



# Patent Ductus Arteriosus

## (Type of Heart Birth Defect)

### Basics

#### OVERVIEW

- “Patent” refers to “open”; “ductus arteriosus” is a blood vessel between the aorta (main artery of the body) and the pulmonary artery (main artery to the lungs) that allows blood flow to bypass the lungs in the fetus
- Following birth, the ductus arteriosus closes and seals off so that blood flows into the lungs, where it gets oxygen and allows carbon dioxide to be removed from the body
- “Patent ductus arteriosus” (PDA) occurs when the open blood vessel persists and does not close following birth; this allows continued blood flow between the aorta and the pulmonary artery, which leads to abnormal circulation of blood in the body
- Flow across a PDA is typically from the aorta to pulmonary artery (that is left to right flow)
- Much less frequently, a large-diameter PDA causes changes in the lungs (including high blood pressure in the lungs [known as “pulmonary hypertension”]), and reversal of blood flow occurs, leading to right to left flow; known as a “reversed” PDA
- Patent ductus arteriosus is the second most common congenital (present at birth) heart defect in dogs; estimated to be up to 2.5 cases per 1,000 live births
- Patent ductus arteriosus is a very uncommon heart defect in cats
- The heart of the dog or cat is composed of four chambers; the top two chambers are the right and left atria and the bottom two chambers are the right and left ventricles

#### GENETICS

- Genetically transmitted defect involving multiple genes (known as a “polygenic” condition) in many canine breeds, including the bichon frise, Cavalier King Charles spaniel, Chihuahua, collie, cocker spaniel, English springer spaniel, German shepherd dog, Maltese, miniature and toy poodle, Pomeranian, Shetland sheepdog, and others

#### SIGNALMENT/DESCRIPTION OF PET

##### Species

- Dogs
- Cats

##### Breed Predilections

- Many canine breeds, including the bichon frise, Cavalier King Charles spaniel, Chihuahua, collie, cocker spaniel, English springer spaniel, German shepherd dog, Maltese, miniature and toy poodle, Pomeranian, Shetland sheepdog, and others

##### Mean Age and Range

- Vast majority of affected pets are identified during examination for initial vaccinations

- Onset of signs related to congestive heart failure (CHF; signs such as cough, difficulty breathing, bluish discoloration of the skin and moist tissues [mucous membranes] of the body); “congestive heart failure” is a condition in which the heart cannot pump an adequate volume of blood to meet the body’s needs—weeks to many years of age

### **Predominant Sex**

- Dogs—females more likely to have patent ductus arteriosus than males in many (but not all) breeds

## **SIGNS/OBSERVED CHANGES IN THE PET**

- Most affected pets have no signs at initial examination
- Breathing distress
- Coughing
- Stunted growth in some pets
- Exercise intolerance; signs usually precipitated by or worsened by exercise
- Typically, continuous, machinery-type heart murmur loudest over pulmonary artery at the left base of the heart; the murmur in puppies less than 6 weeks of age or in cats of any age may not be obviously continuous
- Loud murmurs—may be able to feel vibrations caused by abnormal blood flow (known as “thrills”) when placing hand against the chest wall
- Jerky arterial pulses (known as “water hammer” pulses)
- Rapid breathing (known as “tachypnea”), breathing distress, and inspiratory short, rough snapping sounds (known as “crackles”) heard when listening to the chest with a stethoscope—may indicate left-sided congestive heart failure; congestive heart failure is a condition in which the heart cannot pump an adequate volume of blood to meet the body’s needs
- Rapid, irregular heartbeat, if atrial fibrillation develops; “atrial fibrillation” is a rapid, irregular heart rhythm involving the top two chambers of the heart (atria); atrial fibrillation is more common in larger breed dogs than small-breed dogs
- Onset of “reversed” PDA (in which blood flows from right to left)—quite sudden in dogs (usually before 4 months of age); can develop more gradually in cats
- In right-to-left shunting or “reversed” PDA—no continuous heart murmur is present and arterial pulses are normal; may have a heart murmur or abnormal heart sounds; may see a jugular pulse (in which the jugular vein pulsates)
- Classic feature of right-to-left shunting or “reversed” PDA is differential bluish discoloration of the skin and moist tissues (mucous membranes) of the body caused by inadequate oxygen levels in the red blood cells (known as “cyanosis”): with “reversed” PDA, the tissues near the head usually remain pink, while tissues toward the rear of the body have bluish discoloration (cyanosis)
- Right-to-left shunting or “reversed” PDA—exertional rear limb weakness and complications of increased red blood cell counts (known as “polycythemia”) and sludging of the blood (known as “hyperviscosity”), seizures, sudden death related to irregular heartbeats (known as “arrhythmias”), and blood clots that lodge in blood vessels (known as “emboli”)

