# Occlusion of a patent ductus arteriosus using an Amplatzer vascular plug II in a kitten

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## Verschluss eines offenen Ductus arteriosus bei einer Katze mit einem Amplatzer vascular plug II

Eine fünf Monate alte Katze wurde zum kathetergestützten intravaskulären Verschluss eines offenen *Ductus arteriosus* (PDA) eingeliefert. In Anbetracht der geringen Grösse des Patienten und der Femoralarterie wurde ein transvenöser Zugang über die Femoralvene versucht. Der PDA konnte mit einem Embolisationsapparat namens Amplatzer vascular plug II erfolgreich verschlossen werden. Dieses Gerät kann mit Hilfe eines Katheters, der durch die kaudale *Vena cava,* den rechten Vorhof und die rechte Herzkammer sowie die Lungenarterie bis zum PDA geführt werden muss, retrograd über das Venensystem eingesetzt werden. Der Eingriff wurde unter fluoroskopischer und transösophagealer echokardiographischer Kontrolle durchgeführt. Die Katze erholte sich problemlos von dem Eingriff und konnte am folgenden Tag entlassen werden. Die transvenöse Embolisation von PDA kann auch bei kleinen Patienten oder Tieren mit vergleichsweise kleinen peripheren Arterien, wie Katzen, erfolgreich durchgeführt werden.

**Schlüsselwörter:** Herz, kongenital, Echokardiographie, Katze, mini-invasiv, Shunt

## Summary

A five-month-old kitten has been admitted to catheter assisted intravascular occlusion of a patent ductus arteriosus (PDA). Considering the small size of the patient, and of the femoral artery, a transvenous approach through the femoral vein was attempted. The PDA could be successfully occluded using an embolization device called Amplatzer vascular plug II. This device can be deployed retrogradely through the venous system, using a catheter, that must be passed through the caudal vena cava, right atrium and ventricle, and pulmonary artery, reaching the PDA. The intervention was assisted by fluoroscopic and transesophageal echocardiographic guidance. The cat recovered uneventfully from the procedure, and it was discharged the following day. Transvenous embolization of PDA can be successfully performed also in small patients or animals with comparably small peripheral arteries, like cats.

**Keywords:** Cardiac, congenital, echocardiography, feline, mini-invasive, shunt

## Short communication

A five-month-old European short hair cat was referred for assessment of a heart murmur. The cat was asymptomatic at the time of the examination. A grade 5/6 continuous left sided heart murmur was detected, in absence of other clinical abnormalities. The femoral pulse was strong, with a pulse rate of 160/minute. A transthoracic echocardiography was performed, showing evidence of subjectively moderately dilated left ventricle and atrium (left atrial maximal diameter: 20 mm), with normal left ventricular systolic function and mitral valve (Figure 1A). On right parasternal short axis view, a patent ductus arteriosus (PDA) was suspected based on two-dimensional images. On color Doppler examination a continuous flow across the PDA, with a left-to-right shunt, confirmed the diagnosis (Figure 1B). A mild mitral valve insufficiency was also detected, secondary to volume overload due to the PDA. No other abnormalities were found. The owners were given the option of an intravascular embolization or a surgical ligation through thoracotomy, and they decided for the former. Four weeks after the initial consultation, a mini-invasive occlusion of the PDA was planned. At that time the cat's body weight was 3.2 kg. The cat was anesthetized and placed in right lateral recumbency, and the right femoral vessels were accessed by a cut-down. Due to the small size of the femoral artery, the

