

## Chylous ascites in laparoscopic renal surgery: Where do we stand?

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### Abstract

Postoperative chylous ascites, which is caused by the

disruption of lymphatic channels and persistent lymphatic leakage, was a rare complication in the urologic field before laparoscopic surgery was introduced. Now that laparoscopic urologic surgery, especially laparoscopic nephrectomy, is widely performed, chylous ascites as a complication of laparoscopic renal surgery has been reported more frequently. With these accumulated experiences and data comes knowledge about the proper diagnosis and management of chylous ascites, although there is still some debate regarding the correct protocol for diagnosis and management. Therefore, we performed a systematic review of the current literature regarding the etiology, incidence, diagnosis, management, and prognosis of chylous ascites after laparoscopic renal surgery, as well as strategies used to prevent it, and discuss current perspectives on overcoming this complication in the laparoscopic age.

**Key words:** Chylous ascites; Kidney; Laparoscopy; Nephrectomy; Postoperative complications

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**Core tip:** Now that laparoscopic renal surgery is widely performed, postoperative chylous ascites is encountered more frequently. Although most cases can be managed conservatively without any critical sequelae, severe refractory cases may cause malnutrition and immunological deficiency and require interventional treatment. To overcome this complication, early diagnosis and proper choice of management strategies are necessary. Moreover, understanding the mechanism of and postoperative chylous ascites preventing its occurrence are the most important factors. Meticulous clipping around the great vessels and the use of hemostatic agents during laparoscopic nephrectomy can reduce the incidence of postoperative chylous ascites.

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## INTRODUCTION

Since Clayman *et al*<sup>[1]</sup> first reported the use of laparoscopic nephrectomy in 1991, the technique has been widely performed and includes simple, living-donor, radical, partial nephrectomy and nephroureterectomy. There are several advantages of laparoscopic nephrectomy, such as reduced blood loss and postoperative pain, faster recovery, better cosmesis, and an earlier return to normal activities compared to open nephrectomy. Although laparoscopic nephrectomy has gained popularity due to these merits, unique complications are associated with this technique<sup>[2-5]</sup>.

Chylous ascites, which is the accumulation of chyle in the peritoneal cavity, is mostly caused by diseases that interfere with the abdominal or retroperitoneal lymphatic glands<sup>[6]</sup>. Postoperative chylous ascites, which is caused by the disruption of lymphatic channels and persistent chyle leakage, was a rare complication in urologic field before the introduction of laparoscopic surgery<sup>[6,7]</sup>. The reported incidence of chylous ascites after laparoscopic nephrectomy ranges from 0.013% to 5.9% and is more common after radical or donor nephrectomy<sup>[7-12]</sup>. Although most cases of chylous ascites after laparoscopic nephrectomy can be successfully managed conservatively without critical sequelae, severe refractory cases can develop even with proper medical management. These severe refractory cases can cause devastating complications such as malnutrition, infection, and immunological deficiency and often require invasive and aggressive treatment, because chyle is rich in fat, lymphocytes and immunoglobulins, therefore, loss of chyle means a loss of nutritional energy and immunocompetence<sup>[6]</sup>.

To our knowledge, the first case of chylous ascites after laparoscopic nephrectomy was reported by Shafizadeh *et al*<sup>[13]</sup> in 2002. It occurred after laparoscopic donor nephrectomy, and the patient was conservatively managed with an elemental diet and diuretics for 2 wk. Since that time, many case reports as well as large population-based studies have reported chylous ascites after laparoscopic nephrectomy. Although many studies demonstrated that chylous ascites after laparoscopic nephrectomy is rare, it seems this complication occurs more frequently after laparoscopic renal surgery than after open procedures.

Because laparoscopic renal surgery is becoming more common, urologists need to know how to properly diagnose and manage postoperative chylous ascites. Here, we review the current literature related to chylous ascites after laparoscopic renal surgeries as well as open procedures and discuss current perspectives on the development, management, and prevention of this

complication.

## LITERATURE SEARCH

We performed a PubMed search of the literature on chylous ascites after laparoscopic renal surgery using "chylous ascites" or "chyloperitoneum" and "nephrectomy" as the subject heading. The search yielded 58 articles, 46 of which were related to chylous ascites after renal surgery. Most (31 articles) were case reports, and of the studies with results distinguished by type of surgery, 20 studies involved donor nephrectomy, 17 involved radical nephrectomy, 7 involved simple nephrectomy, 4 involved nephroureterectomy, and 2 involved partial nephrectomy. Among these, 28 articles were associated with laparoscopic nephrectomy, including 4 retroperitoneoscopic procedures.

## ETIOLOGY AND INCIDENCE

Chylous ascites can be caused by several pathological conditions, such as congenital defects of the lymphatic system, malignant neoplasm, liver cirrhosis, blunt or surgical trauma, surgical injury to the lymphatic channels, and peritoneal infections caused by nonspecific bacteria, parasite and tuberculosis<sup>[6]</sup>. Abdominal malignancy in adults and congenital lymphatic abnormalities in children are the most common causes of chylous ascites<sup>[14]</sup>. Meanwhile, postoperative chylous ascites was a rare complication, especially in the urologic field. The mechanism of postoperative chylous ascites is operative damage to the thoracic duct, cisterna chili, or other major retroperitoneal lymphatic channel that results in lymphoperitoneal fistula formation and accumulation of chyle in the peritoneal cavity<sup>[6,7]</sup>. Thus, abdominal aortic surgery is the most common cause of postoperative chylous ascites, accounting for more than 80% of postoperative chylous complications<sup>[15]</sup>. Although the main cause of postoperative chylous ascites is abdominal aortic surgery, spinal surgeries that use a transabdominal approach or gynecologic and urologic surgeries have also been reported to cause this complication. Postoperative chylous ascites in the urologic field has traditionally been reported after retroperitoneal surgery involving extensive lymphadenectomy for testicular or kidney cancer<sup>[16-25]</sup>.

