Use of Total Venous Inflow Occlusion to Enable Correction of an Atrial Septal Defect in a Dog

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ABSTRACT

Background: Atrial septal defects are generally classified into three types: ostium secundum, ostium primum, and sinus venosus. Diagnosis is normally confirmed with Doppler echocardiography, which can identify and classify atrial septal defects types. This cardiac anomaly may be corrected by different surgical approaches, such as cardiopulmonary bypass or transvenous approaches. Therefore, we chose to close the atrial septal defect using a total venous inflow occlusion technique (TIVO), which has been successfully used in other procedures without major postoperative complications, and are notably cheaper and requires no specialized equipment, been able to be done in different places.

Case: An American Pit Bull Terrier was referred to our surgical service for ostium secundum atrial septal defect correction, by the time of surgery the patient presented dyspneic; normal capillary refill time and rectal temperature; the owner mentioned the patient exhibited exercise intolerance and delayed development compared to other dogs of the same age or from the same litter. Cardiac auscultation revealed a systolic murmur at the left base, femoral pulse was normokinetic, and patient was emaciated and prostrated at the time of clinical evaluation. Atrial septal defect was suspected and then confirmed by Doppler echocardiography that revealed a discontinuous area in the interatrial septum, and by color doppler images an aliased signal, that extended through the interatrial septum and shunted from the left to the right atria, was visualized, confirming an ostium secundum atrial septal defect. After a right intercostal thoracotomy, a subphrenic pericardiectomy was performed to provide access to the heart. Cranial and caudal vena cava as well as the azygos vein, were dissected, which allowed placement of a Satinsky’s clamp to proceed with TIVO. Before TIVO initiation, a purse-string suture with 3-0 polypropylene was applied to the right atrium. Blood inflow was occluded, and an atriotomy was performed in the middle of the purse-string suture, allowing visualization of the atrial septal defect. Surgeon temporarily closed the interatrial orifice using another Satinsky’s clamp, a simple continuous suture with 2-0 polypropylene underneath the clamp was performed, in order to permanently close the atrial septal defect. Right atrium closure was then achieved by tying purse-string suture, previously inserted, and blood inflow was reestablished by removing the Satinsky’s clamps from the azygos vein, and cranial and caudal vena cava. TIVO time was 2 min and 40 s.

Discussion: Atrium septal defect generally occurs owing to over-absorption of the septum primum, or flawed development of the septum secundum. Ostium secundum atrial septal defect, reported in this case, was precisely corrected with TIVO and patient had an excellent outcome. The surgical approach was successfully done, which proves that open heart surgeries can be safely done with TIVO. This technique needs training of the surgical team but with planning it can be done with no major complications. Present report shows that even if specialized equipment such as cardiopulmonary bypass machine or fluoroscopy are not available, congenital heart shunts can be surgically repaired by open heart procedures with TIVO. This is an important factor because in Brazil only few centers have those equipment’s which hinders congenital heart anomalies correction.

Keywords: congenital heart defects, heart septal defects, cardiothoracic surgery, dog diseases, echocardiography.
INTRODUCTION

A survey of the total number of patients admitted to some veterinary hospitals shows that about 0.13% to 1.0% of cases are reported to have some type of congenital heart anomaly, and the most common diseases reported are patent ductus arteriosus, pulmonic stenosis, aortic stenosis, ventricular septal defects, and tetralogy of Fallot [2,11,13].

Atrial septal defects are less reported in veterinary medicine, and are classified into three types: ostium secundum, ostium primum, and sinus venosus. The most common type is ostium secundum, which is an anomaly located in the middle of the atrial septum, the same area of the fossa ovalis; it generally occurs owing to over-absorption of the septum primum, or flawed development of the septum secundum [4].

This malformation may be corrected by different approaches [4,5,9]. Therefore, we chose to close the atrial septal defect using a total venous inflow occlusion technique (TIVO), which has been successfully used in other procedures without major postoperative complications [6].

To our knowledge, TIVO has not yet been reported for the correction of an atrial septal defect. The present report describes a case of ostium secundum atrial septal defect in a dog, and the correction of this defect after TIVO for the first time in Brazil.

CASE

A 9-month-old American Pit Bull Terrier with a diagnosis of atrial septal defect was admitted to our surgical service. At the first appointment, at another veterinary hospital, the patient was dyspneic; the owner mentioned the patient exhibited exercise intolerance and delayed development compared to other dogs of the same age or from the same litter.

The patient exhibited normal capillary refill time and rectal temperature. Cardiac auscultation revealed a systolic murmur at the left base. The femoral pulse was normokinetic. The patient was emaciated and prostrated at the time of clinical evaluation.