## **CAUSES**

- Genetic in most cases

## **RISK FACTORS**

- Genetics in dogs
- Breed of dog
- Risk factors in cats are unknown

## **Treatment**

### **HEALTH CARE**

- Manage fluid buildup in the lungs (known as “pulmonary edema”) with medications to remove excess fluid from the body (known as “diuretics,” such as furosemide) and, if necessary, oxygen, medications to dilate blood vessels (known as “vasodilators,” such as nitrates), and cage rest
- Following stabilization, surgically correct the PDA promptly

- Can schedule stable pets for elective surgery or device closure; do not delay procedure—asymptomatic dogs as young as 7–8 weeks of age show no higher surgical mortality rates than older dogs
- Consider referral to a veterinary heart specialist (known as a “veterinary cardiologist”) for placement of a catheter-delivered device within the opening of the blood vessel to block blood flow through the PDA
- Application of an electrical shock to the chest (known as “electrical cardioversion”) to attempt to return the heart to normal rhythm may be considered in dogs with atrial fibrillation (rapid, irregular heart rhythm involving the top two chambers of the heart [atria]) following surgical correction of the PDA
- Dogs with increased red blood cell counts (polycythemia) caused by right-to-left shunting or “reversed” PDA—periodic phlebotomy (procedure in which blood is removed from the body via a vein) to maintain the packed cell volume (“PCV,” a means of measuring the percentage volume of red blood cells as compared to the fluid volume of blood) less than 65% (typically 62–65%)

## ACTIVITY

- Restrict activity until the patent ductus arteriosus is closed (see “Surgery”)
- Restrict activity if the pet is in congestive heart failure; congestive heart failure is a condition in which the heart cannot pump an adequate volume of blood to meet the body’s needs
- Normal activity may be resumed after the first examination and suture removal following closure of the patent ductus arteriosus, as directed by your pet’s veterinarian

## DIET

- Normal usually
- Restricted sodium intake, if pet is in congestive heart failure; congestive heart failure is a condition in which the heart cannot pump an adequate volume of blood to meet the body’s needs

## SURGERY

- Surgical closure of a PDA can be achieved through tying off the blood vessel after opening the chest (surgical opening of the chest known as a “thoracotomy”) to reach the location of the PDA or using a special lighted instrument called an “endoscope” (general term for procedure is “endoscopy”) to visualize the PDA
- Another technique is to place a catheter-delivered device within the opening of the blood vessel; the device is left in place to block blood flow through the ductus arteriosus; smaller pet size may be a limiting factor with ability to use currently available PDA devices
- Surgery generally can proceed within 24–48 hours of medical stabilization
- Following surgery, monitor incision for signs of infection; prevent biting, scratching, or licking of the incision (may require an Elizabethan collar)
- A right-to-left or “reversed” PDA should not be corrected surgically; the right ventricle will not be able to pump blood against the pressure within the blood vessels of the lungs, without the “pop-off valve” effect of the PDA

## Medications

Medications presented in this section are intended to provide general information about possible treatment. The treatment for a particular condition may evolve as medical advances are made; therefore, the medications should not be considered as all inclusive

