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CLINICAL RESEARCH

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Outcome of video-assisted thoracoscopic treatment of idiopathic chylothorax in 15 cats

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[Correction Notice: The affiliation and qualification of author, Filippo Cinti, has been updated in this version.]

Abstract

Objective: To evaluate the outcomes and complications of video-assisted thoracoscopic (VATS) treatment of chylothorax in cats.

Study design: Multi-institutional retrospective study.

Animals: Fifteen client-owned cats.

Methods: The medical records of cats undergoing thoracoscopic thoracic duct ligation (TDL) for treatment of idiopathic chylothorax were reviewed. Cats undergoing additional procedures including thoracoscopic pericardectomy and/or laparoscopic cisterna chyli ablation (CCA)_were included. Follow up was obtained through communication with the referring veterinarian or owner.

Results: All cats underwent thoracoscopic TDL. Thirteen cats underwent simultaneous pericardectomy and two cats underwent laparoscopic CCA without pericardectomy. Conversion from a thoracoscopic to open approach was necessary in 2/15 (13%) of thoracic duct ligations and 1/11 (9%) of pericardectomies. The most common postoperative complication was persistent pleural effusion in five cats (33%). Four of 15 cats (27%) died or were euthanized prior to hospital discharge following surgery. Recurrence of effusion occurred in 1/7 (14%) of cats that sustained resolution of the effusion at the time of surgery with a median follow up of 8 months. The overall mortality attributed to chylothorax was 47%.

Conclusion: Thoracoscopic treatment of idiopathic chylothorax resulted in a low incidence of intraoperative complications or conversion in the study population; however, mortality related to feline idiopathic chylothorax remained high.

Clinical significance: While VATS treatment of idiopathic chylothorax is technically feasible, further consideration of the underlying pathology and current treatment algorithm is needed to improve outcomes as this remains a frustrating disease to treat in the feline population.

1 | INTRODUCTION

Chylothorax is defined as the accumulation of a chylous effusion within the pleural space. Definitive causes of chylothorax in cats can be identified including cardiac disease, mediastinal masses, thrombosis of the cranial vena cava, and trauma which result in impaired or disrupted lymphatic drainage into the venous system within the thorax; however, in most cases an underlying etiology is not identified, classifying the process as idiopathic.[1] Treatment of idiopathic chylothorax in cats can be challenging with many combinations of treatments described with varying results. Medical management with the nutraceutical Rutin has resulted in resolution of effusion in some cats; however, results are variable.[2,3] Surgical intervention remains the mainstay of treatment and most commonly includes a combination of one or many of the following procedures: ligation of the thoracic duct (TDL),[4–6] pericardectomy,[5] and/or cisterna chyli ablation (CCA)[5,6]; however, systemic review of described methods also include omentalization, pleuroperitoneal shunting, and pleurodesis.[7–10] The variety of reported treatments and lack of consensus for the ideal approach reflect the difficulty that can be encountered when treating this disease.

In cats, surgical outcomes have traditionally been poor independent of which surgical procedures are performed, with postoperative survival ranging from 20% to 54%.[4–6] For example, in the first and largest cases series of cats with idiopathic chylothorax, only 20% of cats treated surgically with either TDL or CCA had complete resolution of effusion.[6] Another report, looking at treatment with thoracic duct ligation alone, had improved outcomes with 54% of cats resolving their effusion.[4] This is in contrast to dogs, however, in which reports of surgical outcomes have an overall higher survival with traditional surgical approaches (53%–100%).[11–15] The reason for the discrepancy in outcomes between these two species remains unclear but could be related to differences in anatomy or differences in the underlying pathogenesis of this poorly understood disease.[16] The combination of surgical techniques have been evaluated in both dogs and cats, with no combination providing a clearly superior outcome to any other (e.g., TDL with pericardectomy vs. CCA).[5,12]

