Development of a Special Alligator Forceps for Removal of Pulmonary Heartworms in Very Small Dogs

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The flexible alligator forceps were developed by the authors in 1985, as an instrument for removal of heartworms from the pulmonary arteries via the external jugular vein [3]. These forceps were introduced clinically in the following year in Japan [4]. They are used for heartworm removal in dirofilariasis of the common pulmonary type [2, 6] and the special type such as hemoglobinuria (caval syndrome) [1]. However, it is difficult to use these forceps in very small dogs, which have a very slender external jugular vein and a small heart with interior walls of small radius.

With the technical cooperation of Fuji Photo Optical Co., Ltd. of Omiya, Japan, the authors designed a special prototype forceps for use in very small dogs. These forceps were improved in an effort to resolve some of the problems associated with the use of forceps having a 3 mm outside shaft diameter, and their new performance was investigated in removal of pulmonary heartworms from very small dogs.

The grasping jaws of the forceps consist of a stationary jaw of 9 mm and a mobile one of 8 mm length; the outside diameter of the closed jaws is 2.5 mm. The forceps measure 515 mm in overall length, and effective shaft length is 320 mm. The forceps provide a completely flexible front shaft of 180 mm and a semi-flexible one in the rear. The distance between the tip of the jaws and the center of the flexion portion is about 24 mm, and the minimum radius is only 6 mm. However, the basic construction (i.e., grasping jaws, insertion shaft, jaw and flexion portion manipulators) is the same as in the flexible alligator forceps with the 3 mm outside shaft diameter which we developed in 1985 [3-5].

In the preliminary performance test of the forceps for several dogs weighing 1.5 to 2.4 kg,

the shaft of the forceps allowed insertion into the main branches of the left and right pulmonary arteries through the external jugular vein. At their autopsy immediately after manipulations, a few petechia were found in the endocardium of the right ventricle, although along with scratches in the endotherium of the jugular vein, no other severe harm was found.

Table 1 shows the removal efficacy using the newly developed forceps. In 13 patient dogs weighing from 1.9 to 5.7 kg, the diameter of external jugular vein was thicker than that of the forceps, when the vein was exposed surgically. Therefore, the shaft could be easily inserted into the vein in every one of them. The forceps were also easily inserted into the main branches of the left and right pulmonary arteries via the tricuspid and pulmonary valve orifices by advancing the shaft with angling and stretching manipulations under fluoroscopy (Figs. 1 and 2).

In 8 cases of pulmonary heartworm disease with sub-clinical or chronic symptoms such as coughing, enlargements of the right heart and pulmonary trunk in the radiographs, 4 to 9 mature heartworms were removed from the pulmonary trunk and the main left or right pulmonary arteries, and all dogs showed good progress. In 5 cases affected with CS (Nos. 9-13) showing acute symptoms such as anorexia, tachypnea, systolic heart murmur and hemoglobinuria, a total of 6 to 39 worms were removed from between the venae cavae and the tricuspid valve orifice, and 3 to 15 mature worms could be removed from the left and right pulmonary arteries in 4 cases (Nos. 9, 10, 12 and 13). The dogs exhibited good progress and recovered roughly within about a week in 4 cases, but one case (No. 10) showed a poor prognosis as a result of heartworm coiling around the tricuspid cord.

The total time required for all the heartworm removal was from 6 to 30 minutes, including 4 to 25 forceps' and other manipulations. The mean

