SURGICAL METHODS FOR EXTRACTION OF ADULT FORMS OF 
DIROFILARIA IMMITIS FROM THE HEART IN DOGS

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ABSTRACT

The localization of adult forms of *Dirofilaria immitis* in the heart provokes the development of the so-called “Caval syndrome” and lead to the development of severe cardiorespiratory disorders. The animals are in a severe general condition and surgical interventions must be précised as severity and duration.

The purpose of this article is to revealed the methods and surgical techniques for removing these forms of the parasite from the heart as well as to describe the most common complications in the postoperative period.

Key words: *dirofilaria*, surgical treatment, heartworm, dog.

Introduction

In animals with “Caval syndrome”, the surgical extraction of adult forms of *Dirofilaria immitis* is the only way to alleviate the condition of the patient. This procedure reduces the probability of pulmonary thromboembolism and allows subsequent treatment with specific agents (*melarsomine*) (9). Surgical extraction can be performed by thoracotomy or jugular venotomy (11). Methods involving thoracotomy are associated with a high risk for the patient and high mortality due to the severity of surgical intervention (3, 6). In this review article we will discuss various minimally invasive techniques for extracting adult forms of *Dirofilaria immitis*.

Materials and methods

Pre-operational preparation

Two weeks prior to the scheduled surgery, the patient should be stabilized with furosemide (1 mg/kg PO, twice daily) and enalapril (0.5 mg/kg, PO, once daily) to reduce cardiac overload (especially in high-degree heart weakness, dyspnea, cough and syncope). The reduction of thromboembolic risk induced by both surgical intervention and the risk of dying of adult forms of parasites was achieved by prednisolone (0.5 mg/kg PO, twice daily) and cetirizine (1 mg/kg, PO once daily) one week before the procedure (1). Some authors recommend the inclusion of *doxycycline* (5mg / kg, PO, twice a day) 5–7 days (11) or 2 weeks prior to the intervention (1).

Immediately prior to the operation, a thoroughly pre-anesthetic examination should be performed, including biochemical and morphological blood tests, electrolytes examination, thoracic X-ray and echocardiography. The imaging-diagnostic methods serve to visualize the pulmonary arteries, to determine the approximate number of adult parasites and their localization (5).

Anesthesia protocol

Premedication – Most authors (4, 8, 11, 12) suggest that premedication should be performed with anticholinergic agents and benzodiazepines. Analgesia can be provided by including opioid agents – fentanyl (such as bolus injection, 0.01–0.03 mg/kg) or midazolam + fentanyl in continuous rate infusion (CRI) (4).
The inclusion of heparin (100 U/kg, SC) as an anticoagulant is considered a prerequisite before induction of anesthesia (1).

The drugs used for induction and maintenance of anesthesia should provide a high level of analgesia, which would shorten the postoperative recovery period. Propofol (4 mg/kg IV) remains the first and most preferred drug for initiating anesthesia due to its high safety, rapid effect and lack of cumulative effect, but the major drawback is the onset of hypotension and myocardial sensitization. In high-grade intraoperative blood loss in combination with the hypotension caused by propofol, a critical decrease in blood pressure and heart failure may occur. The use of propofol should be accompanied by adequate fluid therapy, both during surgery and postoperative (11).

Many authors (1, 8, 11, 12) recommend maintaining a deep anesthesia plan with isoflurane (2-5 vol%, depending on the patient's weight). Another suggest anesthetic protocol with Ketamine HCl (10 mg/kg IM) that provides excellent analgesia, keeps heart activity and blood pressure stable and does not depress severe breathing. Its inclusion into the anesthesia protocol is preceded by tranquilization with benzodiazepines (diazepam, 0.5 mg/kg IV). Maintenance may be performed with isoflurane (2-5 vol%, depending on the weight of the patient) (2).

The imidazole derivative Etomidate is considered a suitable agent in patients with cardiovascular problems that do not compromise cardiac contractility and maintain cardiac stability. A significant drawback in its use is post-operative immunosuppression due to blockade of steroidogenesis. For this reason, Etomidate is only used as a single bolus dose for administration, and maintenance is performed with isoflurane or sevoflurane. (4)

Surgery protocol

Most authors recommend left-lateral recumbency for the patient and using the access to v. jugularis dextra (1, 4, 8, 12). Some authors (12) recommend using right-lateral recumbency with performing a venotomy of v. jugularis sinistra.

1st method:
Extraction with Ishihara Flexible Alligator Forceps

It is performed with a special tool developed for the extraction of adult forms of Dirofilaria immitis (Fig. 1). Under fluoroscopic control, the flexible forceps can reach not only the right atrium and chamber, but also pulmonary arteries (7). With the use of this technique, intraoperative morbidity in patients is extremely low (5).
Method of execution

The patient is placed in the left-lateral recumbency and access is made to the right v. jugularis, which is isolated and ligated or clamped at its proximal end. Through an incision (approximately 2 cm long), the tool is inserted. Under the fluoroscopic control (Fig. 2), the forceps passes through the vein and enters the right ventricle and finally into the pulmonary artery (2).

