

Case Report Surgery



Clip ligation for treatment of patent ductus arteriosus occlusion in three cats

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ABSTRACT

Patent ductus arteriosus (PDA) is a rare congenital cardiovascular anomaly in cats. Due to their small body, intercostal thoracotomy is the most common option to close the PDA. However, few reports detail the surgical technique for ligating PDA in kittens. In this case report, three cats weighing 1.4 kg, 1.2 kg, and 2.9 kg were diagnosed PDA. Clip ligation via left fourth intercostal thoracotomy was performed and the cats were successfully treated. Postoperative echocardiography showed no residual flow in any of the cases. This case report highlights clip occlusion for small cats with PDA could be safe and effective.

Keywords: Case report; cat; patent ductus arteriosus; clip ligation

INTRODUCTION

Patent ductus arteriosus (PDA) is a rare congenital cardiovascular anomaly in cats, though it accounts for 25% to 30% of congenital malformations in dogs [1]. The prevalence of PDA is substantially lower (0.2 cases/1,000 cats) in cats [2] than in dogs.

Without surgical treatment, left-sided congestive heart failure and pulmonary hypertension will develop in cats [3]. PDA closure with left-to-right shunting is associated with a good long-term outcome in cats. Early surgical occlusion of the PDA is the recommended treatment and can be performed by a range of surgical procedures. The direct approach to ducts using traditional intercostal thoracotomy is most commonly performed, as it can be performed regardless of the patient's size and requires no special equipment such as that needed for C-arm fluoroscopy or thoracoscopy. In general, postponement of the surgical procedure to allow the cat to grow is not recommended, due to fears of congestive heart failure developing, which increases the mortality rate after PDA attenuation [4].

Recent studies reported that the most common surgical complication with PDA open surgical ligation in cats is intraoperative hemorrhage (6.1%–26.6%), which is potentially fatal [5, 6]. Some reports suggest that the incidence of intraoperative hemorrhage in cats is relatively higher than that reported in dogs (6%–11%) [7-9], and may be a consequence of the smaller size and more difficult dissection of feline patients. There is a demand for information on

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Conflict of Interest

The authors declare no conflicts of interest.

the safe, effective surgical technique for treating PDA in small cats. The use of hemostatic clips for treating PDA has the advantage of decreasing the risk of hemorrhage by avoiding unnecessary medial dissection of the ductus. To the author's knowledge, however, no reports have yet focused on hemostatic ligation of PDA in cats. In this case report, three small cats with diagnosed PDA were successfully treated with surgical ligation using hemostatic clips. There were no complications, such as intraoperative hemorrhage or postoperative residual ductal flow.

CASE PRESENTATION

Case 1 was a 5-month-old, intact Russian blue male, weighing 1.4 kg. Case 2 was a 3-month-old, intact Munchkin male, weighing 1.2 kg. Case 3 was a 10-month-old, intact mixed-breed male, weighing 2.9 kg. Case 1 and 2 were referred to the Dog and Cat Pediatric Hospital, while case 3 was referred to the Tokyo University of Agriculture and Technology Animal Medical Center. In the three cases, physical examination revealed a continuous heart murmur (grades IV–VI) with maximal intensity over the left heart base. Case 3 had mild exercise intolerance, but case 1 and 2 had no clinical signs. The electrocardiogram revealed a normal sinus rhythm. Thoracic radiography showed no findings of pulmonary edema or cardiomegaly in the three cases. Echocardiography in case 1 and 3 revealed left ventricular internal dimension in diastole (LVIDd) above the reference range (case 1: 23.6 mm, case 3: 25.3 mm; reference range: 11.0–19.0 mm [10]). Left atrial enlargement was revealed with increasing of left atrial/aortic root proportion (LA/Ao) in all three cases (case 1: 1.69, case 2: 1.51, case 3: 1.76; reference range, < 1.5 [11]). Color-flow Doppler showed continuous flow from the descending aorta into the main pulmonary artery (**Fig. 1**). There was no evidence of congestion findings or pulmonary hypertension in any of the cases. In all three cases, medical treatment was not prescribed until surgical treatment.

