Case Report
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Salvage Cisterna Chyli and Thoracic Duct Glue Embolization in 2 Dogs with Recurrent Idiopathic Chylothorax

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Case Report

Case 1

A 4-year-old male castrated English Mastiff weighing 72 kg (158 lb) was evaluated for acute dyspnea after a 1-week history of restlessness, episodes of increased respiratory effort, and inappetance. The dog was otherwise healthy and received seasonal heartworm preventative medication and routine vaccinations.

On initial examination, the dog was bright, alert, responsive, and had a body condition score of 5/9. The body temperature was 101.8°F (38.7°C), and the heart rate was 150 beats/min. There was an increased respiratory effort during both inspiration and expiration with an abdominal component. Thoracic auscultation revealed decreased lung sounds in the ventral lung fields. Heart sounds were of normal rhythm, but muffled. Femoral pulses were bilaterally symmetric, and pulse quality was strong and synchronous with the heartbeat.

A complete blood count, serum biochemistry profile, and coagulation screen were all within normal limits. Occult heartworm test and titers for *Ehrlichia canis* and *Borrelia burgdorferi* were negative. Thoracocentesis yielded 0.575 L of a milky, turbid fluid from the right hemithorax and 1.5 L of similar fluid from the left hemithorax. Analysis of the pleural fluid (using a hematology analyzer) revealed a composition of 87% lymphocytes, 9% macrophages, and 4% neutrophils, with fluid triglyceride concentration of 498 mg/dL.

Abbreviations:

PO	administered by mouth
PRN	administered as needed

The sample was too lipemic to obtain an accurate total protein concentration. No microorganisms or atypical cells were identified. Comparison of the fluid triglyceride concentration with the serum triglyceride concentration (57 mg/dL; reference interval 50–150 mg/dL), combined with cytologic findings, was consistent with chylous effusion.

Thoracic radiography revealed a small hyperlucent region in the caudodorsal thorax, suggesting mild pneumothorax presumably secondary to recent thoracocentesis. No evidence of valvular or myocardial disease was observed during echocardiogram evaluation.

The presumptive diagnosis was idiopathic chylothorax. The owners decided to pursue conservative medical management with Rutin[a] administration at 48 mg/kg (105.6 mg/lb) PO q8h. No change in diet was made at that time.

The dog returned with chylothorax 2 weeks later, and the owners decided to pursue surgical treatment by pericardectomy and thoracic omentalization via a median sternotomy. During surgery, 6 L of chylous pleural effusion was removed. All lung lobes were examined and appeared normal. The pericardium appeared grossly normal, but was partially resected and submitted for histopathology. The omentum was mobilized through the diaphragm and sutured within the thoracic cavity. Thoracostomy tubes were placed bilaterally to enable evacuation of fluid, air, or both after the procedure.

Recovery from anesthesia was uneventful. Pleural fluid production decreased dramatically within the next 4 days, and the dog was discharged with Rutin treatment at 48 mg/kg (105.6 mg/lb) PO q8h. The dog was healthy and breathing normally at reexamination 1 week later. Histopathology of the pericardium revealed severe mesothelial cell proliferation with lymphoid infiltration of the pleural surface. Continued treatment with Rutin was recommended for an additional 4 weeks until reexamination.

The dog was readmitted 1 year later with a decreased appetite, weight loss of 3.3 kg (7.3 lb; 4.6% of body weight), tachycardia, tachypnea, and recurrence of pleural effusion identified on referral thoracic radiographs. Because of return of the previous clinical

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signs, Rutin had been administered for the previous 3 days at 48 mg/kg (105.6 mg/lb) PO q8h. Four liters of a grossly similar fluid were evacuated from the right hemithorax via thoracocentesis; a cell count was not obtained at this visit. The pleural fluid triglyceride concentration (385 mg/dL) was higher than serum triglyceride concentration (92 mg/dL). Aerobic culture of the pleural fluid yielded *Enterococcus faecalis* after 48 h, and this was considered to be a contaminant in light of the dog's stable condition and clinical signs.

Additional treatment options discussed with the owner included thoracic duct ligation and cisterna chyli/thoracic duct glue embolization. Pleural adhesions from the previous thoracotomy and omentalization were expected to make thoracic duct identification and ligation difficult at surgery, and therefore, the owners elected to have transabdominal cisterna chyli and thoracic duct glue embolization performed.