Two-dimensional images, achieved by Doppler echocardiography, revealed a discontinuous area in the interatrial septum, which suggested presence of an atrial septal defect. Color doppler images allowed visualization of an aliased signal that extended through the interatrial septum (Figure 1), from the left to the right atria, which confirmed the presence of an ostium secundum atrial septal defect. The aliased signal, which was evident whether pulsed or continuous wave doppler was used, had a velocity of 1.17 m/s and a pressure gradient of 5.47 mmHg.

The surgical procedure selected in this case depended on TIVO. After a right intercostal thoracotomy, a subphrenic pericardiectomy was performed to provide access to the heart. The surgeon dissected the cranial and caudal vena cava as well as the azygos vein, which allowed placement of a Satinsky’s clamp to proceed with TIVO. Before clamping the veins, the surgeon applied a purse-string suture with 3-0 polypropylene to the right atrium to guarantee a fast and safe closure of the chamber after atrial septal defect correction. Blood inflow was occluded, and an atriotomy was performed in the middle of the purse-string suture, which allowed visualization of the atrial septal defect.

Figure 1. Atrial septal defect confirmed by color flow doppler. A- Atrial septal defect shown by color doppler in right parasternal short-axis view of the heart base (asterisk). B- Note discontinuity in the middle of the atrial septum (arrow).
Next, the surgeon temporarily closed the interatrial orifice using another Satinsky’s clamp, and then used a simple continuous suture with 2-0 polypropylene to permanently close the atrial septal defect, releasing the Satinsky’s clamp thereafter (Figure 2). Closure of the right atrium was achieved by tying the purse-string suture, previously inserted, and blood inflow was reestablished by removing the Satinsky’s clamps from the azygos vein, and cranial and caudal vena cava.

TIVO time was 2 min and 40 s. No major complications were observed; the patient exhibited bradycardia at the end of the inflow occlusion procedure, but this problem ceased five minutes after blood perfusion was reestablished.

DISCUSSION

The present case represents the most common form of atrial septal defect, which is a rare congenital heart disease in small animals. Ostium secundum atrial septal defect was precisely diagnosed by Doppler echocardiography, which is, in accordance to Silvestry et al. [14], the diagnostic test of choice for this condition. The color doppler pattern blood was flowing from the left to the right atrium, and two-dimensional ultrasound images showed a defect of about 14.3 ± 5.0 mm [2].

There are two standard surgical procedures to correct atrial septal defects: open heart procedures with cardiopulmonary bypass, and transvenous approaches, which are performed percutaneously. The first treatment choice, also known as open surgical procedure, is a more aggressive approach. This procedure allows the surgeon to directly visualize the defect and apply sutures to it, or use surgical materials such as bovine pericardium to close the defect. Cardiopulmonary bypass requires an extracorporeal machine and a perfusionist, which are not always available in veterinary medicine [1].

The percutaneous approach, also known as interventional cardiology procedure or minimally invasive surgical procedure, has some advantages compared to the open surgical procedure. However, performing this type of approach requires specialized medical equipment such as a fluoroscope. This equipment is very expensive and is not always available, especially in veterinary hospitals [3].

TIVO has been reported for different surgeries, all over the world, but we failed to find any report of the use of this technique to enable repair of atrial septal defects in veterinary medicine, which makes this a unique case report [1,8,10,15].

In humans, TIVO has been reported in the past, but it is not frequently used anymore because of the development of cardiopulmonary bypass, which allows more complex procedures with excellent outcomes [12]. The time limit when TIVO is performed is always a challenge because of the hemodynamic, metabolic and neurological effects of the procedure. [7].

This time limit is determined by neurological and cardiovascular consequences to the patient. In this case, we observed transient bradycardia at the end of TIVO, but the heart rate returned to normal five minutes after reestablishment of blood flow through the heart. No other complications were detected.

In the present case, TIVO was maintained by 2 min and 40 s. According to a review written by Griffiths [6], that is an excellent length of time to perform the procedure, which could be performed within up to eight minutes with mild or no complications.

Our group believes that this technique may not always be effective to correct atrial septal defects because of communication with the left side of the heart, which could cause major blood loss; however, in the present case, there were no major complications, and the patient could be discharged two days after surgery.
Based on this successful procedure, we believe that TIVO can be an alternative to enable correction of atrial septal defects, as no other option is viable in many veterinary hospitals.

Declaration of interest. The author’s report no financial or other conflicts related to this report.

REFERENCES