Since the introduction of laparoscopy to the field of urologic surgery, reports of chylous ascites following laparoscopic nephrectomy have become more frequent<sup>[7-9,11-13,26-46]</sup>. The reported incidence of chylous ascites after laparoscopic nephrectomy ranges from 0.6% to 5.9%<sup>[7-11]</sup>. The proposed cause for this increased incidence of chylous ascites after laparoscopic nephrectomy is that lymphatics are not routinely ligated during laparoscopic surgery, even though they are usually burned with energy-based sealing devices such as monopolar or bipolar electrocautery and ultrasonic shears<sup>[9,11,47,48]</sup>. Although chylous ascites after laparoscopic nephrectomy

is frequently reported, reported incidence of chylous ascites was quite different. These differences in incidence may be due to the differences in surgical technique among surgeons and the placement and indwelling time of the drainage catheter. If a surgeon prefers wide dissection and extensive lymphadenectomy during laparoscopic radical nephrectomy and usually performs extensive dissection around the hilar area and skeletonizing renal pedicle, aorta, and/or inferior vena cava during any type of laparoscopic nephrectomy, the incidence of postoperative chylous ascites may increase. In addition, many milder cases of chyle leak due to minor lymphatic channel disruption can improve spontaneously, without the need for any additional treatment. However, routine placement of the drainage catheter and indwelling it until oral intake is resumed may lead to early diagnosis of these milder cases of chylous ascites, which can spontaneously improve and may not be diagnosed if a drainage catheter is not placed<sup>[7]</sup>. This may be another reason for the variation in the reported incidence of chylous ascites after laparoscopic nephrectomy.

## DIAGNOSIS

Chylous ascites is defined by the presence of chylomicrones, which are however difficult to measure, so that triglycerides are usually taken as surrogate parameters. Use of an indwelling drainage catheter is the easiest and earliest means by which to diagnose postoperative chylous ascites. If the color of the drainage fluid changes to milky white, chylous ascites can be suspected. However, if a drainage catheter is not placed, early diagnosis is difficult. Moreover, the milky aspect may be misleading if the patient is fasting (in the absence of fat absorption, no triglycerides are transported) or if the ascites is chylous and bloody, which may resemble pus. Clinical diagnosis can be made by physical signs and symptoms of peritoneal fluid accumulation, similar to those of ascites due to other causes, including abdominal distention, dyspnea due to limitations of diaphragmatic movement, and weight gain. Nonspecific gastrointestinal symptoms such as nausea, vomiting, dyspepsia, and rarely wound site ascites leakage can be present. Most studies did not mention the time to presentation of these symptoms, but it is generally variable, ranging from several days to months after surgery<sup>[6]</sup>.

When patients present these symptoms and accumulation of ascitic fluid is found by physical examination and/or imaging studies, such as abdominal ultrasound or computed tomography (CT), chylous ascites can be confirmed by analyzing the ascites obtained by diagnostic paracentesis. It is typically milky in color, odorless, and sterile, and it has a high triglyceride content (usually 2- to 8-fold that of plasma or greater than 150-200 mg/dL)<sup>[6,7]</sup>. However, sterility is not necessary for the diagnosis of chylous ascites, which may become superinfected.

Several imaging techniques can be used to diagnose chylous ascites. CT can be used to confirm the

accumulation of ascitic fluid in the peritoneal cavity, but CT findings are not specific to chylous ascites, and it is indistinguishable from urine, bile, bowel secretions, and simple ascites<sup>[6,49]</sup>. Lymphangiography is useful for the diagnosis of chylous ascites, enabling localization of the exact site of injury to the lymphatic channels<sup>[50]</sup>. However, an invasive procedure must be performed to find the exact site of chyle leakage, which is not necessary for cases that can be managed conservatively. Thus, lymphangiography should be considered for patients in whom conservative treatment fails and for whom surgical repair is planned to localize the exact site of chyle leakage<sup>[7]</sup>. Lymphoscintigraphy and radionuclide scans, such as a simple diaminetriamine-pentaacetic acid renal scan, can also be used as noninvasive, physiological radiologic diagnostic tools for the diagnosis of chylous ascites. Lymphoscintigraphy may be especially useful when lymphangiography is contraindicated<sup>[51]</sup>, and it can also be used during patient follow-up to confirm a decrease or cessation of chyle leakage<sup>[52]</sup>. These imaging techniques may indicate the cause of chylous ascites, but are not adequate to diagnose chylous ascites.

## MANAGEMENT

Although the severity of chylous ascites varies, several cases may spontaneously resolve without any specific treatment, because a small amount of ascitic fluid can be absorbed in the peritoneal cavity and a small leakage site of the lymphatic channel can close spontaneously. Therefore, many clinically insignificant cases might not be detected if a drain tube is not routinely placed after surgery. This may explain why the incidence of chylous ascites after laparoscopic nephrectomy is lower in most studies than in those conducted by Kim *et al.*<sup>[7]</sup> and Capocasale *et al.*<sup>[9]</sup>.

Several strategies have been used to treat postoperative chylous ascites, and some investigators have reported their own management protocol<sup>[6,11]</sup>. Although there is still some debate over the correct approach, most authors advocate conservative treatment as an initial treatment modality<sup>[6,7,9,11,28]</sup>. Conservative treatment aims to decrease mesenteric lymphatic flow and consequently limit the leakage of chyle into the peritoneum. Moreover, other goals of conservative treatment are relief of the mechanical symptoms, such as abdominal distention, and restoration of nutritional losses. The success rate of conservative treatment ranges from 67% to 100%<sup>[6,10,11]</sup>.