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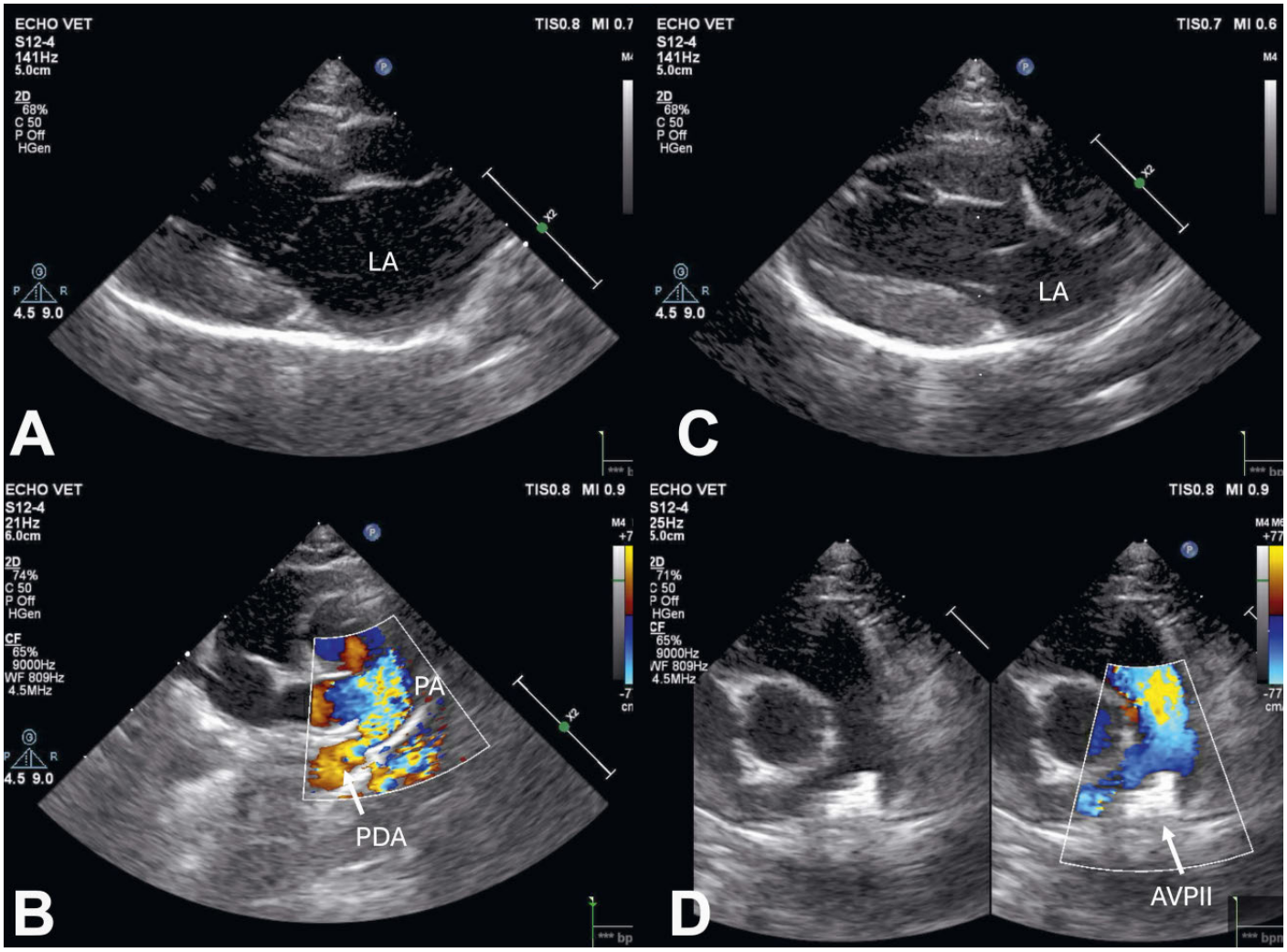


**Figure 1:** Transthoracic echocardiographic images obtained before (A and B), and after (C and D) the occlusion of a PDA in a kitten. On the upper panels the heart is displayed from a right parasternal long axis view. A: the LA appears subjectively dilated before the intervention (20 mm). C: few hours after the occlusion of the PDA, the LA shows already a significant reduction in diameter (13 mm), with a subjective normalization of its volume. On the lower panels the heart and PDA are displayed with a right parasternal short axis view at basilar level. B: the PDA appears as a tubular structure with a funnel shape (arrow). On color Doppler examination a turbulent flow from the PDA to the main PA is visible. D: combined two-dimensional grey scale and color Doppler images of the PDA after occlusion with an AVPII. The AVPII appears in place into the PDA ampulla (arrow), with no evidence of residual shunt across the PDA. AVPII: Amplatzer vascular plug II; LA: left atrium; PA: pulmonary artery; PDA: patent ductus arteriosus.

femoral vein was prepared for cardiac catheterization by use of a modified Seldinger technique. Briefly the vein was punctured using a 20G over the needle catheter, a soft (0.025") 45 cm long guidewire was used to exchange the catheter with a 4 French vascular introducer (Radifocus® introducer II, Terumo GmbH, Eschborn, Bodenäckerstrasse 3, 8957 Spreitenbach, Switzerland). A transesophageal echocardiography was performed with a pediatric probe (Philips EPIQ 7, Philips AG, Seestrasse 87, 8810 Horgen, Switzerland). The PDA had a funnel-shaped ampulla, with a minimal duct diameter of 1,3 mm and a maximal ampullar diameter of 4 mm. A continuous shunting flow was evident through the PDA on color Doppler (Figure 2A).