Four hours before the induction of anesthesia, 30 mL of corn oil (0.45 mL/kg; 0.99 mL/lb PO) was administered to the dog every hour to aid in visualization of the lymphatic system. Perioperative cefoxitin[b] was administered at 30 mg/kg (66 mg/lb) IV once, followed by 15 mg/kg (33 mg/lb) IV q2h during anesthesia.

The dog was placed under general anesthesia and a ventral midline approach to the abdomen was made. The lymphatics in the abdomen were easily visualized after the administration of corn oil, and the dilated efferent mesenteric lymphatics between the cecocolic lymph nodes and cisterna chyli were identified (Fig 1). An efferent mesenteric lymphatic was bluntly dissected and isolated with stay sutures using 4-0 polydioxanone.[c] A 12-inch, 22-gauge through-the-needle catheter[d] was threaded ~2 cm into the lymphatic lumen. The catheter was secured in place with ligatures and a tacking suture to the adjacent intestinal wall. A second mesenteric lymphatic was dissected, isolated with stay sutures, and catheterized in a similar fashion with a 3 French introducer. Two catheters were placed for security in case one became dislodged during transfer to the angiography suite.

Thoracic duct lymphangiography was performed by injecting aqueous contrast material[e] (5–10 mL) into the preplaced catheter. The efferent lymphatics, cisterna chyli, and thoracic duct branches were easily identified after opacification (Fig 2A–C). The catheter was then flushed to clear the contrast material with a 5% dextrose solution with water (D5W)[f] to prevent glue polymerization within the catheter. The glue embolization mixture was prepared by combining equal volumes of isobutyl-2-cyanoacrylate[g] and lipiodolized poppy seed oil[h] in a small sterile glass basin. Because of the anticipated rapid polymerization time (~5–10 s) upon exposure to ionic fluids, the glue mixture was injected (total glue injected = 3 mL) into the lymphatic catheter under fluoroscopic visualization and during positive pressure ventilation until the glue embolus was observed in the thoracic duct at the level of T10 to T13 (Fig 2D–F). The catheter was then flushed with the D5W solution to ensure patency for follow-up lymphangiography and to prevent adhesions of the catheter to the lymphatic vessel wall. After 5 min, repeat lymphangiography was performed to confirm complete obstruction of the cisterna chyli and thoracic duct. Embolization of the cisterna chyli and thoracic duct was successful under fluoroscopic

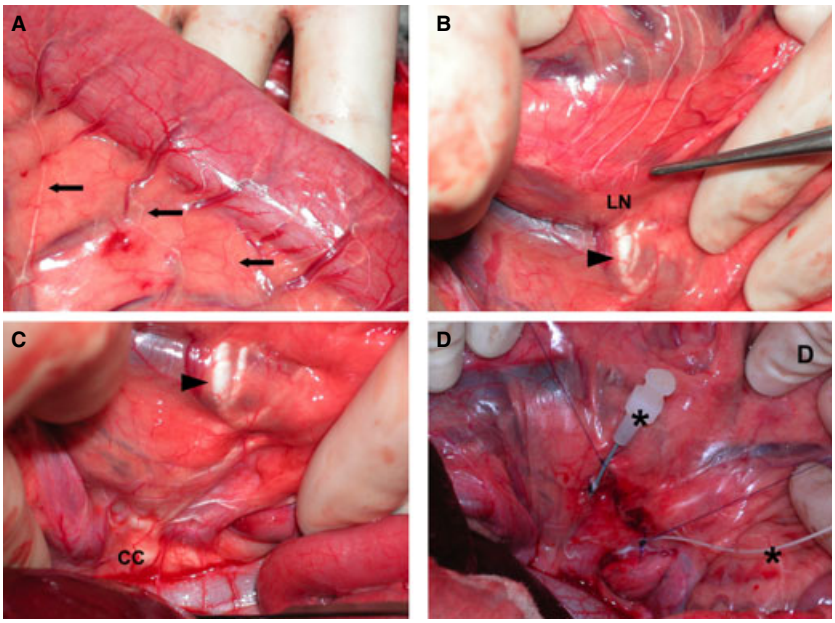

Fig 1. Intraoperative view during mesenteric lymphatic cannulation after preoperative corn oil administration. (A) Afferent lymphatics (black arrows) in jejunal mesentery. (B) Mesenteric lymph node (LN) with larger efferent lymphatics (arrowhead). (C) Efferent lymphatics (arrowhead) leading to cisterna chyli (CC). (D) Efferent lymphatics catheterized (*) with 3 French introducer and 22-gauge catheter for lymphangiography and subsequent glue embolization.

