Robotic-assisted thoracoscopic thoracic duct ligation with fluorescence imaging with indocyanine green for chylothorax after thoracoabdominal aneurysm repair

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ABSTRACT

Postoperative chylothorax (POC) is an uncommon complication after thoracoabdominal aortic aneurysm (TAAA) open surgical repair. We report the case of a 70-year-old woman previously treated with ascending aorta replacement who presented with a 60-mm extent II TAAA. TAAA open surgical repair was performed. A POC was diagnosed on postoperative day 5. After failed conservative therapy, on postoperative day 24 a robotic-assisted thoracic duct (TD) ligation using indocyanine green fluorescence achieved POC complete resolution, the patient tolerated a full diet and was discharged. At the 3-month clinical follow-up, the patient is well. Robotic-assisted thoracic duct ligation with indocyanine green provided effective minimally invasive treatment with good results. (J Vasc Surg Cases Innov Tech 2025;11:101807.)

Keywords: Aortic aneurysm; Thoracoabdominal aortic aneurysm; Chylothorax; Robotic surgery; Indocyanine green; Fluorescence

Postoperative chylothorax (POC) is an uncommon complication after surgical procedures involving the descending thoracic/thoracoabdominal aorta, ranging from 0.4% to 2.0%.[1] Diagnosis is suspected when there is a change in thoracic drainage, presenting a milky appearance and increased thoracic drainage, and may be associated with dyspnea.[1,2]

When treated conservatively, POC may be associated with malnutrition, infection, immune dysfunction, and mortality as high as 30%.[3] Management may include dietary alternatives, including total parenteral nutrition (TPN), drugs, and surgical procedures. Operative intervention after thoracoabdominal aortic aneurysm (TAAA) open surgical repair (OSR) usually consists of thoracic duct (TD) ligation via right thoracotomy or video-assisted thoracoscopic surgery (VATS).

The robotic approach for POC was first described in 2007 by Thompson et al.[4] To the best of our knowledge, there are no previous reports of POC after OSR of TAAA managed with robotic surgery. We report the case of a 70-year-old woman with POC after TAAA OSR, who underwent TD identification and ligation with robotic surgery using fluorescence imaging with indocyanine green (ICG). The patient gave her consent for publication.

CASE REPORT

A 70-year-old woman with hypertension, dyslipidemia, and a history of smoking was admitted for an extent II TAAA. At the age of 66, she underwent ascending aorta replacement.

Laboratory tests and preoperative workup were within the normal range. Computed tomography angiography showed a 60-mm extent II TAAA, with an anatomical variant of the hepatic artery arising from the aorta (Fig 1).

A TAAA OSR was performed according to our standard approach,[5] using somatosensory evoked potentials, motor evoked potentials, and transesophageal echocardiography monitoring. Cerebrospinal fluid drainage was performed with LiquoGuard 3.0 (LiquoGuard-Möller Medical, Fulda, Germany), an automated system for cerebrospinal fluid drainage measurement and drainage.[6] The incision was performed in the fifth intercostal space. After exposure of the aorta, the patient was connected to the left heart bypass. The proximal aortic cross-clamping was placed distally to the left subclavian artery. Using a 28-mm Dacron graft, the thoracoabdominal aorta was replaced, with reimplantation of the celiac trunk, hepatic artery, superior mesenteric artery, and right renal using the Carrel patch technique, an aortorenal bypass for the left renal was performed with an 8-mm bypass. The renal arteries were perfused with cold histidine-tryptophan-ketoglutarate solution (Custodiol-Dr Franz-Kohler Chemie, Bensheim, Germany) and the visceral arteries with hematic perfusion. Reimplantation of three pairs of intercostal arteries was performed with an 8-mm bypass, although intraoperative somatosensory evoked potentials and motor evoked potentials were within the normal range. Two chest tubes were positioned in the left hemithorax (32F straight and 28F angled tube).