The three cats were surgically treated within five days of their initial consultation. General anesthesia was induced using butorphanol tartrate (Vetorphale; Meiji Seika Pharma, Japan), 0.2 mg/kg BW, IV, and midazolam hydrochloride (Dormicum injection 10 mg; Tstellas Pharma, Japan) 0.2 mg/kg BW, IV, and propofol to effect (Propofol injection 1% for animal use; MSD Animal Health, Japan). Anesthesia was maintained with isoflurane (Isoflurane for animal use; MSD Animal Health) after intubation. Monitoring included electrocardiography, indirect blood pressure, and end tidal CO₂ concentration. Thoracotomy was performed via an incision in the left fourth intercostal space. In case 3, the third intercostal space thoracotomy

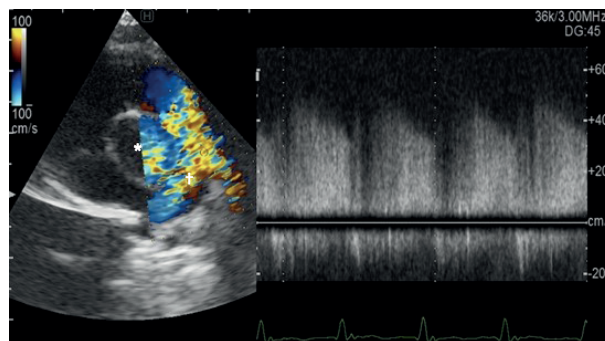


Fig. 1. Right cranial parasternal short-axis echocardiogram view of a case 1. Color-flow Doppler and continuous-wave Doppler revealed continuous flow into the main pulmonary artery.
 *Aorta; †Pulmonary artery.

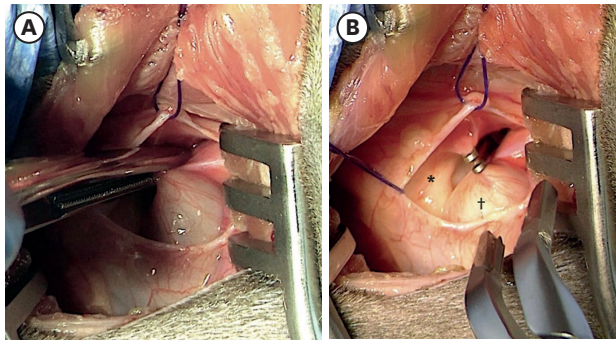


Fig. 2. Intraoperative findings of case 1. The aorta (*) and pulmonary artery (†) were detected. A temporal clamp of the PDA was performed by DeBakey tissue forceps (A). DeBakey tissue forceps were inserted in the cranial and caudal portion of the PDA and gently clamped the ductus. After confirming the disappearance of thrill by temporal clamping, the hemostatic clip was placed to occlude the ductus (B). The cranial side is to the left of the image. PDA, patent ductus arteriosus.
*Aorta; †Pulmonary artery.

was performed but it made difficult to dissect the ductus, then it was converted to the fourth intercostal thoracotomy. The left cranial lung lobe was gently retracted dorsally and caudally with small, damp gauze. The vagus nerve was isolated at the level of the ductus and gently retracted dorsally with one or two stay sutures. The recurrent laryngeal nerve was difficult to detect in all cases. The caudal aspect of the ductus was isolated by right-angle forceps between the descending aorta and left pulmonary artery branch. Exposure of the cranial aspect of the ductus was facilitated by dissecting the loose connective tissues between the ascending aorta and ductus. The medial aspect of the ductus was not dissected. A temporary clamp of the ductus with DeBakey tissue forceps was gently performed to confirm the disappearance of the thrill (**Fig. 2A**). Increasing of blood pressure was found after temporary clamp of the ductus in all cases.