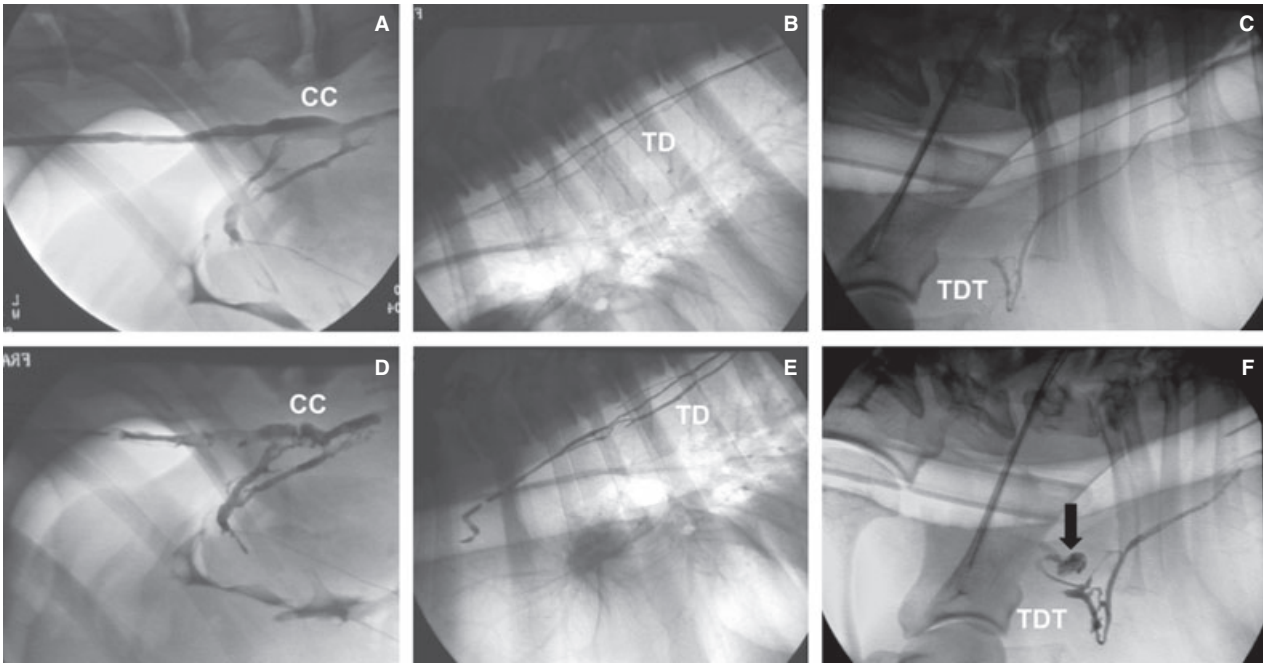

Fig 2. Intraoperative fluoroscopy during cisterna chyli and thoracic duct glue embolization with dog's head to the left in each image. (A) Lymphangiogram demonstrating filling of efferent lymphatics and cisterna chyli (CC). (B) Contrast seen within 2 branches of the thoracic duct (TD). (C) Contrast reaching thoracic duct termination (TDT) at the level of the jugular-subclavian angle. (D) Glue mixture filling efferent lymphatics and CC. (E) Glue mixture filling TD. Notice the increased number of branches apparent as branches occlude and allow filling of other previously unidentified branches. (F) Glue mixture filling TDT with small glue embolus present in pulmonary arterial system (black arrow). This degree and length of thoracic duct filling is beyond what was planned.

observation and the abdominal incisions were closed routinely. The duration of the procedure was 180 min.