Under fluoroscopic guidance, the PDA was catheterized retrogradely using a 65 cm, 4 French main pulmonary artery catheter (MP A1, Cordis Germany GmbH, Südportal 1, 22848 Norderstedt, Germany), passing through the caudal vena cava, right atrium, right ventricle, pulmonary artery, PDA and ending into the descending aorta. A (0.035") 145 cm long guidewire (Amplatz support wire guide, Cook Switzerland AG, Landenbergstrasse 34, 6005 Luzern, Switzerland) was used to exchange the pulmonary artery catheter and the short introducer with a 4 French, 55 cm long sheath (Flexor® Check-Flo® Introducer, Cook Switzerland AG, Landenbergstrasse 34, 6005 Luzern, Switzerland), that was placed with the tip into the descending aorta. Based on the transesophageal echocardiographic finding, an Amplatzer vascular plug II (AVPII) with a width and a length of 6 mm (Amplatzer™ Vascular Plug II, Abbott Vascular International BVBA, Culliganlaan 2B, 1831 Diegem, Belgium) was chosen. The AVPII, attached to a delivery cable, was loaded into the sheath. The first (distal) disc of the AVPII was opened into the aortic lumen, then the entire sheath and AVPII were retracted, and the central component of the device was left opening into the ampulla of the PDA, finally the device was secured by further retraction of the sheath and deployment of the last (proximal) disc into the pulmonary artery lumen. Secure position of the AVPII was determined by gentle push and pull manipulation of the delivery cable. Positioning of the device, patency of the right and left pulmonary artery, and complete shunt occlusion was verified by transesophageal echocardiography (Figure 2B and 3). The cat was administered peri-operatively cephalexin (Kefzol®, 100 mg/ml, Teva Pharma AG, Basel, 30 mg/kg i.v.) every 90 minutes. The procedure, from the initial incision to the final suture, lasted 50 minutes. Recovery from the anesthesia was uneventful. After successful deployment of the device no heart murmur was present at cardiac auscultation. At control transthoracic echocardiography, performed few hours after the intervention, the left heart appeared already smaller (left atrial maximal diameter: 13 mm), the AVPII appeared correctly in place, and no rest-shunt could be detected on color Doppler (Figure 1C and D).

Patent ductus arteriosus is one of the most common cardiovascular malformations in dogs, but less prevalent in cats (0.2 cases per 1000 cats).[5,7] It originates from the lack of closure of the ductus arteriosus, that connects the aorta and