More recently, a case series of 39 dogs with idiopathic chylothorax treated with video-assisted thoracoscopic (VATS) thoracic duct ligation and pericardectomy was reported with durable resolution of the effusion in 95% of cases.[17] This is the largest report of the surgical treatment of chylothorax to date, suggesting that a minimally invasive approach could provide an alternative approach and result in a positive surgical outcome. The success of a minimally invasive surgical approach is often times dependent on proper case selection including the considerations of a more technical surgery in comparison to patient size. For example, the median bodyweight in the previous report of dogs treated thoracoscopically for idiopathic chylothorax was 27.8 kg.[17] The typical feline population is much smaller; however, VATS has been described in cats for the determination of the cause of pleural effusion,[18] correction of a PRAA,[19] lung lobectomy,[20] and thymoma resection.[21] Furthermore, Haimel et al. described the successful treatment of idiopathic chylothorax in two cats with thoracoscopic TDL and subtotal pericardectomy, with resolution of clinical signs in up to 24 months following surgery.[22] However, the small number of cases in this report limited conclusions as to whether VATS-assisted treatment of chylothorax is feasible in a larger cohort of cats, or if the historical discrepancies in outcomes between dogs and cats would continue to persist despite a different approach.

The objective of the present study was to report the perioperative outcomes, complications, and long-term resolution of pleural effusion following thoracoscopic treatment of idiopathic chylothorax in cats. We hypothesized that a minimally invasive approach would not result in improved survival and that survival would be less that 80%.[5,17]

2 | MATERIALS AND METHODS

Medical records from four academic and three private practice institutions were reviewed to identify cats that underwent thoracoscopic treatment for idiopathic chylothorax between August 2009 and June 2021. Cats were considered to have an idiopathic chylothorax if they had evidence of chylous effusion without an underlying predisposing cause (e.g., primary cardiac disease, abdominal disease, neoplastic disease, thromboembolic disease). Cats were included in the study if they underwent primary thoracoscopic TDL.

Case records were reviewed for signalment (age, weight, breed, and sex), history, preoperative diagnostics and imaging, details of surgical treatment, intra- and postoperative complications, and outcomes. Complications were graded based on a previously proposed scale (grade 0–4) for soft tissue and oncologic surgical procedures.[23] Grade 0 was classified as no deviation from the procedure, grade 1 as deviation without the need for intervention, grade 2 as nonlife threatening deviation with the need for intervention, grade 3 as life threatening deviation with interventions, and grade 4 as death. Follow-up information was obtained from review of the medical records and via phone contact with the referral hospital or owner.

Data analysis was performed using descriptive statistics without statistical analysis given the small sample size. Descriptive statistics are reported as median and range for continuous variables and as count and percentage for categorical variables.

3 | RESULTS

3.1 | Signalment and clinical signs

Fifteen cats met the inclusion criteria. Seven cats were neutered males, seven were spayed females, and one was an intact female. The median age at presentation was 8.0 years (range, 0.7–15.1). The median weight was 4.9 kg (range, 3–8.8). For those cats of which body condition was reported, the BCS was ≥7 in 5/6 cats. Twelve cats were domestic short or long hair and the remainder of the cats were purebred (2 Siamese and 1 Persian).

The median duration of clinical signs prior to presentation at the referral center was 2 months (range, 0.5–24 months). Details of previous medical management was reported in eight cats. Seven of eight cats were administered benzopyrone (Rutin) at varying doses ranging from 375 to 1500 mg/day. Additional treatments described included various diuretics or ACE inhibitors (3), steroids (2), and antibiotics (1). Clinical signs included difficulty breathing (6), coughing (5), lethargy (4), tachypnea (3), decreased appetite (3), gagging (1), and weight loss (1). The chylothorax was found incidentally in the one cat that was under 1 year of age, without clinical signs during a presterilization examination. On physical examination, nine cats were characterized as having an increased respiratory effort or dyspnea, and four cats were described as tachypneic. Two cats had decreased lung sounds ventrally and three cats had muffled heart sounds.

3.2 | Diagnostics

Complete blood count and serum biochemistry were reported in all cats; however, results were nonspecific and therefore not reported in detail. Seven cats underwent testing for heartworm antigen or antibodies and all were negative. For those cats in which serum triglyceride levels were available in addition to pleural effusion triglyceride levels ($n = 7$), the median fluid to serum triglyceride ratio was 52.1 (range, 3.0–64.4).