The dog recovered uneventfully in the intensive care unit and was closely monitored overnight. Analgesics and medications administered after the surgery included hydromorphone[i] (0.1 mg/kg; 0.22 mg/lb) IM PRN, carprofen[j] (4 mg/kg; 8.8 mg/lb) IV once, two 100 μg/h transdermal fentanyl patches[k] (3 μg/kg; 6.6 μg/lb), famotidine[l] (0.5 mg/kg; 1.1 mg/lb) IV q24h, and crystalloid fluid therapy. The dog was discharged the next day with instructions to feed a low-fat diet consisting of turkey and rice. Administration of the Rutin was discontinued.

Five days after the procedure, the dog returned to the Emergency Service with dyspnea and an increased respiratory rate. Thoracic ultrasonography confirmed the presence of pleural effusion, and therapeutic thoracocentesis produced 2.5 L of uncharacterized fluid (not submitted for analysis) from the right hemithorax and 1.25 L of uncharacterized fluid from the left hemithorax. An additional therapeutic thoracocentesis was necessary 1 week later when 4.18 L of serosanguinous fluid was removed from the left hemithorax. At that time, fluid analysis revealed a pleural fluid triglyceride concentration of 47 mg/dL.

At reexamination 4 weeks after the procedure, the dog appeared bright, alert, and responsive, with an improvement in appetite and no apparent respiratory difficulty. Thoracic radiography identified a mild pleural effusion. The embolization glue was in place; however, a small piece (~0.1 × 0.8 cm) migrated to a branch of the right pulmonary artery and appeared to be of no clinical concern at that time (Fig 3). A consolidated area of the right middle lung lobe was also evident, suggesting either a consequence of the underlying disease process or pneumonia. The dog appeared to be in good health and plans were made to monitor the dog through subsequent examinations without medication.

Four weeks later, the dog presented with enlarged mandibular lymph nodes and a mass at the back of the head. Fine-needle aspirates of both lymph nodes demonstrated reactivity and revealed no evidence of neoplasia at that time; aspiration of the mass at the back of the head was declined. Eight weeks later, the dog died at home of unknown cause, ~4 months after cisterna chyli and thoracic duct glue embolization. A necropsy was not performed.

Case 2

A 3-year-old, 58-kg (128 lb) male castrated Great Dane was admitted for treatment of recurrent chylothorax. The dog was originally evaluated 22 months prior for acute respiratory distress secondary to right middle lung lobe torsion and concurrent chylothorax. A right middle lung lobectomy and subtotal pericardectomy were performed at that time through a right lateral thoracotomy. Complete resolution of the chylothorax

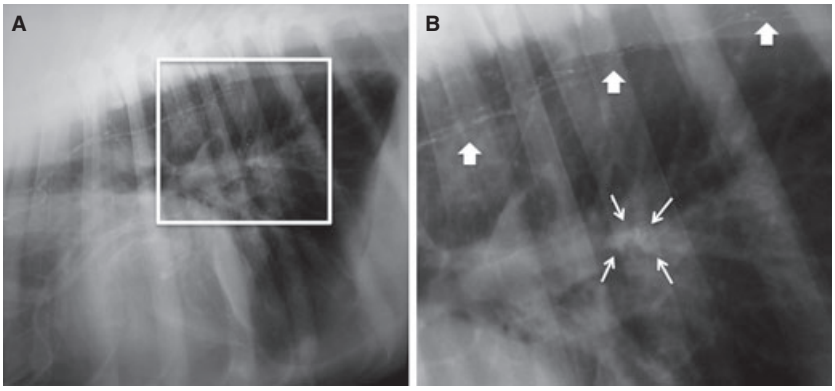

Fig 3. Four-week postprocedure lateral thoracic radiograph of Case 1. (A) A white square marks the area magnified in 3B. (B) Notice the radio-opaque glue embolus present in the pulmonary vasculature (thin arrows) as well as the persistent radio-opaque glue mixture seen in the thoracic duct branches (block arrows).

occurred 2 weeks after surgery. The dog was then evaluated 20 months later for tachypnea secondary to a recurrence of chylothorax. Thoracoscopic thoracic duct ligation was offered to the owners who consented to the procedure. The procedure was performed successfully, and the chylothorax again resolved.