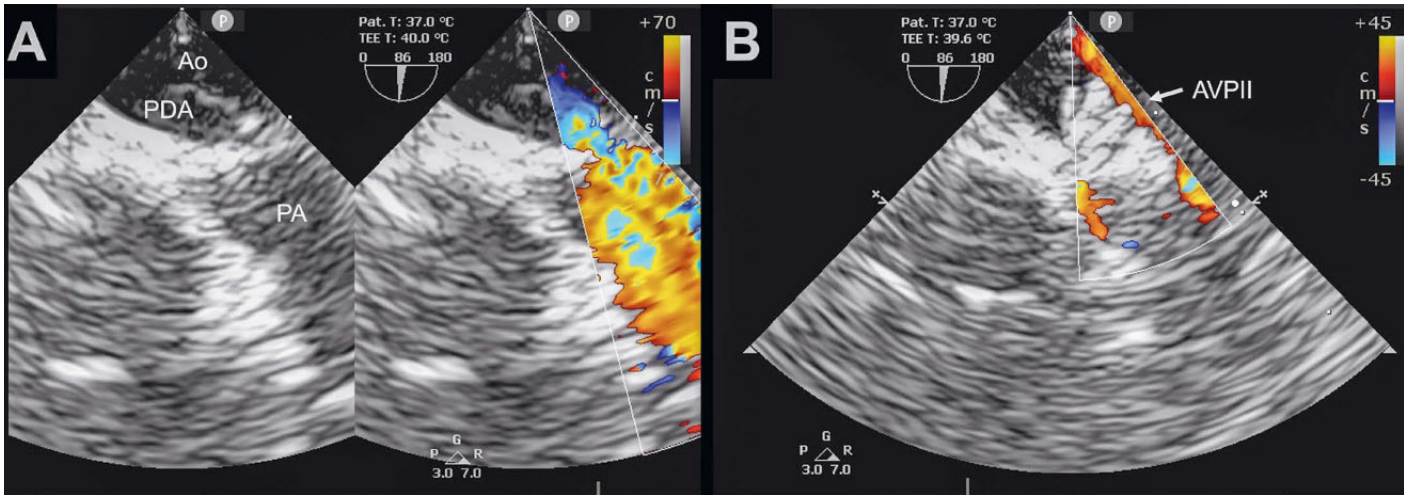


**Figure 2:** Transesophageal echocardiographic images obtained before (A), and after (B) the occlusion of a PDA in a kitten. A: combined two-dimensional grey scale and color Doppler images showing the PDA in long axis, with a shunt flow into the PA. B: after implantation of an AVPII into the PDA ampulla, there is no evidence of residual shunt into the PA. AVPII: Amplatzer vascular plug II; PA: pulmonary artery; PDA: patent ductus arteriosus.

the pulmonary artery during fetal life, allowing the blood flow to bypass the unexpanded lungs, during fetal development. Few hours after birth, the PDA should undergo complete occlusion. In case of lack of contractile elements within the wall of the ampulla incomplete occlusion may occur. This usually results in a left-to-right shunt due to pressure gradient between the aorta and pulmonary artery. Depending of the size of the PDA left sided volume overload and subsequentially congestive heart failure (i.e. pulmonary edema) and premature death may be observed.[1,5] In rare cases, the PDA might induce a severe increase in the pressure of the pulmonary vasculature, with possible reversion of shunt's direction (right-to-left shunt).[1,3] In case of left-to-right shunts, life expectancy can be usually normalized by occluding the PDA.[5] Surgical ligation of the PDA has been historically the method most commonly used to treat this anomaly in cats. However, lateral thoracotomy and duct ligation has been reported to have a relatively high mortality risk (with percentages going from 2,9 % to 80 %, depending on the publication).[1,4] Moreover, in cats this type of surgery carries a significant risk of complications, including hemorrhage, laryngeal paralysis, voice change, difficulty in swallowing, fever, and postoperative chylous effusion.[4] Finally, surgery time is also longer (median duration 115 minutes in a series of 13 cats)[4] compared to the time required for mini-invasive occlusion in the cat of this report (50 minutes). Besides surgical ligation, several mini-invasive techniques have been developed in pediatric and veterinary cardiology, to attempt to occlude the PDA intravascularly.[6,7] As opposed to surgery, that requires a thoracotomy, intravascular embolization can be performed with a percutaneous puncture of the vessel, or through a small skin incision and direct vascular visualization and catheterization. The trans-arterial approach requires the catheterization of the femoral artery, abdominal and descending aorta, until the PDA. At this level the vessel can be occluded using embolization coils or an Amplatzer canine duct occluder. The appropriate size of the coil or Amplatzer canine duct occluder should be then decided based on twice the minimal duct diameter.[6,7] This approach is relatively straight forward since only the arteries, but not the heart, need to be catheterized in order to reach the PDA. The limitation of choosing an arterial approach is the size of the artery, that in cats is usually extremely small, and does not allow to advance into it an introducer of the appropriate size to perform the procedure. On the other side, femoral veins are usually comparably larger, and a 4 French sheath can be advanced relatively easily even in smaller cats. This approach requires therefore to follow retrogradely the venous system, through the caudal vena cava, right atrium and ventricle, until the pulmonary artery and eventually the PDA. At this level the vessel can be occluded with a control-release coil (not available on the market in Switzerland) or an AVPII.[2,6] The correct sizing of the PDA for selecting the most appropriate AVPII and its accurate deployment can only be safely performed under transesophageal echocardiographic guidance. The diameter of the AVPII selected for deploying should be about 1.3-1.5 times the maximal diameter of the PDA ampulla. In small patients, such as cats and toy breed dogs (less then 4-5 Kg of body weight) use of a specific pediatric probe is mandatory due to the small size, in order to avoid esophageal damage and laceration.[8,9]

To the authors' knowledge this is the first case of PDA occlusion using a transvenous approach with an AVPII in a cat. High level of technical skills and high-end equipment such as fluoroscopy and a pediatric transesophageal probe is needed to ensure safe and successful intervention. Assuming that all these factors are met, potentially every patient of any size could be a candidate for a mini-invasive occlusion of a PDA. This approach offers a shorter hospitalization time compared to surgery, along with less pain and a reduced risk of complications, such as vessel laceration or the inadvertent ligation of a pulmonary artery branch.[4,7]