Thoracic radiographs were performed in 11 cats and findings were nonspecific including pleural effusion in 10 cats. One cat had evidence of pneumothorax on thoracic radiography; however, thoracocentesis had been performed prior to imaging. Abdominal imaging (ultrasound or CT) was performed in 12 cats and all results were unremarkable or insignificant compared to the existing thoracic disease. Eleven cats underwent echocardiographic evaluation. In nine cats the study was deemed normal and the remaining two cats had evidence of a mildly thickened pericardium. In total, all cats were diagnosed with idiopathic chylothorax based on preoperative diagnostics.

Thirteen cats underwent thoracic CT with 11 cats receiving intravenous contrast to rule out a thromboembolic event. Of the 13 cats undergoing thoracic CT, computed tomography lymphangiogram (CTLA) was performed in 10 cats. CTLA was considered successful in 5/10 cats (50%) defined as contrast visible within the thoracic duct. Only one cat with a successful CTLA demonstrated leakage of contrast from the duct into the thoracic cavity. The site for injection of contrast in those cats with successful CTLA included three in the tarsal pad and two in the popliteal lymph node. Sites of injection resulting in unsuccessful CTLA included two in the perianal region and one each in the tarsal pad, popliteal lymph node, or ultrasound guided mesenteric lymph node injection. In two cats with successful CTLA, more than one branch of the thoracic duct was identified coursing through the thorax; however, in all five cats the thoracic duct traversed entirely or converged to a single duct within the left hemithorax.

3.3 | Surgical procedures

Time from first presentation to the referral center to surgical intervention ranged from 1 to 41 days. No cats had undergone previous surgical procedures for treatment of their chylothorax. All 15 cats underwent thoracoscopic TDL. Thirteen cats underwent simultaneous pericardectomy. The remaining two cats underwent VATS TDL followed by laparoscopic CCA, without pericardectomy. In one cat that underwent VATS TDL and pericardectomy and open cisterna chyli ligation was also performed. One lung ventilation was not used in any of the cases.

For TDL, cats were positioned in right lateral recumbency (4) or sternal recumbency (11). In all 15 cats, access to the thoracic duct was through a left-sided approach regardless of CTLA findings. Three portals were used in all cases in varying combinations, placed between the seventh and 12th intercostal spaces. Intraoperative injection of contrast to aide in thoracic duct visualization was performed in 13 cats. Contrast was injected into a mesenteric lymph node via a limited abdominal incision in all 13 cats. In 11 cats, methylene blue was injected into the lymph nodes. Indocyanine green was injected in two cats and near-infrared fluorescence lighting used to visualize the thoracic duct. Ligation of the thoracic duct was achieved using hemoclips in 12/15 cats. In 2/12 cats, the ligation was re-enforced with suture ligation. One thoracic duct was occluded using intracoporeal suturing alone. In the remaining two cases, the thoracic duct was ligated using a vessel sealing device (Ligasure, Medtronic, Minneapolis, Minnesota) and no other modality. In four cats, the thoracic duct was transected with a vessel sealing device (1) or between the cranial and caudal hemoclip ligation (3). Repeated injection of contrast into mesenteric lymph nodes was performed in three cats following occlusion of the thoracic duct. No flow of contrast was seen beyond the occlusion in these cases.

For the 13 cats that underwent subsequent pericardectomy, nine cats were repositioned into dorsal recumbency, either from sternal or right lateral recumbency. Portal placement was variable with all cats having the addition of a subxyphoid telescope portal. Pericardectomy was performed in sternal recumbency using the portals previously placed for TDL in one cat. A planned mini thoracotomy was performed in one cat. In the remaining two cats, pericardectomy was performed through the thoracotomy that resulted from TDL conversion. A subtotal pericardectomy was performed in seven cats, and a pericardial window performed in six cats based on surgeon preference. Instrumentation for pericardectomy included a vessel sealing device alone in three cats, sharp dissection alone in five cats, and a combination of both in five cats.

Additional procedures performed at the time of surgery include laparoscopic CCA (2), open CCA (1), and placement of a PleuraPort (4) (Norfolk Vet Products, Skokie, Illinois). The median surgery time was 152.5 min for all combination of procedures (range, 60–255).