Unfortunately, 2 months after the procedure, the dog's respiratory status worsened, warranting evaluation for presumptive recurrent chylothorax. Thoracic radiography revealed a right-sided mediastinal shift consistent with the previous right middle lung lobectomy. A significant amount of pleural effusion was also noted, and fluid analysis after thoracocentesis was consistent with a chylous effusion. Echocardiographic findings were within normal limits.

The dog was administered heavy cream PO, and embolization of the cisterna chyli and thoracic duct was performed as described in the previous case; a total of 1.8 mL of glue was administered during this procedure. Upon removal of the catheter from the abdominal lymphatic vessel, a small piece of the distal end of the catheter adhered to the glue in the lymphatic vessel. It was transected and left in place. Before the completion of anesthesia, a thoracic drain connected to a subcutaneous port was placed within the thoracic cavity to allow for drainage of any fluid that accumulated in the thorax after the procedure (Fig 4). The duration of the procedure was 153 min.

The dog experienced no difficulty under anesthesia and recovered uneventfully. The dog was discharged from the hospital 6 days after admission. Four days after discharge, the dog was again admitted to the hospital for an increase in his respiratory rate and effort. On physical examination, the dog had a markedly distended abdomen and palpable abdominal fluid wave. The dog's bronchovesicular sounds were dull ventrally and radiographs demonstrated the presence of pleural and abdominal effusion.

The pleural effusion was diagnosed as a transudate (total protein <2.5 g/dL, nucleated cell count 300/μL, no triglyceride concentration obtained), and the abdominal effusion was chylous (triglyceride concentration 523 mg/dL). The peripheral venous triglyceride concentration was 52 mg/dL. Bacterial culture of the abdominal effusion demonstrated no growth.

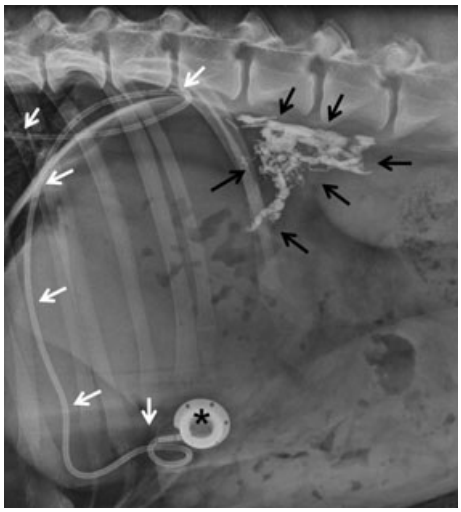

Fig 4. Lateral thoracic radiograph obtained 1 day postoperatively in Case 2. The radio-opaque glue mixture fills the cisterna chyli (black arrows) up to the surgical clips. More thoracic duct filling would have been preferable. The thoracic drainage catheter (white arrows) and subcutaneous port (*) are visible.

Two more thoracocenteses were performed at 30 and 34 days after the procedure and chylothorax was confirmed at both visits. Because of worsening of his overall condition (anorexia, lethargy, weight loss) and continued pleural effusion, the dog's owners elected humane euthanasia 50 days after cisterna chyli/thoracic duct glue embolization. Necropsy was declined.

Chylothorax is a condition characterized by an abnormal accumulation of lymphatic fluid (chyle) within the pleural space. Medical management of chylothorax should be directed at treating the underlying disease process when identified. Animals that fail to respond to medical management should be considered for surgery. Common surgical options include open or thoracoscopic thoracic duct ligation and pericardectomy, with other techniques such as thoracic omentalization, cisterna chyli ablation, pleurodesis, and active

pleuroperitoneal or pleurovenous shunting having been described.[1–9] The most widely accepted form of surgical intervention for idiopathic chylothorax is thoracic duct ligation; however, the success of this procedure alone resulting in complete resolution of pleural effusion is only evident in ~50% of affected dogs and <40% of affected cats.[4,5]

As persistence and recurrence after the medical and surgical treatment of chylothorax are common in dogs and cats, alternative therapies and techniques need to be considered in the primary treatment of the disease. In addition, the use of alternative options after failed initial therapy needs to be further investigated. Thoracic duct glue embolization involves the use of liquid embolics such as butyl cyanoacrylate combined with contrast material to aid in visualization during lymphangiography.