Conservative treatment includes therapeutic paracentesis, dietary modification, total parenteral nutrition, and the use of somatostatin analogs. If the drainage tube is placed when chylous ascites is detected, natural continuous drainage of ascitic fluid can be expected and accumulation of ascites in the peritoneal cavity can be prevented. However, in cases of delayed suspicion of chylous ascites without a drainage tube, paracentesis may be necessary to confirm the diagnosis of chylous ascites and relieve abdominal fullness. Nevertheless,

there are some concerns that repeat paracentesis or permanent drainage catheter placement may cause prolonged leakage, increasing both nutritional and immunological depletion and the risk of infection<sup>[6,17,53,54]</sup>. Intravenous reinfusion of ascitic fluid may prevent the nutritional losses associated with paracentesis or percutaneous drainage, but this carries the risk of serious complications, such as fat embolism and infection<sup>[55]</sup>.

Dietary intervention, which includes medium-chain triglycerides and high-protein and low-fat intake, is normally used as a first-line treatment. It can reduce the lymphatic flow in the major lymphatic channels and facilitate the closure of chylous leakage<sup>[6,9]</sup>. Approximately 50% of mild cases of chylous ascites can be resolved using dietary intervention alone, and this treatment should be continued for several weeks or months to prevent recurrences<sup>[6,11]</sup>.

Total parenteral nutrition is also an effective conservative management modality for postoperative chylous ascites. It can reduce the production and flow of lymph by allowing the bowels to rest<sup>[6]</sup>. The success rate of total parenteral nutrition alone or combined with a medium-chain triglyceride, high-protein, and low-fat diet for several weeks ranges from 60% to 100%<sup>[6,7,9,11]</sup>. Many investigators recommend total parenteral nutrition as a second-line treatment when conservative management with dietary modification fails. However, several studies, including our previous study, demonstrated that an early trial of total parenteral nutrition in patients with postoperative chylous ascites may be more effective and facilitate earlier improvement<sup>[7,53]</sup>. Total parenteral nutrition can also be used as a last treatment regimen when interventional or surgical treatment fails<sup>[6]</sup>. More recently, Jairath *et al.*<sup>[11]</sup> suggested that if the daily drainage output of chylous ascites is less than 500 mL, dietary modification should be tried first, but if the drain output is greater than 500 mL per day, total parenteral nutrition should be used as a first-line treatment.

Since Ulíbarri *et al.*<sup>[56]</sup> reported the effectiveness of continuous intravenous high-dose somatostatin for the closure of postoperative lymphatic drainage in 1990, somatostatin and its analogs are widely used, although their exact mechanism of action is not clearly understood<sup>[11]</sup>. Somatostatin is known to decrease the intestinal absorption of fats and attenuate lymphatic flow in the major lymphatic channels. Moreover, it reduces gastric, pancreatic, and intestinal secretions, inhibits intestinal activity and slows intestinal absorption, and decreases splanchnic blood flow, which may contribute to reduced lymphatic production<sup>[6]</sup>. Based on these data and clinical experience, earlier use of somatostatin and its analogue are highly recommended in combination with dietary intervention<sup>[6,11]</sup>.

Although many cases of postoperative chylous ascites can be successfully managed using conservative treatment, there are severe refractory cases that require surgical repair. The purpose of surgical repair is direct ligation of the chyle leakage site. It was historically

performed using an open procedure, but with the development of laparoscopic techniques, successful management can be expected using a laparoscopic approach<sup>[34,38,57]</sup>. Although the exact timing of surgical intervention remains controversial, previous studies recommend 4 to 12 wk of conservative treatment before surgery<sup>[6,7,9,11]</sup>. However, some authors have recommended early interventional treatment to provide a better chance of direct visualization of the injured lymphatics and definite repair, thus preventing nutritional and immunological deficiency and prolonged hospitalization<sup>[6,58,59]</sup>. Since the most important step in surgical repair is to identify the chylous leakage point, several authors have suggested milk ingestion or a high-fat diet before surgery or intravenous indigo carmine injection during surgery<sup>[34,60]</sup>. If a leakage point cannot be identified, nonselective suturing of the periaortic or pericaval tissues can resolve chyle leakage. In addition, application of a hemostatic agent, such as fibrin glue, can also effectively occlude disrupted lymphatic channels<sup>[6,9]</sup>.

Alternatively, peritoneovenous shunting and percutaneous transabdominal embolization can be performed, especially in patients with poor performance status and persistent severe chyle leakage<sup>[6,61-63]</sup>. Although peritoneovenous shunting does not cause nutritional deficiency, as ascitic fluid is recirculated, and has a lower risk of infection compared to repeat paracentesis, it can also carry the risk of serious complications, such as fat embolism, disseminated intravascular coagulation, and sepsis<sup>[6,11,53]</sup>. Cope *et al.*<sup>[62]</sup> reported successful embolization of the lymphatic ducts using a transabdominal percutaneous puncture, but there are limited data related to percutaneous embolization, and more studies are needed to validate the efficacy and safety of this procedure.