After surgery, the patient was transferred to the intensive care unit. On postoperative day (POD) 1, she was extubated and

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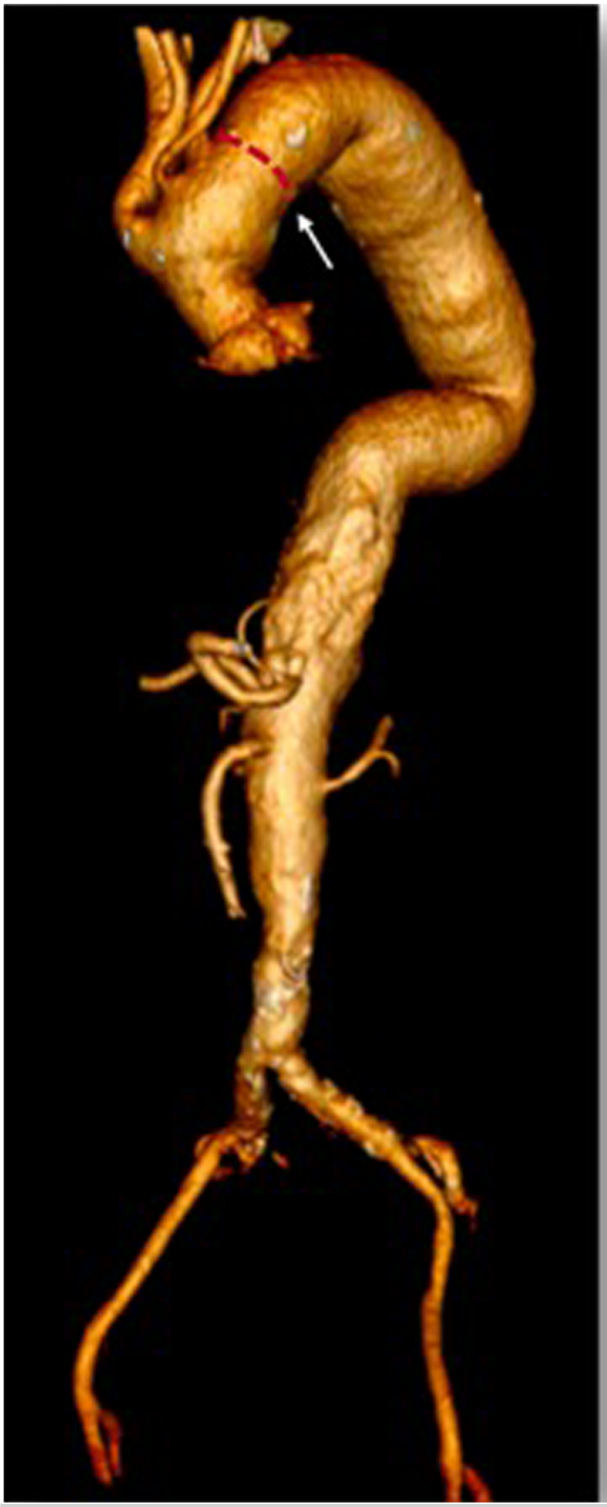

Fig 1. Preoperative computed tomography angiography. The preoperative computed tomography angiography (three-dimensional volume rendering reconstruction) showed an extent II thoracoabdominal aortic aneurysm (TAAA), with a maximum diameter of 60 mm, with an anatomical variant for the origin of the right hepatic artery arising from the aorta. The site of the proximal aortic cross-clamping is detailed with a *white arrow*.

neurologically intact; however, she developed a transitory paraplegia, probably caused by hemodynamic status and pressure fluctuations. The hemodynamic status was treated using fluid administration and vasopressors, and the paraplegia promptly and fully recovered. On POD 2, the patient was transferred to our surgical ward. Respiratory insufficiency occurred, secondary to pneumonia (POD 4), with a positive blood culture for *Klebsiella pneumoniae*.