![Figure 2: Position of the forceps in the heart under fluoroscopic control (source: Ranko Georgiev et al., 2016)](image1)

The fork grabs the parasites between its jaws and pulls out the worms themselves. The procedure is repeated until all parasites are removed.

![Figure 3: Extraction of the parasites using the forceps (source: Mark D. Kittleson, D.V.M., Ph.D.)](image2)

At the end of the surgery, the vein is ligated proximally and distally (Fig. 3). Studies have shown that this does not lead to any clinical consequences, even in the ligation of both jugular veins. The remaining tissues are sewn routinely (2).

This method of extracting adult forms of *D. immitis* has high success rate and minimal invasiveness. A major disadvantage is that it is not suitable for animals with low weight – it is difficult to reach the pulmonary artery because of the small lumen and the insufficient jaw opening
Surgical methods for extraction of adult forms of *Dirofilaria immitis* …

space (12). It should also be borne in mind that, due to the incision of v. jugularis we may experience a high blood loss (8).

**II**nd **method:**

Percutaneous extraction using grasping catheters (endoscopic grasping forceps; flexible three wires nail-tipped forceps – Fig. 4)

![Endoscopic grasping forceps tool](source: Lee S.G)

The patient is subjected to a standard general anesthesia and is fixed in the right-lateral position. There follows aseptic field preparation in the v. jugularis area. Percutaneous venipuncture is performed with an 18G needle and a guiding wire is inserted through the lumen under fluoroscopic control (Fig. 5, A) – it should pass through the right ventricle and enter the pulmonary artery. The needle is then removed and an introducer sheath (Fig. 5, B) (*Flexer Tuohy-Borst Side-Arm Introducer, COOK, USA*) is introduced through the guiding wire (Lee SG).

![Introducing the guiding wire](source: Lee Seung-Gon)

![Introducing the introducer sheath](source: Lee Seung-Gon)

The removal of the guiding wire is followed, with the sheath fixed to the skin with simple interrupted sutures. One of the two types of extraction catheters (Fig. 6) is introduced into the lumen of the sheath under fluoroscopic control, with the ends if the catheters grasp the parasites themselves.
Initially, the worms are pulled out of the pulmonary artery, only when we are sure that all the forms are removed, the sheath, together with the catheter, are pulled back until they enter the right ventricle, where the adult forms are also extracted. Finally, the sheath is drawn further back to the atrium, where the last parasite extraction follows. After completion of the procedure, the punctured v. jugularis is ligated with non-absorbable suture material (Nylon, 1).

A great advantage of this method is the fact that no incision on v. jugularis is required, resulting in minimal bleeding during the intervention. Because the skin remains intact, it does not require suturing the muscles and skin around the vein. Because of their smaller diameter, these catheters are used with success in smaller animals, as opposed to flexible forceps extraction, which requires a large lumen to open the jaws (Seung-Gon Lee).

IIIrd method:
Extraction with a guiding catheter and a basket retrieval device

The patient undergoes general anesthesia and is position in the right lateral recumbency. We make an approach to v. jugularis sinistra and perform a linear incision along its length. Through the access in the vein, a fixed core wire guide (curved) is inserted into the right atrium, the right ventricle, and finally the pulmonary artery. After that, a sheath (Flexor Tuohy-Borst Sidearm Introducer, Cook Medical, USA), size 6–8 according to the weight of the dog, is guided by the pre-set fixed core wire guide, the sheath enters the pulmonary artery, then the wire guid is removed. The basket device (15–30 mm. width, 1.8–2.4 mm diameter, depending on the weight of the animal, Fig. 7) slides closed in the insertion sheath, and under fluoroscopic control opens in the area of the pulmonary artery.

Figure 6: Position of the extraction catheter under fluoroscopic control 6, source: (source: Lee Seung-Gon)

Figure 7: Basket retrieval device (source: Stephen L. Jones, DVM).
The basket device is then drawn back, with a pause of 3–4 heartbeats per minute between each extraction attempt. Intervention is repeated until echocardiographically no more parasites are observed (Won-Kyoung Yoon).

**Conclusion**

These operative techniques have minimal invasiveness and are successfully used for the extraction of adult forms of *Dirofilaria immitis*. The use of forcepses and catheter extractors is preferred in larger animals because of the need for a broad vascular lumen to open the jaws. With these methods there is a risk of injuring the vessel wall when the jaws are closed. In the basket retrieval devices, this risk is avoided, but the extraction of the parasites is made “blind”. The choice of method depends on the size of the animal and the surgeon's preference accordingly (W. K. Yoon, Seung-Gon Lee).

The only form of complete disease control is the prevention of infection by strict application of agents used to control heartworm!

**References**