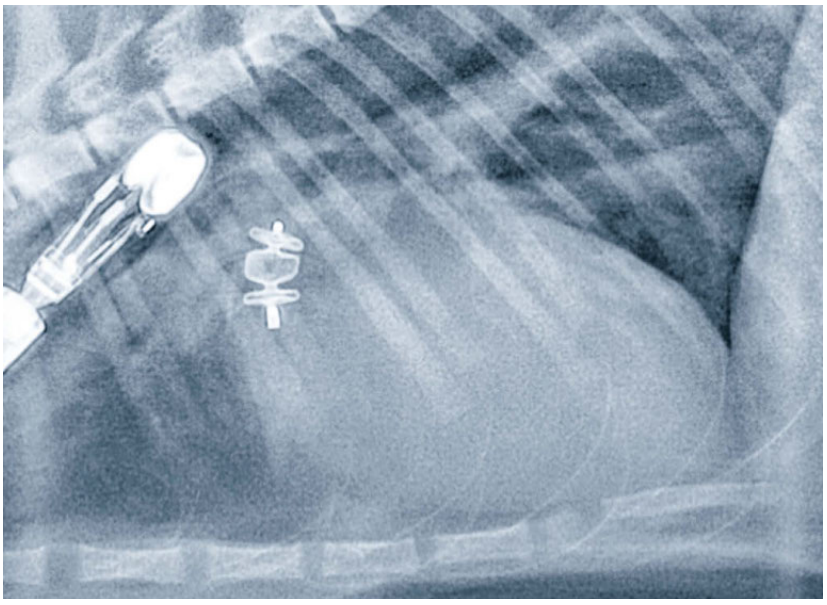

**Figure 3:** Latero-lateral radiographic image of the thorax of a kitten, obtained right after implantation of an Amplatzer vascular plug II (radiopaque structure with a triple disc configuration) for the transvenous occlusion of a patent ductus arteriosus. The radiopaque tubular structure dorso-cranial to the heart silhouette is a pediatric transesophageal probe.

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## Occlusion d'une persistance ductus arteriosus à l'aide d'un bouchon vasculaire Amplatzer II chez un chaton

Un chaton de cinq mois a été admis pour une occlusion intravasculaire assistée par cathéter d'une persistance du canal artériel (PDA). Compte tenu de la petite taille du patient et de l'artère fémorale, une approche transveineuse par la veine fémorale a été tentée. Le PDA a pu être occlus avec succès à l'aide d'un dispositif d'embolisation appelé Amplatzer vascular plug II. Ce dispositif peut être déployé par voie rétrograde dans le système veineux, à l'aide d'un cathéter qui doit passer par la veine cave caudale, l'oreillette et le ventricule droits, et l'artère pulmonaire, pour atteindre le PDA. L'intervention a été assistée par fluoroscopie et échocardiographie transœsophagienne. Le chat s'est remis sans problème de l'intervention et a été autorisé à sortir le lendemain. L'embolisation transveineuse du PDA peut également être réalisée avec succès chez les petits patients ou les animaux ayant des artères périphériques comparativement petites, comme les chats.

**Mots clés:** Cardiaque, chat, congénital, échocardiographie, mini-invasif, shunt

## Occlusione di un dotto arterioso pervio utilizzando un dispositivo di occlusione vascolare Amplatzer II in un gattino

Un gattino di cinque mesi è stato riferito per l'occlusione intravascolare assistita da catetere di un dotto arterioso pervio (PDA). Considerando le piccole dimensioni del paziente e dell'arteria femorale, è stato tentato un approccio transvenoso attraverso la vena femorale. Il PDA è stato occluso con successo utilizzando un dispositivo di embolizzazione chiamato Amplatzer vascular plug II. Questo dispositivo può essere impiantato per via retrograda attraverso il sistema venoso, utilizzando un catetere che deve essere passato attraverso la vena cava caudale, l'atrio e il ventricolo destro e l'arteria polmonare, fino a raggiungere il PDA. L'intervento è stato assistito da una guida fluoroscopica ed ecocardiografica transesofagea. Il gatto si è ripreso senza problemi dall'intervento ed è stato dimesso il giorno successivo. L'embolizzazione transvenosa del PDA può essere eseguita con successo anche in pazienti di piccola taglia o in animali con arterie periferiche relativamente piccole, come i gatti.

**Parole chiave:** Cardiaco, congenito, ecocardiografia, gatto, mini-invasivo, shunt

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