3.4 | Intraoperative complications and conversions

In total, one (6%) intraoperative complication occurred and was classified as grade 1.[23] This included laceration of an intercostal artery and the bleeding was stopped through use of a hemoclip without conversion. Conversion to an open procedure was necessary in 2/15 cats (13%) for TDL and in 1/11 cats (9%) during thoracoscopic pericardectomy for an overall conversion rate of 20%. In one cat, conversion during TDL was necessary due to excessive fat within the mediastinum. This finding had been seen on the preoperative CTLA and dissection proved to be too difficult without risking transection of the thoracic duct. A second case experienced mild bleeding during TDL and conversion was deemed to necessary to control the hemorrhage. For cats in which thoracoscopic pericardectomy was initiated (11 cats), conversion was necessary in one case due to poor visualization; however, the cause for decreased visualization was not noted in the medical record. Three cats underwent planned thoracotomy or thoracotomy after TDL conversion for completion of the pericardectomy. No cats died during the operative period. A summary of surgical procedures and outcomes is detailed in Table 1.

3.5 | Postoperative complications and outcome

No cats underwent postoperative CTLA immediately or in the long term. At the time of the study, only four cats were alive at the time of last follow up with a median follow up time of 8 months (range 1–31). Postoperative complications occurred in eight cats (53.3%) in the perioperative period with four cats (26.6%) not surviving to discharge. Complications included persistent effusion (5), arrythmia and/or hypotension (2), cardiac or respiratory arrest (2), need for transfusion (1), and coma (1). Of the five cats with continued effusion postoperatively, one was euthanized while still in hospital. In the remaining four cats discharged with pleuraport effusion, a PlueraPort was placed prior to discharge in a separate procedure in one cat and two cats were euthanized related to their persistent effusion. In the remaining cat, the effusion had resolved on recheck radiographs at 1 month postoperatively.

A total of 11 cats survived to hospital discharge. Seven cats had no evidence of effusion at the time of discharge and four had persistent effusion. Two cats died acutely at home within 1 month of discharge without documented recurrence of effusion. Three cats developed recurrent effusion and were euthanized between 1 week and 8 months postoperatively due to recurrent or persistent effusion, and two cats died from unrelated causes at 10 and 25 months postoperatively. The overall mortality rate directly attributed to the chylothorax within the study time frame was 7/15 cats (46.6%) with five cats dying within 1 week of surgery, and six within 1 month (Table 2).

4 | DISCUSSION

A thoracoscopic approach to TDL combined with minimally invasive pericardectomy or CCA did not improve outcomes for cats as compared to traditional open surgical approaches.[5] Mortality related to feline chylothorax remained high (46.6%); however, the cases here resulted from postoperative decline or recurrence of effusion rather

TABLE 1 Summary of individual case outcomes for cats with idiopathic chylothorax.

	Conversion for TDL	Conversion for pericardectomy	Other procedures	Continued effusion post op	Survival to discharge	Alive at 1 week	Alive at 1 month post op	Effusion at 1 week post op	Effusion at 1 month post op	Cause of death
1	No	Yes		Yes	Yes	Yes	No	Yes	-	Euthanasia due to chylothorax after discharge
2	No	No		No	Yes	Yes	Yes	No	No	Died of unrelated cause
3	No	No	Pleural port placement	Yes	Yes	Yes	No	Yes	-	Euthanasia due to chylothorax after discharge
4	No	No		No	No	-	-	-	-	Euthanasia before discharge
5	No	-	Open pericardectomy, pleural port placement	No	Yes	Yes	No	No	-	Unknown
6	No	No		No	Yes	Yes	No	No	-	Unknown
7	Yes	-	Open pericardectomy	Yes	Yes	Yes	Yes	Yes	No	-
8	No	No		No	Yes	Yes	Yes	No	Yes	-
9	No	No		No	Yes	Yes	Yes	No	Yes	Euthanasia due to chylothorax after discharge
10	No	No		No	Yes	Yes	Yes	No	No	-
11	No	No		No	No	-	-	-	-	Cardiac arrest before discharge
12	No	-	Laparoscopic CCA	No	No	-	-	-	-	Euthanasia before discharge
13	No	-	Laparoscopic CCA	Yes	Yes	Yes	Yes	Yes	Yes	-
14	No	No		Yes	No	-	-	-	-	Euthanasia before discharge
15	Yes	-	Open pericardectomy, open CCA	No	Yes	Yes	Yes	No	No	Died of unrelated cause

Abbreviations: CCA, cisterna chyli ablation; TDL, thoracic duct ligation.