On POD 5, after resuming solid food intake, the thoracic drainage showed a milky appearance and increased in quantity. On POD 6, a chest radiograph showed left pleural effusion with areas of atelectasis.

Treatment with dietary restrictions of fats and pharmacological therapy with somatostatin was attempted, with no improvements, for 2 weeks. Then, TPN was administered; however, the patient experienced an 8-kg weight loss despite the nutritional program. Computed tomography angiography, performed on POD 18, confirmed left pleural effusion with atelectasis.

Owing to failed medical management, on POD 24 she underwent a TD ligation via robotic surgery with fluorescence imaging with ICG, via robotic and three ports of 8 mm. A three-portal approach with three arms was performed, and the incisions made at the fifth right intercostal space on the anterior axillary line, seventh intercostal space on the anterior axillary line, and eighth space on the line of the scapula (Fig 2). The DaVinci Xi system, featuring an integrated fluorescent camera mode, was used. Before the sterile draping of the patient and docking of the robot, the right inguinal region was accessed, and a 27G spinal needle was advanced into a lymph node, according to the technique previously reported in literature.[7-9] Once 10 mL of ICG was slowly injected into the lymphatic system, the needle was removed. The operative field was prepared, and the robot docked and thoracic incisions began. When lights were out in the thorax, a clear signal in the TD was observed within 5 to 10 minutes after injection, and the ICG allowed clear identification of the TD, whereas with the normal thoracoscopy, the TD location could only be inferred from the anatomical markers (Fig 3, *A* and *B*). The azygos vein required mobilization (Fig 4, *A-D*), and the TD was doubly ligated with a nonabsorbable suture. A 28F angled chest tube was placed. The postoperative course was uneventful, and the procedure resulted in a fast POC resolution. The patient resumed solid food intake 2 days after the procedure. The 28F tube was removed 3 days after surgery. After another week of hospitalization, the patient was discharged tolerating a full oral diet. At the 3-month clinical follow-up, the patient is well. The chest radiograph at discharge showed complete resolution (Fig 5, *A-C*).

DISCUSSION

POC results from leakage of chylous fluid into the pleural cavity owing to damage to the TD during surgery. The condition is diagnosed clinically with milky drainage from the chest tubes, and laboratory tests may confirm the clinical suspicion, when triglyceride levels are greater than 110 mg/dL.[10]