A medium-large size double-shanked hemostatic clip (DS Titanium Ligation Clips; B.BRAUN Aesculap, Japan) in case 1 and 2, and two medium size single-shanked hemostatic clip (Titanium Ligating Clips; B.BRAUN Aesculap) in case 3 were placed over the ductus and compressed to occlude the ductus (**Fig. 2B**). In all cases, the determination of the adaptive size of the clip was performed based on intraoperative gross anatomical findings. After ligation, surgeons confirmed that the thrill was not palpated and increasing of blood pressure was measured by indirect blood pressure. Intraoperative transesophageal echocardiography (TEE) was available for case 3 only, due to the patient size; this confirmed there was no residual ductal flow after ligation. Thoracic drainage (Phycon tube SH No.3: 2.5 mm inner diameter, 4.0 mm outer diameter; Fuji Systems Corporation, Japan) was set up, and the thorax was closed using the standard method. The intercostal block of bupivacaine was performed for analgesia. All cats recovered uneventfully from anesthesia. The surgical duration from the time of skin incision to the placement of the final skin suture was 31, 32 minutes, and 74 minutes for case 1, 2, and 3 respectively. Each surgery was performed by three different residency-trained surgeons. Buprenorphine hydrochloride (Buprenorphine injection 0.2mg; Nissin Seiyaku, Japan), 0.01 mg/kg BW, IV was administered twice a day for postoperative analgesia until office discharge. Within several hours after surgery, all cats could eat food and drink tap water. The day after surgery, the thoracic drainage tube was removed for each case after confirmation there was no pleural effusion or air present. On the day after surgery, echocardiography revealed LVIDd was within the reference range for all cases (case 1: 13.8 mm, case 2: 12.2 mm, case 3: 18.5 mm; reference range: 11.0–19.0 mm

[10]). LA/Ao was also within reference range for all cases (case 1: 1.3, case 2: 1.2, case 3: 1.31, reference range: < 1.5 [11]). Color-flow Doppler echocardiography revealed there was no residual shunting flow in any of the cases. All cats were discharged two days after surgery and based on the echocardiography findings, medical treatment was not required after surgery. Follow-up echocardiography, at 12 days (case 1), 182 days (case 2), and 16 days (case 3) post-surgery, revealed the ductus arteriosus was completely occluded in all cases and patients presented no symptoms. On physical examination, no heart murmur or respiratory tract abnormalities were auscultated. In case 1, 1-month postoperative exam was scheduled, but it was failed due to the first owner transferred to another owner. In case 3, phone call follow-up was performed and the owner mentioned the cat condition is good without any symptoms, and regular veterinarian confirmed no heart murmur by auscultation.

DISCUSSION

Surgical technique for cats with PDA is often determined by extrapolating treatments from dogs with PDA, due to the limited number of papers detailing surgical techniques for cats with PDA. A few reports showed the benefit of hemostatic clip ligation for PDA closure techniques in dogs [12-14]. In this preliminary report, the hemostatic clip method for PDA closure was effective and safe in three cats. By utilizing the hemostatic clip, much of the danger of iatrogenic damage to vessels and fatal intraoperative hemorrhaging can be avoided and the technique may reduce surgery time in cats. In case 3, the surgical time was extended because it was required to convert from third to fourth intercostal thoracotomy approach during surgery.

There are some concerns of postoperative complications associated with the hemostatic clip method for treating PDA, such as postoperative residual flow and recanalization. To reduce the risk of postoperative residual ductal flow, we performed a temporary clamp of the ductus with DeBakey tissue forceps and palpated the disappearance of the thrill or confirmed the complete occlusion with intraoperative TEE, and found the increasing of blood pressure. To determine the size of clip, intraoperative gross anatomical finding was most reliable, although preoperative measurement of PDA diameter was attempted on echocardiogram, it was technically difficult due to patient size. Whether recanalization is a problem in veterinary medicine is unknown but according to the previous report, postoperative recanalization cannot occur due to the physical properties of the hemostatic clips [14]. In this report, despite the short follow-up time and small number of cases, there was no evidence of postoperative recanalization according to echocardiography.

Unilateral laryngeal paralysis after surgical ligation of PDA in a kitten has been reported previously [15]. This report suggested iatrogenic damage to the recurrent laryngeal nerve occurred during dissecting of the ductus. In our three cases, we could not identify the recurrent laryngeal nerve that branches from the vagus nerve in the region of the ductus. However, we observed no postoperative symptoms associated with damage of the laryngeal nerve, and laryngoscopy was not performed. In this report of just three cases, it is uncertain whether the clip ligation method, which does not require complete dissection of the surrounding ductus in cats, decreases the risk of iatrogenic damage to the recurrent laryngeal nerve.

In conclusion, although there is limitation of the small number case series, this report highlights how hemostatic clip ligation of PDA in cats could be an effective, safe treatment method, valuable for small cats with PDA.

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