Because of the variation in thoracic duct anatomy in dogs, embolizing the duct with glue could be much more efficient than ligating the duct and all of its collateral branches, as the liquid agent will hypothetically diffuse readily into the various lymphatic branches. Theoretically, when performing thoracic duct ligation, chyle leakage can occur caudal to the level of the ligation. Embolization of the entire duct from the cisterna chyli cranially would address this concern. While there is some concern about leaving the glue in place permanently, the isobutyl 2-cyanoacrylate mixture is inert and has been shown to inhibit bacterial growth.[10,11]

Distant, nontarget embolization is a potential serious complication of this procedure. In 1 dog of this report, glue was noted in a pulmonary artery, although this complication resulted in no clinical signs in this dog over a 6-month period after the procedure. Brief positive pressure ventilation can be used to stop cranial flow of the embolus until polymerization of the glue is complete.[10,11] In the second case, the tip of the catheter became adhered to the lymphatic vessel, necessitating leaving the tip in place. This was a technical error on the surgeon's part in that the catheter should have been removed more quickly before glue polymerization. It is anticipated that, with additional experience, the incidence of such a complication should be minimized. There were no known subsequent deleterious effects identified resulting from this complication.

Our initial experience with this interventional procedure has proven successful by achieving complete obstruction of the cisterna chyli and thoracic duct. The first dog in this report demonstrated complete resolution of chylothorax when evaluated ~4 months after the procedure, although a serosanguinous effusion was noted initially 5–12 days after treatment. It is possible that this effusion was an inflammatory reaction secondary to pleuritis caused by the chronic chylous effusion. Unfortunately, the dog returned 2 months postembolization with lymph node enlargement and a mass on the back of the head. Lymph node aspirates submitted for cytology revealed no evidence of neoplasia. Further diagnostics were declined and the dog died at home 2 months later with no documented return of respiratory complications.

The second dog had a very temporary resolution similar to the previous thoracic duct clipping. Unfortunately, a necropsy was not performed to identify the underlying lesions and source of the chyle. As this dog had undergone previous thoracic duct ligation, it is possible that the glue did not travel beyond the previously placed clips, but did fill the cisterna chyli. This could have simultaneously resulted in the resolution of chylothorax and the development of chylous ascites. It is unknown why the transudate in the thorax later redeveloped into a chylous effusion, although this could be a result of the development of chylous ascites or failure of the glue embolization to cause long-term chylothorax in that particular case.

Cisterna chyli and thoracic duct glue embolization successfully controlled the accumulation of chyle within the thoracic cavity in the first dog, and this technique could be useful in other cases in which standard therapies have failed or been declined. In addition, percutaneous catheterization of the thoracic duct was recently described in healthy dogs and could hold promise as part of the future treatment of chylothorax in clinically affected dogs, although the procedure was determined to be technically difficult.[12] Further evaluation could help determine whether this technique could be considered as a less invasive, primary treatment option.

Footnotes

[a] Nature's Plus, Amityville, NY
[b] Orchid Chemicals & Pharmaceuticals Ltd, Apotex Corp, Weston, FL
[c] PDS™, Ethicon Inc, Somerville, NJ
[d] I-CATH, C.R. Bard Inc, Murray Hill, NJ
[e] Renovist, Squibb & Sons Inc, Princeton, NJ
[f] Hospira Inc, Lake Forest, IL
[g] Aron Alpha Type 501, Vigor Co, New York, NY
[h] Pantopaque, Lafayette Pharmacal Inc, Lafayette, IN
[i] Dilaudid®, Baxter Healthcare Corp, Deerfield, IL
[j] Rimadyl®, Pfizer Animal Health, Pfizer Inc, New York, NY
[k] Mylan Pharmaceuticals Inc, Morgantown, WV
[l] Bedford Labs, Bedford, OH

Acknowledgments

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Conflict of Interest: Drs Weisse, Culp, and Berent have all spoken at laboratories sponsored by a company that makes instrumentation that may be used to perform some of these procedures. In addition, Drs Solomon and Weisse are both equity holders of the same company. None of the instrumentation specifically made by that company are footnoted here (as it was not used on these 2 cases), but if the procedure is

to be performed in the future, it may be used instead of some of the instrumentation designated here.

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