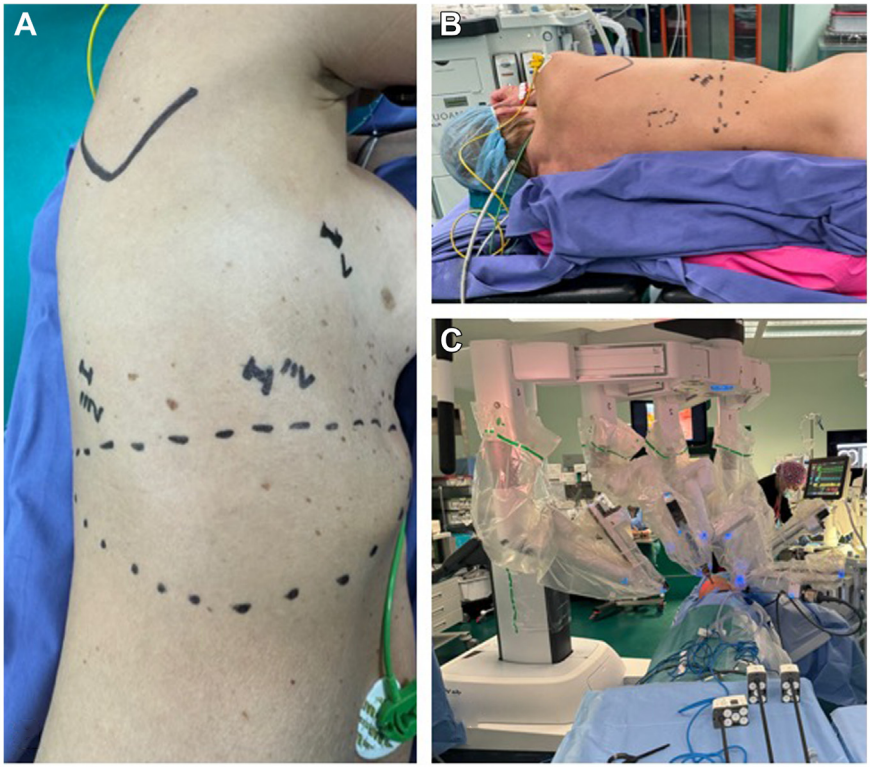

Fig 2. **(A)** Thoracic incisions. The optic is inserted at the VII space on the anterior axillary line, the utility incision is performed at the V intercostal space on the anterior axillary line and the third access at the VIII intercostal space on the line of the scapular angle. **(B)** Patient position in left lateral decubitus. **(C)** Docked robot position.

POC can lead to significant morbidity owing to the loss of fat, proteins, electrolytes, immunoglobulins, and T lymphocytes, leading to malnutrition, weight loss, and an impaired immune system, with a subsequent longer hospital stay.[11] Some authors reported that up to 40% of patients with POC after TAAA OSR needed a re-exploration for surgical control of the chylous leak, regardless of prompt initial conservative treatment, owing to prolonged chylous leak (>10 days) or persistent large-volume chylous drainage (>10 mL/kg/d).[1,11] In contrast, Uchida et al[12] have advocated an early surgical approach may be associated with decreased mortality; however, there remains debate on the optimal timing of surgical intervention.

Several authors have suggested that aortic clamping proximal to the left subclavian artery and TAAA extension may be considered as possible risk factors for POC; however, Wu et al[11] demonstrated that it was not associated significantly. A reason for the damage of the TD is its transparency (owing to the preoperative fasting period), making its identification difficult during dissection and exposure of the aorta. An uncommon additional risk factor could be the presence of an accessory or a TD anatomical variant, which may increase the risk of an unnoticed injury during dissection.[13] Notably, this patient had an anatomical variant of the right hepatic artery, and Bang et al[14] reported that TD anomalies tend to co-occur with cardiovascular anomalies.

Regardless of its etiology, when POC is identified, medical treatment may be initiated. Conservative therapy is usually the first choice based on pleural drainage and decreased chylous production. This involves dietary modifications or TPN.[15] The use of somatostatin[16,17] and octeotride[18] may reduce chylous production.[18] When conservative measures fail, an operative approach is required.[19] Traditionally, surgical treatment has involved thoracotomy or VATS approaches to ligate the TD.[20] The embolization[21] of the TD has also been described as a minimally invasive option,[22] with a clinical success rate of 52%.[23]

More recently, robotic-assisted TD ligation has emerged as an effective alternative, allowing for the benefits of a minimally invasive approach.[24] Robotic thoracic surgery, as widely discussed in literature, is associated with higher costs. Owing to the rarity of the pathology, there are no