Table 1. Removal efficacy of heartworms from patient dogs with dirofilariasis

Dog No.	Breed	Age (year)	Sex	Body weight (kg)	Approx. inside JV diameter	Removed heartworms				Type of disease	Result	
						PA		VC to TCVO				Total
						F	M	F	M			
1	Yorkshire terrier	4	F	2.8	2.5~3.0	3	3			6	PHWD	Recovery
2	"	6	"	3.0	3.0~4.0	2	2			4	"	"
3	Mixed maltese	7	"	5.3	4.0~5.0	6	2			8	"	"
4	Toy poodle	6	"	5.0	3.0~4.0	6	3			9	"	"
5	Shiba dog	"	M	5.4	3.0~4.0	4	2			6	"	"
6	Shelty	"	F	5.5	3.0	3	2			5	"	"
7	Shiba dog	"	M	5.7	3.0~4.0	4	2			6	"	"
8	Maltese	"	F	1.9	3.0	1	2			3	"	"
9	"	5	M	3.1	3.0		7	10		17	CS	"
10	Toy poodle	9	"	3.3	3.0~3.5	4	11	12	13	40	"	Poor prognosis
11	Japanese pug	8	"	4.2	3.0			10	1	11	"	Recovery
12	Mixed pomeranian	"	"	4.3	4.0	4		6		10	"	"
13	Shelty	6	"	4.3	3.0	2	1	27	12	42	"	"

Remarks F: Female M: Male JV: Jugular vein PA: Pulmonary arteries VC: Venae cavae
TCVO: Tricuspid valve orifice PHWD: Pulmonary heartworm disease CS: Caval syndrome

time required for fluoroscopy per forceps manipulation was about 13 seconds, and the total fluoroscopy times ranged from 72 to 280 seconds, under load conditions of 1 mA and 50 KV at 100 cm FFD. Therefore, the animals would totally be exposed to less than 7 milli-Sievert (mSv) within 5 minutes fluoroscopy on calculation under the heartworm removal. The exposure is tolerable in comparison to human gastric fluoroscopy with some radiograph dosed with radiopaque medium, in which 50 mSv/10 minutes would be totally received with an overtube apparatus under the conditions of 1 mA and 90 to 100 KV.

Usually, the forceps are used relatively less in very small dogs than in medium-sized dogs,

which are mainly raised indoors with no mosquitoes. The risk of adulticidal therapy or removal by thoracotomy for very small dogs is considerably greater than that for medium or large sized-dogs. Although the forceps for miniature or very small dogs are used relatively less frequently, they are essential for heartworm removal. Their serviceability is enhanced not only for very small dogs but also small dogs weighing several kg, and heartworm removal is performed in them more easily than with the forceps having a 3 mm outside shaft diameter.

When these forceps are inserted into the main left and right branches of the pulmonary arteries through the external jugular vein via the right

Fig. 1. Forceps inserted into the main pulmonary artery of the left caudal lobe in a Yorkshire terrier weighing 2.2 kg.

Fig. 2. Forceps inserted into the pulmonary artery of the right middle lobe in an extra-small dog weighing 2.4 kg.

heart, the performance of the forceps is influenced by the construction, of course, and they outperform forceps with a slender shaft and having a small angling with a short distance between the jaw tip and the center of the flexion portion. These two points are especially necessary in forceps application to very small animals. In a case of Japanese cat weighing 3.5 kg (male, 5 years) with pulmonary heartworm disease, the forceps with an outside 2.5 mm shaft can not be inserted into the jugular veins, because it has a slender jugular vein with much contractibility. However, in the tested cases of very small dogs weighing 1.5 to 5.7 kg, the new flexible alligator forceps offer the two advantages above-mentioned for easy heartworm removal, although it is possible that some miniature dogs

may have a jugular vein smaller than the 2.5 mm shaft.

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要 約

超小型犬の犬糸状虫摘出用フレキシブル・アリゲーター鉗子の開発 (短報): 石原勝也・佐々木栄英・北川均・北尾 哲¹⁾・竹橋史雄²⁾ (岐阜大学農学部家畜内科学講座, ¹⁾動物メディカルセンター, ²⁾千代田動物病院) —犬糸状虫摘出に使う超小型犬用のフレキシブル・アリゲーター鉗子を開発した。この鉗子の挿入軸は、外径が2.5ミリで有効軸長は320ミリである。把握爪の長さは9ミリ、爪の先端から屈曲中心までの距離はわずか22ミリで、最少屈曲半径も6ミリである。鉗子は体重1.5kg~5.7kgの超小型犬の外頸静脈から右心を経て左右肺動脈に容易に挿入され、犬糸状虫症13例に適用し、肺動脈あるいは右房などから1例あたり3~42匹の成虫が摘出された。