## PROGNOSIS

Chylous ascites after laparoscopic nephrectomy is most commonly reported after living-donor nephrectomy, although it can occur after any type of laparoscopic nephrectomy (radical, partial, simple, nephroureterectomy, or donor) (Table 1). The success rate of conservative treatment in published studies of laparoscopic nephrectomy ranges from 50% to 100%, except in case reports or original articles involving only 1 or 2 cases of chylous ascites<sup>[7,9,11,12,44]</sup>. In this review, 89 patients of chylous ascites after laparoscopic nephrectomy were included from original articles and case reports. Of these patients, 70 cases (78.7%) were success fully managed by conservative treatment (Table 1).

The prognosis of chylous ascites depends on the underlying pathological disease and can be poor, as mortality rates can be as high as 43% to 83%<sup>[6,55,64]</sup>. However, the prognosis of postoperative chylous ascites is generally favorable, with a significantly lower mortality rate<sup>[6,53]</sup>. Although it is likely that published reports of chylous ascites after laparoscopic nephrectomy contain more severe cases, most of these cases were successfully

**Table 1** Previously reported cases of chylous ascites after laparoscopic nephrectomy

Ref.	Type of laparoscopic nephrectomy	Success rate of conservative treatment (%)	Interventional treatment
Original articles			
Jairath <i>et al</i> <sup>[11]</sup>	Radical, donor, simple	67.7 (6/9)	Surgery
Tiong <i>et al</i> <sup>[12]</sup>	Donor	50 (5/10)	Surgery
Wan <i>et al</i> <sup>[44]</sup>	Partial	100 (5/5)	
Capocasale <i>et al</i> <sup>[9]</sup>	Donor	100 (8/8)	
He <i>et al</i> <sup>[31]</sup>	Donor	0 (0/1)	Surgery
Kim <i>et al</i> <sup>[3]</sup>	Radical, donor, simple, partial, nephroureterectomy	96.9 (31/32)	Surgery
Breda <i>et al</i> <sup>[8]</sup>	Donor	100 (2/2)	
Wadström <sup>[43]</sup>	Donor	0 (0/1)	Surgery
Ramani <i>et al</i> <sup>[39]</sup>	Donor	0 (0/1)	Surgery
Wu <i>et al</i> <sup>[45]</sup>	Donor	100 (1/1)	
Seo <i>et al</i> <sup>[46]</sup>	Donor	100 (2/2)	
Case reports			
Monge Mirallas <i>et al</i> <sup>[35]</sup>	Radical	100 (1/1)	
Itou <i>et al</i> <sup>[65]</sup>	Radical	0 (0/1)	Percutaneous obliteration
Fariña <i>et al</i> <sup>[29]</sup>	Radical	100 (1/1)	
Nishizawa <i>et al</i> <sup>[38]</sup>	Radical	0 (0/1)	Surgery
Meulen <i>et al</i> <sup>[33]</sup>	Donor	100 (1/1)	
Gagliano <i>et al</i> <sup>[30]</sup>	Donor	100 (1/1)	
Sinha <i>et al</i> <sup>[41]</sup>	Donor	0 (0/1)	Surgery
Aerts <i>et al</i> <sup>[26]</sup>	Donor	0 (0/1)	Surgery
Caumartin <i>et al</i> <sup>[28]</sup>	Donor	0 (0/1)	Surgery
Bachmann <i>et al</i> <sup>[27]</sup>	Donor	100 (1/1)	
Sharma <i>et al</i> <sup>[40]</sup>	Donor	100 (1/1)	
Molina <i>et al</i> <sup>[34]</sup>	Donor	0 (0/1)	Surgery
Shafizadeh <i>et al</i> <sup>[13]</sup>	Donor	100 (1/1)	
von Rundstedt <i>et al</i> <sup>[42]</sup>	Nephroureterectomy	100 (1/1)	
Negoro <i>et al</i> <sup>[37]</sup>	Nephroureterectomy	50 (1/2)	Sclerotherapy
Jensen <i>et al</i> <sup>[32]</sup>	Simple	100 (1/1)	

managed using conservative treatment. Moreover, even cases managed using interventional therapy successfully improved without any critical sequelae. Thus, one can expect a good prognosis if early diagnosis and proper management are achieved, although some severe cases will need to be managed using interventional therapy.