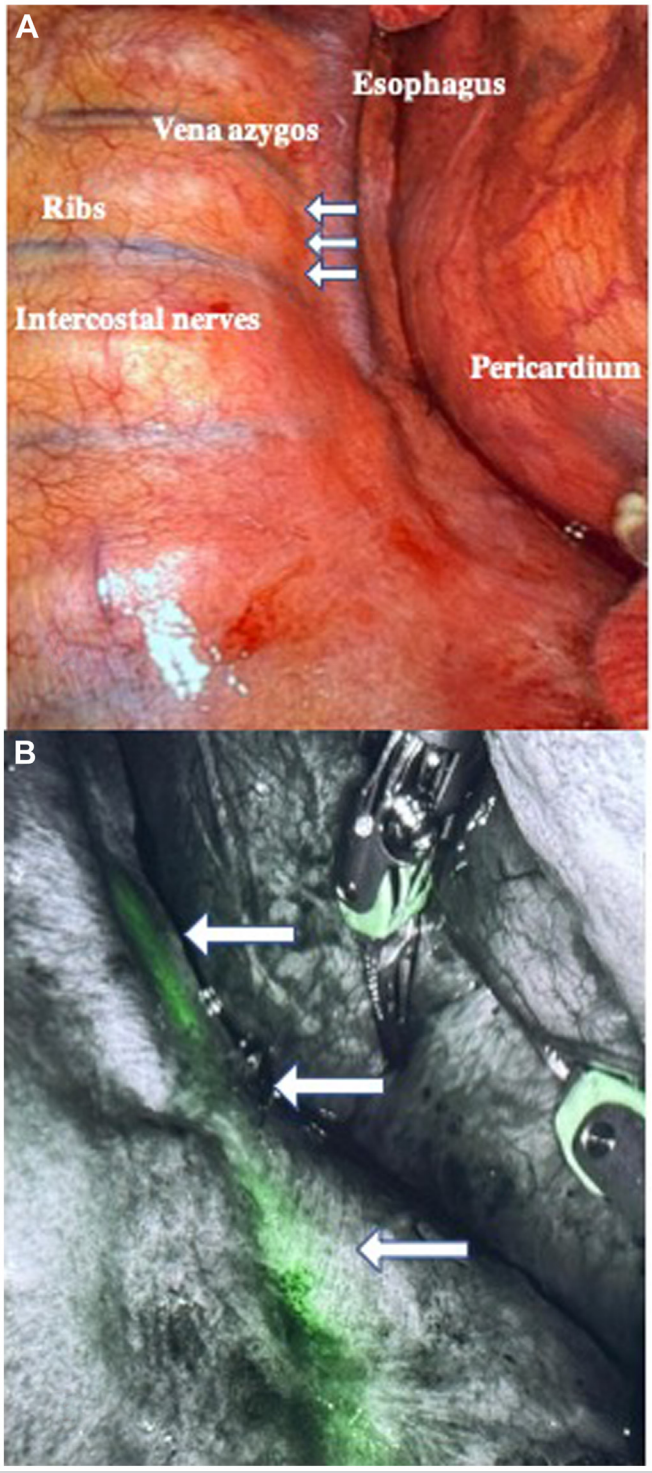

Fig 3. Identification of the thoracic duct (TD) with indocyanine green (ICG) fluorescence during robotic-assisted surgery. The normal laparoscopy lighting the location of the TD could only be imagined from the knowledge of the anatomical markers **(A)**. When lights were out in the thorax, a clear signal in the TD was observed within 5 to 10 minutes after injection, and the ICG allowed precise and clear identification of the TD (**B**, *white arrows*).

specific cost assessments for TD ligation; however, in an analysis of costs for robotic-assisted thoracoscopic surgery in an Italian public reimbursement system, the use of robotic tools was associated with an increase in the total costs of up to 14.5% (including the hospital stay) compared with standard VATS.[25]

Robotic-assisted TD ligation offers, when compared with standard VATS, several technical advantages: easy