- Treat fluid buildup in the lungs (pulmonary edema) with medications to remove excess fluid (medications known as “diuretics,” such as furosemide); diuretics can be discontinued when the PDA is corrected surgically
- When surgery is not an option—use medications to remove excess fluid (such as furosemide) and heart medications (such as enalapril and pimobendan) to control congestive heart failure; congestive heart failure is a condition in which the heart cannot pump an adequate volume of blood to meet the body’s needs
- When atrial fibrillation (rapid, irregular heart rhythm involving the top two chambers of the heart [atria]) has developed, add digoxin and diltiazem to the treatment protocol
- To control severe, life-threatening congestive heart failure—can use medications to enlarge or dilate blood vessels (vasodilators), such as hydralazine or sodium nitroprusside
- Prostaglandin inhibitors (such as indomethacin) do *not* close PDAs effectively in dogs and should not be used; prostaglandin inhibitors have been used in treatment of PDA in human infants—prostaglandins are substances that have numerous effects on body function; a prostaglandin is involved in keeping the ductus arteriosus open

during human fetal development, and the levels of the prostaglandin normally decrease after birth, allowing the blood vessel to close

- Consider hydroxyurea to treat severely increased red blood cell counts (polycythemia) unresponsive to phlebotomy (procedure in which blood is removed from the body via a vein)
- Medications to control pain (known as “analgesics”) should be administered following surgical correction or placement of catheter-delivered device for closure of the PDA

## Follow-Up Care

### PATIENT MONITORING

- Post-operative—monitor vital signs and difficulty breathing (dyspnea), which may be related to the presence of air in the space between the lungs and chest wall (condition known as “pneumothorax”)
- Listen to the heart with a stethoscope (known as “cardiac auscultation”) post-operatively and at suture removal; if sounds are normal, no further follow-up or diagnostic studies may be required
- Persistent, continuous murmur indicates either incomplete closure of the ductus arteriosus, reopening of the PDA (rule out infection or device migration), or a coexistent heart defect
- Systolic heart murmurs variably heard post-operatively should resolve by time of suture removal; reinvestigate unexpected heart murmurs by performing a Doppler echocardiogram (use of ultrasound to evaluate the heart and major blood vessels)
- Sudden (acute) illness, fever, or breathing difficulties (dyspnea) post-operatively—consider bacterial infection of the closure site with pneumonia; aggressive antibiotic therapy is needed

### PREVENTIONS AND AVOIDANCE

- Do not breed affected pets

### POSSIBLE COMPLICATIONS

- Left-sided congestive heart failure; congestive heart failure is a condition in which the heart cannot pump an adequate volume of blood to meet the body’s needs
- Irregular heartbeats (arrhythmias)
- Blood-vessel disease in the lungs with high blood pressure (pulmonary hypertension), right-to-left or “reversed” blood flow through the PDA, exercise intolerance, and increased red blood cell counts (polycythemia)
- Reopening of the ductus arteriosus, following corrective procedures (surgery or catheter-delivered device)
- Problems with the catheter-delivered device (such as the device moving from its desired location or infection)
- Death

### EXPECTED COURSE AND PROGNOSIS

- Infrequently dogs may not have any clinical signs during their life
- Unless the PDA is corrected (surgery or catheter-delivered device), approximately 50% to 60% of dogs die from congestive heart failure within 1 year of diagnosis; congestive heart failure is a condition in which the heart cannot pump an adequate volume of blood to meet the body’s needs
- Surgery performed prior to onset of moderate-to-severe congestive heart failure—excellent prognosis overall; approximately 3% of affected pets die during surgery or in the post-operative recovery period in hospitals with veterinarians experienced in performing the corrective procedures
- Moderate-to-severe congestive heart failure related to failure of the muscle of the left ventricle or atrial fibrillation (rapid, irregular heart rhythm involving the top two chambers of the heart [atria])—guarded prognosis; consider referral to a veterinary heart specialist (veterinary cardiologist)
- Dogs with right-to-left or “reversed” PDA can live for several years, but often die suddenly; occasionally, dogs live beyond 5 years of age (especially cocker spaniels)
- Cats—varies from rapidly progressive left-sided congestive heart failure to gradual development of blood-vessel disease in the lungs; even right-sided congestive heart failure can develop in some of these cats

## Key Points

- Do not delay corrective procedures (surgery or catheter-delivered device) for treatment of patent ductus arteriosus

- Following successful closure of the PDA and a 2-week convalescence, the dog can be treated normally

## Notes

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