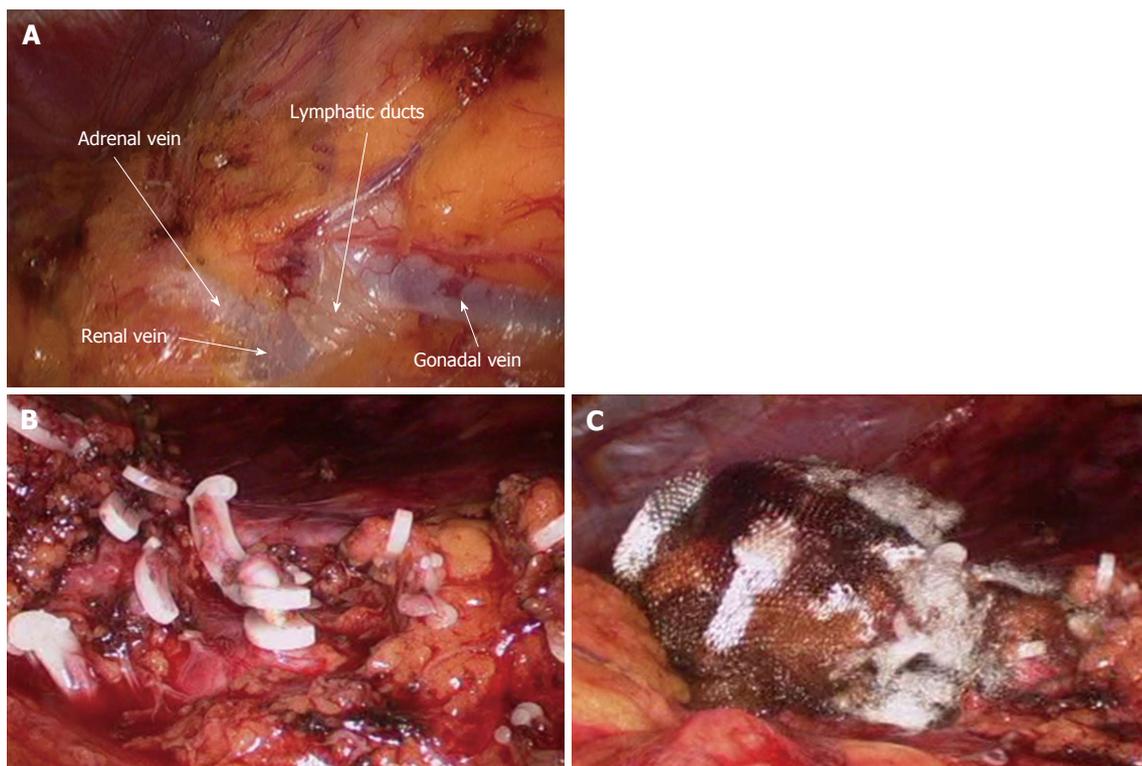
## PREVENTION

With accumulated experience and understanding of the mechanisms of occurrence, early diagnosis and proper management of postoperative chylous ascites can be facilitated. However, although the incidence of postoperative chylous ascites is not very high, this complication can decrease a patient's quality of life and prolong hospitalization. Thus, the best treatment strategy is obviously the prevention of postoperative chylous ascites during the initial surgery. In our experience, appropriate lymphostasis cannot be achieved with monopolar, bipolar, or ultrasound devices, which are the most commonly used for hemostasis in laparoscopic nephrectomy<sup>[7]</sup>. Therefore, lymphatic channels should be identified and carefully divided during surgery (Figure 1A). In addition, if disruption of the lymphatic channels occurs and extravasation of lymphatic fluid is recognized intraoperatively, careful ligation of the lymphatic duct using hemoclips should be performed (Figure 1B). Moreover, empirical application of hemostatic agents over the dissected area, such as biological tissue adhesive and

fibrin glue, can also be helpful, regardless of whether lymphatic disruption or extravasation is identified<sup>[9]</sup> (Figure 1C). Furthermore, the placement of a drainage tube in patients who are suspected to be at high risk of postoperative chylous ascites, such as obese patients, those undergoing extensive lymphadenectomy, or patients with obvious lymphatic leakage during surgery, can be useful for the early diagnosis of chylous ascites.

## CONCLUSION

As laparoscopic nephrectomy has gained popularity, postoperative chylous ascites is no longer a very rare complication. Although many studies have reported a good prognosis for postoperative chylous ascites, it can become a highly morbid complication of laparoscopic renal surgery that requires early diagnosis and proper management. The treatment strategy should be individualized according to the severity of chylous ascites and its consequences. Initial management should be conservative treatment using high-protein, low-fat dietary modification with medium-chain triglycerides, total parenteral nutrition, and somatostatin or its analogs for several weeks. Depending on the severity of chylous ascites and the response to conservative treatment, interventional therapy including surgery, sclerotherapy, and peritoneovenous shunting should be considered. The prevention of postoperative chylous ascites is the most important factor. Therefore, careful dissection of the



**Figure 1** Intraoperative image of the hilar area during left-sided laparoscopic donor nephrectomy. A: Prominent lymphatic ducts cross the renal vein; B: The perihilar and retroperitoneal fatty tissue is meticulously clipped; C: The hilar area is completely sealed using surgical and fibrin glue.

great vessels and renal pedicle, meticulous clipping and application of hemostatic agents to the area of perihilar and retroperitoneal fatty tissue, and placement of a drainage tube is highly recommended in patients at high risk of chylous ascites.

