right parasternal section of the heart base of the pulmonary artery.**

The pulmonary valve shows pulmonary type B stenosis. PA: Pulmonary Artery.