TABLE 2 Summary of outcomes of VATS treatment of idiopathic chylothorax in cats.

Outcomes	Number (%)
Conversion to open surgery	
TDL	2/15 (13%)
Pericardectomy	1/11 (9%)
Postoperative complications	
Persistent effusion	5/15 (33%)
Arrythmia/hypotension	2/15 (13%)
Cardiac/respiratory arrest	2/15 (13%)
Coma	1/15 (7%)
Transfusion	1/15 (7%)
Death or euthanasia prior to discharge	4/15 (27%)
Resolution of effusion at discharge	7/11 (64%)
Recurrence of effusion	1/7 (14%)

Abbreviations: TDL, thoracic duct ligation; VATS, video-assisted thoracoscopic surgery.

that intraoperative complications. The findings of the current study further demonstrated the challenge in treating feline idiopathic chylothorax. Further re-evaluation of the underlying pathology of idiopathic chylothorax and the current treatment algorithm should be considered to improve the outcomes in cats with this frustrating disease.

VATS TDL and/or pericardectomy appeared to be a technically feasible procedure with minimal intraoperative complications and a rate of conversion similar to that in dogs.[17] A successful left-sided approach to the thoracic duct was achieved in this study with cats positioned in sternal or right lateral recumbency despite the smaller body size and inherent increase in technical challenge. Additionally, in this series, TDL was able to be performed in these small cases without the use of one lung ventilation and without significant morbidity to the patient. This may be reflective of the fact that all surgeons were skilled in minimally invasive procedures. In one case of conversion for TDL, a large volume of mediastinal fat was seen on preoperative CT and subsequently this was found to preclude the safe dissection of the thoracic duct; demonstrating that case selection remained important for successful outcomes in minimally invasive techniques.

In cases of idiopathic chylothorax, preoperative CTLA and intraoperative lymphangiography are performed to aide in surgical planning by outlining the course and number of branches of the thoracic duct. CTLA has been described experimentally in healthy cats and dogs with injection of contrast into the popliteal lymph node[24] and mesenteric lymph nodes,[25] and in dogs with injection into the perianal region[26] with high success rates of visualizing the thoracic duct. Given that most studies describing this imaging technique are performed in healthy animals, recommendations for the most successful site for injection in clinical cases remains questionable. In this study, injection of contrast into the popliteal lymph node or tarsal pad most commonly resulted in a successful CTLA, while injection into a mesenteric lymph node or into the perianal region was not successful in any cats. Two recent studies of naturally occurring idiopathic chylothorax in dogs and cats demonstrated a 90% success rate of visualizing the thoracic duct with CTLA following injection of iohexol into the metatarsal pad.[27,28] The variability and low number of successful CTLA in the present study limited objective conclusions for the ideal injection site; however, the success of tarsal pad and popliteal lymph node injections suggested that these sites may be preferred for achieving a successful CTLA in cats clinically affected by idiopathic chylothorax. No cats in the study underwent postoperative CTLA, either immediately or at recurrence of effusion. A previous study showed that manipulation of the TDL alone may cause transient occlusion of the thoracic duct with CTLA.[29] Additionally, a more recent study found that persistent, patent thoracic ducts were present in 50% of dogs undergoing CTLA 1 week following VATS TDL and pericardectomy, including the appearance of ducts that were not visible in the preoperative scans.[30] These ducts were thought to be a result of collateral lymphatic flow that were collapsed prior to TDL, and that an increase of pressure within the lymphatic system following TDL opened these ducts and resulted in persistent effusion. The significance of additional collateral lymphatic flow in cats has not been evaluated but could be a contributing factor in the outcomes of surgical treatment of idiopathic chylothorax in this population. As such, repeated imaging of the lymphatic system could present an area for improvement of outcomes.