## REFERENCES

- 1 **Clayman RV**, Kavoussi LR, Soper NJ, Dierks SM, Meretyk S, Darcy MD, Roemer FD, Pingleton ED, Thomson PG, Long SR. Laparoscopic nephrectomy: initial case report. *J Urol* 1991; **146**: 278-282 [PMID: 1830346]
- 2 **Hsu TH**, Su LM, Ratner LE, Kavoussi LR. Renovascular complications of laparoscopic donor nephrectomy. *Urology* 2002; **60**: 811-815; discussion 815 [PMID: 12429304]
- 3 **Kim BS**, Yoo ES, Kwon TG. Complications of transperitoneal laparoscopic nephrectomy: a single-center experience. *Urology* 2009; **73**: 1283-1287 [PMID: 19362334 DOI: 10.1016/j.urology.2009.01.017]
- 4 **Simon SD**, Castle EP, Ferrigni RG, Lamm DL, Swanson SK, Novicki DE, Andrews PE. Complications of laparoscopic nephrectomy: the Mayo clinic experience. *J Urol* 2004; **171**: 1447-1450 [PMID: 15017195 DOI: 10.1097/01.ju.0000117942.61971.41]
- 5 **Siqueira TM**, Kuo RL, Gardner TA, Paterson RF, Stevens LH, Lingeman JE, Koch MO, Shalhav AL. Major complications in 213 laparoscopic nephrectomy cases: the Indianapolis experience. *J Urol* 2002; **168**: 1361-1365 [PMID: 12352393 DOI: 10.1097/01.ju.0000023288.55478.42]
- 6 **Leibovitch I**, Mor Y, Golomb J, Ramon J. The diagnosis and management of postoperative chylous ascites. *J Urol* 2002; **167**: 449-457 [PMID: 11792897]
- 7 **Kim BS**, Yoo ES, Kim TH, Kwon TG. Chylous ascites as a complication of laparoscopic nephrectomy. *J Urol* 2010; **184**: 570-574 [PMID: 20639020 DOI: 10.1016/j.juro.2010.03.128]
- 8 **Breda A**, Veale J, Liao J, Schulam PG. Complications of laparoscopic living donor nephrectomy and their management: the UCLA experience. *Urology* 2007; **69**: 49-52 [PMID: 17270612 DOI: 10.1016/j.urology.2006.09.030]
- 9 **Capocasale E**, Iaria M, Vistoli F, Signori S, Mazzoni MP, Dalla Valle R, De Lio N, Perrone V, Amorese G, Mosca F, Boggi U. Incidence, diagnosis, and treatment of chylous leakage after laparoscopic live donor nephrectomy. *Transplantation* 2012; **93**: 82-86 [PMID: 22143459 DOI: 10.1097/TP.0b013e31823b2d8e]
- 10 **Harper JD**, Breda A, Leppert JT, Veale JL, Gritsch HA, Schulam PG. Experience with 750 consecutive laparoscopic donor nephrectomies--is it time to use a standardized classification of complications? *J Urol* 2010; **183**: 1941-1946 [PMID: 20303114 DOI: 10.1016/j.juro.2010.01.021]
- 11 **Jairath A**, Singh A, Ganpule A, Mishra S, Sabnis R, Desai M. Management Protocol for Chylous Ascites After Laparoscopic Nephrectomy. *Urology* 2015; **86**: 521-528 [PMID: 26210005 DOI: 10.1016/j.urology.2015.06.001]
- 12 **Tiong HY**, Goel RK, White WM, Goldfarb DA, Kaouk JH. Chylous ascites after laparoscopic donor nephrectomy. *Asian J Endosc Surg* 2015; **8**: 34-39 [PMID: 25384614 DOI: 10.1111/ases.12144]
- 13 **Shafizadeh SF**, Daily PP, Baliga P, Rogers J, Baillie GM, Rajagopalan PR, Chavin KD. Chylous ascites secondary to laparoscopic donor nephrectomy. *Urology* 2002; **60**: 345 [PMID: 12137847]
- 14 **Browse NL**, Wilson NM, Russo F, al-Hassan H, Allen DR. Aetiology and treatment of chylous ascites. *Br J Surg* 1992; **79**: 1145-1150 [PMID: 1467885]
- 15 **Combe J**, Buniet JM, Douge C, Bernard Y, Camelot G. [Chylothorax and chylous ascites following surgery of an inflammatory aortic aneurysm. Case report with review of the literature]. *J Mal Vasc* 1992; **17**: 151-156 [PMID: 1613407]
- 16 **Allen W**, Parrott TS, Sariipkin L, Allan C. Chylous ascites following retroperitoneal lymphadenectomy for granulosa cell tumor of the testis. *J Urol* 1986; **135**: 797-798 [PMID: 3959207]
- 17 **Baniel J**, Foster RS, Rowland RG, Bihrlle R, Donohue JP. Management of chylous ascites after retroperitoneal lymph node