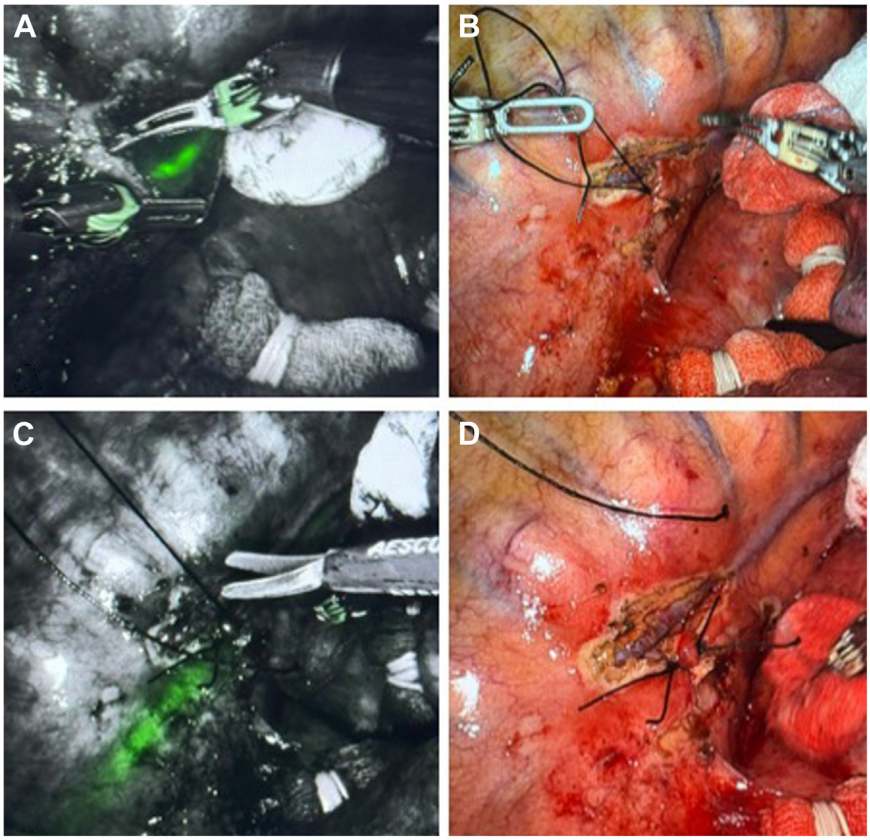

Fig 4. Thoracic duct (TD) robotic ligation. Progressive dissection of the proximal and distal site of ligation of the TD under indocyanine green (ICG) fluorescence guidance **(A)**, with the azygos vein requiring mobilization to separate the TD from it **(B)**, and double ligation of the TD with a non-absorbable suture, under ICG fluorescence guidance **(C)**. The final results visualized in thoracoscopic surgery **(D)**.

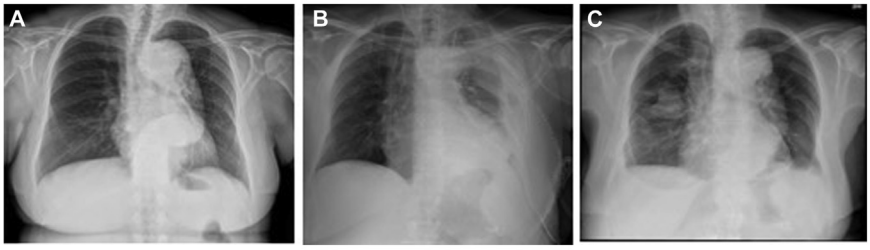

Fig 5. Chest radiograph performed at admission **(A)**, after thoracoabdominal aortic aneurysm (TAAA) open surgical repair (OSR) **(B)** and at discharge **(C)**. Before the index open operation, the chest radiograph was normal **(A)**. On postoperative day (POD) 6, the chest radiograph showed left pleural effusion, with areas of atelectasis and severe reduction of the pulmonary parenchyma **(B)**, despite the chest tube still being in place. After TD ligation, the chest radiograph showed a complete resolution of the pleural effusion, without any signs of lung fluid collections or lung atelectasis **(C)**.

handling of the instruments and quick identification and isolation of the TD and the possibility to use the same camera with infrared light mode. All these aspects provide the surgeon with direct and precise identification of the TD with ICG, facilitating precise ligation of the TD, factors that may contribute to higher success rates and lower complication rates.

CONCLUSIONS

In this case of POC after TAAA OSR, the robotic-assisted approach with ICG fluorescence imaging to identify and ligate the TD proved to be a minimally invasive option with good immediate results. Therefore, it could be considered in such patients, when conservative management fails.

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DISCLOSURES

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