Dogs undergoing surgical treatment for idiopathic chylothorax have achieved durable resolution of the effusion with no lasting detriment to their health. The goal of TDL ligation is to occlude the duct and stimulate new lymphaticovenous connections to form within the abdominal cavity. A previous study demonstrated that ligation of the thoracic duct in healthy cats without chylothorax does result in these lymphaticovenous anastomoses, and so the current surgical algorithm of thoracic duct ligation should result in a similar resolution of chylothorax in cats if their disease pathology or progression is similar to dogs.[29,31] Rather it is plausible that chylothorax in cats represents a differing underlying pathophysiology that make them more prone to poorer outcomes. In this study, one cat had evidence of lymphangiectasia on biopsy of the liver at the time of surgery which could point to a diffuse lymphatic disruption manifesting as chylothorax rather than a primary issue within the thoracic duct system. In humans, lymphangiomatosis or diffuse lymphatic malformations have been documented to present with chylothorax.[32,33] In these cases, ligation of the thoracic duct alone would fail to resolve pleural effusion as chyle is not the only component of lymphatic drainage toward the thorax. For example, the lymphatics draining the cranial aspect of the cat would not contain chyle, and as such a more diffuse lymphatic pathology could still result in a nonchylous, but persistent pleural effusion. and result in persistent effusion. Additionally, the chronic exposure of the pleural space to chyle has secondary ramifications which have been documented including fibrosing pleuritis.[34] It is possible that cats respond dissimilar to dogs in the face of a chronic inflammatory stimulus (i.e., chyle), resulting in more chronic changes within the thoracic cavity that worsen their ability to respond to and/or recover from surgery. In other instances of inflammation, such a neoplasia or infection, it has been documented that cats and dogs do not behave similarly immunologically.[35–37] Further investigation into the underlying pathophysiology of cats with presumed idiopathic chylothorax may reveal differences in the disease process between these two species.

In this study, all cats underwent TDL with a combination of additional surgical procedures including pericardectomy, CCA, and/or Pleuroport placement. Previous retrospective studies in cats and dogs have drawn variable conclusions on which of these additional procedures may improve outcomes.[5,12] The choice of which procedures to perform in this study was at the discretion of the attending surgeon, and given the number of institutions included, the surgical procedures varied widely. This is a limitation inherent to the retrospective nature of the study and the number of institutions involved to gather cases. Given the limited number of cases no definite conclusion on influence of procedure could be made.

Additional limitations to this study were related to its retrospective nature including the small number of cases, and in some cases, an incomplete medical record. A prospective study of outcomes in cats undergoing VATS treatment for idiopathic chylothorax could strengthen the above findings and allow for a larger cohort to identify possible risk factors associated with survival and outcome. Additionally, there was a limited number of cats with long term follow up (i.e., >1 year); however, given that short term outcome of most cats is poor, we concluded that the availability of longer term follow up would be unlikely to change conclusions.

In conclusion, the findings of this study supported that the long-term outcomes for cats with idiopathic chylothorax remained poor and that a minimally invasive approach to surgical treatment did not improve these outcomes. While VATS TDL proved to be technically feasible in cats, further studies evaluating the optimal preoperative and/or postoperative imaging and re-evaluating the underlying pathophysiology of this complex disease may be more eye opening for improving these outcomes.

AUTHOR CONTRIBUTIONS

Dickson R, DVM: Involved with study design and concept, data acquisition, analysis and interpretation of data, and drafting of the article. Adam A, DVM: Involved with data acquisition and contribution of cases (3). Rubio DG, DVM: Involved with data acquisition and contribution of cases (3). Cinti,F, DVM: Involved with data acquisition and contribution of cases (2). Singh A, DVM, DVSc, DACVS (Small Animal): Involved with data acquisition and contribution of cases (1). Mayhew P, BVM&S, DACVS (Small Animal): Involved with data acquisition and contribution of cases (1). Case JB, DVM, MS, DACVS: Involved with data acquisition and contribution of cases (1). Fransson BA, DVM, PhD, DACVS: Involved with study design and concept, data acquisition and contribution of cases (4), analysis and interpretation of data, and drafting of the article. All authors were involved in revising the article for intellectual content and final approval of the completed article and are in agreement of the accountability of all authors for all aspects of the work.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest related to this report.

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