- dissection for testicular cancer. *J Urol* 1993; **150**: 1422-1424 [PMID: 8411415]
- 18 **Bigley HA**, Chenault OW. Chylous ascites following retroperitoneal lymphadenectomy. *J Urol* 1975; **114**: 948-950 [PMID: 1195482]
- 19 **Eberl W**, Kwee T, Mau G. [Chylous ascites after tumor nephrectomy with retroperitoneal lymphadenectomy]. *Monatsschr Kinderheilkd* 1991; **139**: 47-50 [PMID: 1851534]
- 20 **Ferrigni RG**, Novicki DE. Chylous ascites complicating genitourinary oncological surgery. *J Urol* 1985; **134**: 774-776 [PMID: 4032594]
- 21 **Isa Kroon WA**, Sánchez de la Muela P, Ucar Terren A, Robles García JE, Zudaire Bergera JJ, Berrián Polo JM. [Post-lymphadenectomy lymphorrhagia caused by renal adenocarcinoma]. *Actas Urol Esp* 1988; **12**: 371-373 [PMID: 3189031]
- 22 **Jansen TT**, Debruyne FM, Delaere KP, de Vries JD. Chylous ascites after retroperitoneal lymph node dissection. *Urology* 1984; **23**: 565-567 [PMID: 6730125]
- 23 **Miedema EB**, Bissada NK, Finkbeiner AE, Casali RE. Chylous ascites complicating retroperitoneal lymphadenectomy for testis tumors: management with peritoneovenous shunting. *J Urol* 1978; **120**: 377-382 [PMID: 682267]
- 24 **Spence CR**, Solomon HD, Agee RE, Gangai MP. Chylous ascites: an unusual complication following retroperitoneal lymphadenectomy for testis tumor. *J Urol* 1977; **117**: 676-677 [PMID: 859211]
- 25 **Jayabose S**, Kogan S, Berezin S, Slim M, San Filippo JA, Godine L, Beneck D, Tugal O, Sunkara S. Combined occurrence of chyloperitoneum and chylothorax after surgery and chemotherapy for Wilms' tumor. *Cancer* 1989; **64**: 1790-1795 [PMID: 2551473]
- 26 **Aerts J**, Matas A, Sutherland D, Kandaswamy R. Chylous ascites requiring surgical intervention after donor nephrectomy: case series and single center experience. *Am J Transplant* 2010; **10**: 124-128 [PMID: 19958336 DOI: 10.1111/j.1600-6143.2009.02883.x]
- 27 **Bachmann A**, Ruszat R, Dickmann M, Giannini O, Mayr M, Steiger J, Gasser TC, Sulser T. Chyloretroperitoneum with secondary chylothorax after retroperitoneoscopic donor nephrectomy. *Urology* 2005; **66**: 881 [PMID: 16230168 DOI: 10.1016/j.urol.2005.04.025]
- 28 **Caumartin Y**, Pouliot F, Sabbagh R, Dujardin T. Chylous ascites as a complication of laparoscopic donor nephrectomy. *Transpl Int* 2005; **18**: 1378-1381 [PMID: 16297058 DOI: 10.1111/j.1432-2277.2005.00219.x]
- 29 **Fariña LA**, Martínez MC. [Chylous ascites following radical nephrectomy. Conservative management without paracentesis]. *Actas Urol Esp* 2009; **33**: 703-705 [PMID: 19711757]
- 30 **Gagliano M**, Veroux P, Corona D, Cannizzaro MA, Giuffrida G, Giaquinta A, Veroux M. Chylous ascites following laparoscopic living donor nephrectomy. Case report. *Ann Ital Chir* 2011; **82**: 499-503 [PMID: 22229241]
- 31 **He B**, Mitchell A, Delriviere L, Shannon T, Pemberton R, Tan A, Bremner A, Vivian J. Laparoscopic donor nephrectomy. *ANZ J Surg* 2011; **81**: 159-163 [PMID: 21342388 DOI: 10.1111/j.1445-2197.2010.05568.x]
- 32 **Jensen JB**, Ostraat EO. [Chyloascites after laparoscopic nephrectomy]. *Ugeskr Laeger* 2008; **170**: 2892 [PMID: 18796289]
- 33 **Meulen ST**, van Donselaar-van der Pant KA, Bemelman FJ, Idu MM. Chylous ascites after laparoscopic hand-assisted donor nephrectomy: Is it specific for the left-side? *Urol Ann* 2013; **5**: 45-46 [PMID: 23662011 DOI: 10.4103/0974-7796.106967]
- 34 **Molina WR**, Desai MM, Gill IS. Laparoscopic management of chylous ascites after donor nephrectomy. *J Urol* 2003; **170**: 1938 [PMID: 14532813 DOI: 10.1097/01.ju.0000091660.15018.66]
- 35 **Monge Mirallas JM**, Asensio Lahoz LA, Ruiz Izquierdo F, Campos Sañudo JA, Martínez Bretones F, Martín Cuesta L. Chylous ascytis causing abdominal distension after laparoscopic radical nephrectomy. *Arch Esp Urol* 2014; **67**: 575-578 [PMID: 25048591]
- 36 **Mullins JK**, Pierorazio PM, Hyams ES, Mitchell SE, Allaf ME. Lymphangiography with sclerotherapy: a novel therapy for refractory chylous ascites. *Can J Urol* 2012; **19**: 6250-6254 [PMID: 22704307]
- 37 **Negoro H**, Oka H, Kawakita M. Two cases of chyloretroperitoneum following retroperitoneoscopic nephroureterectomy. *Int J Urol* 2006; **13**: 487-489 [PMID: 16734885 DOI: 10.1111/j.1442-2042.2006.01427.x]
- 38 **Nishizawa K**, Ito N, Yamamoto S, Kamoto T, Ogawa O. Successful laparoscopic management of chylous ascites following laparoscopic radical nephrectomy. *Int J Urol* 2006; **13**: 619-621 [PMID: 16771738 DOI: 10.1111/j.1442-2042.2006.01372.x]
- 39 **Ramani AP**, Gill IS, Steinberg AP, Abreu SC, Kilciler M, Kaouk J, Desai M. Impact of intraoperative heparin on laparoscopic donor nephrectomy. *J Urol* 2005; **174**: 226-228 [PMID: 15947643 DOI: 10.1097/01.ju.0000162048.15746.52]
- 40 **Sharma A**, Heer M, Subramanaym Malladi SV, Minz M. Chylous ascites after laparoscopic donor nephrectomy. *J Endourol* 2005; **19**: 839-840 [PMID: 16190840 DOI: 10.1089/end.2005.19.839]
- 41 **Sinha A**, Mamode N. Laparoscopic management of chylous ascites following laparoscopic donor nephrectomy. *BMJ Case Rep* 2010; **2010**: bcr0820092141 [PMID: 22242080 DOI: 10.1136/bcr.08.2009.2141]
- 42 **von Rundstedt FC**, Kamper L, Brandt AS, Lazica D, Roth S. [Chylous ascites after laparoscopic nephroureterectomy]. *Aktuelle Urol* 2009; **40**: 44-48 [PMID: 19177321 DOI: 10.1055/s-0028-1098713]
- 43 **Wadström J**. Hand-assisted retroperitoneoscopic live donor nephrectomy: experience from the first 75 consecutive cases. *Transplantation* 2005; **80**: 1060-1066 [PMID: 16278586]
- 44 **Wan Y**, Tang Z, Chen Z, Tian W, Xiao L, Luo K, Li D. [Chylous leakage after retroperitoneoscopic upper-pole heminephrectomy for duplex kidney]. *Zhong Nan Da Xue Xue Bao Yi Xue Ban* 2012; **37**: 405-407 [PMID: 22561573 DOI: 10.3969/j.issn.1672-7347.2012.04.015]
- 45 **Wu CT**, Chiang YJ, Liu KL, Chu SH. Laparoscopic donor nephrectomy: new combination of hand-assisted and standard approaches. *Transplant Proc* 2004; **36**: 1909-1911 [PMID: 15518695 DOI: 10.1016/j.transproceed.2004.08.096]
- 46 **Seo SI**, Kim JC, Hwangbo K, Park YH, Hwang TK. Comparison of hand-assisted laparoscopic and open donor nephrectomy: a single-center experience from South Korea. *J Endourol* 2005; **19**: 58-62 [PMID: 15735385 DOI: 10.1089/end.2005.19.58]
- 47 **Kajiyama Y**, Iwanuma Y, Tomita N, Amano T, Hattori K, Tsurumaru M. Sealing the thoracic duct with ultrasonic coagulating shears. *Hepatogastroenterology* 2005; **52**: 1053-1056 [PMID: 16001628]
- 48 **Abe K**, Terashima M, Fujiwara H, Takagane A, Uesugi N, Saito K. Experimental evaluation of bursting pressure in lymphatic vessels with ultrasonically activated shears. *World J Surg* 2005; **29**: 106-109 [PMID: 15592912 DOI: 10.1007/s00268-004-7547-5]
- 49 **Patten RM**, Calkins CM, Moore EE. Isolated traumatic rupture of the cisterna chyli: CT diagnosis. *J Comput Assist Tomogr* 1999; **23**: 701-702 [PMID: 10524850]
- 50 **Sachs PB**, Zelch MG, Rice TW, Geisinger MA, Risius B, Lammert GK. Diagnosis and localization of laceration of the thoracic duct: usefulness of lymphangiography and CT. *AJR Am J Roentgenol* 1991; **157**: 703-705 [PMID: 1892021 DOI: 10.2214/ajr.157.4.1892021]
- 51 **Baulieu F**, Baulieu JL, Mesny J, Ducouret N, Benhamou AC, Barsotti J, Itti R. Visualization of the thoracic duct by lymphoscintigraphy. *Eur J Nucl Med* 1987; **13**: 264-265 [PMID: 3665972]
- 52 **Andrews JT**, Binder LJ. Lymphoscintigraphy pre- and post-surgical lymphatic leak repair. *Australas Radiol* 1996; **40**: 19-21 [PMID: 8838882]
- 53 **Pabst TS**, McIntyre KE, Schilling JD, Hunter GC, Bernhard VM. Management of chyloperitoneum after abdominal aortic surgery. *Am J Surg* 1993; **166**: 194-198; discussion 198-199 [PMID: 8352415]
- 54 **DeHart MM**, Lauerman WC, Conely AH, Roettger RH, West JL, Cain JE. Management of retroperitoneal chylous leakage. *Spine (Phila Pa 1976)* 1994; **19**: 716-718 [PMID: 8009338]
- 55 **Vasko JS**, Tapper RL. The surgical significance of chylous ascites.

- Arch Surg* 1967; **95**: 355-368 [PMID: 4166570]
- 56 **Ulibarri JI**, Sanz Y, Fuentes C, Mancha A, Aramendia M, Sánchez S. Reduction of lymphorrhagia from ruptured thoracic duct by somatostatin. *Lancet* 1990; **336**: 258 [PMID: 1973814]
- 57 **Geary B**, Wade B, Wollmann W, El-Galley R. Laparoscopic repair of chylous ascites. *J Urol* 2004; **171**: 1231-1232 [PMID: 14767309 DOI: 10.1097/01.ju.0000110104.68489.70]
- 58 **Aalami OO**, Allen DB, Organ CH. Chylous ascites: a collective review. *Surgery* 2000; **128**: 761-778 [PMID: 11056439 DOI: 10.1067/msy.2000.109502]
- 59 **Boran N**, Cil AP, Tulunay G, Ozgul N, Kose MF. Chylous ascites following para-aortic lymphadenectomy: a case report. *Gynecol Oncol* 2004; **93**: 711-714 [PMID: 15196870 DOI: 10.1016/j.ygyno.2004.03.022]
- 60 **Ma L**, Pu Q, Zhu Y, Liu L. Chyle leakage in port incision after video-assisted thoracoscopic surgery: case report. *J Cardiothorac Surg* 2010; **5**: 83 [PMID: 20950471 DOI: 10.1186/1749-8090-5-83]
- 61 **Akhan O**, Karcaaltincaba M, Ozmen MN, Akinci D, Karcaaltincaba D, Ayhan A. Percutaneous transcatheter ethanol sclerotherapy and catheter drainage of postoperative pelvic lymphoceles. *Cardiovasc Intervent Radiol* 2007; **30**: 237-240 [PMID: 17205362 DOI: 10.1007/s00270-006-0180-y]
- 62 **Cope C**. Diagnosis and treatment of postoperative chyle leakage via percutaneous transabdominal catheterization of the cisterna chyli: a preliminary study. *J Vasc Interv Radiol* 1998; **9**: 727-734 [PMID: 9756057]
- 63 **Matsufuji H**, Nishio T, Hosoya R. Successful treatment for intractable chylous ascites in a child using a peritoneovenous shunt. *Pediatr Surg Int* 2006; **22**: 471-473 [PMID: 16477467 DOI: 10.1007/s00383-006-1648-1]
- 64 **Ablan CJ**, Littooy FN, Freeark RJ. Postoperative chylous ascites: diagnosis and treatment. A series report and literature review. *Arch Surg* 1990; **125**: 270-273 [PMID: 2405815]
- 65 **Itou C**, Koizumi J, Myojin K, Yamashita T, Mori N, Imai Y. A case of refractory chylous ascites after nephrectomy successfully treated with percutaneous obliteration using adhesive glue. *Jpn J Radiol* 2013; **31**: 71-74 [PMID: 23065489 DOI: 10.1007/s11604-012-0146-8]

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