

Knacks and pitfalls of retroperitoneal sarcoma surgery, part 1: preparation for tumor resection

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ABSTRACT

Although retroperitoneal sarcoma (RPS) is a rare malignancy, it is unlikely that a general surgeon would go through their career without encountering at least one case. Surgical resection remains the only potentially curative treatment and is performed in many institutions worldwide. However, given its low incidence, most centers manage only one or two cases annually, resulting in limited operative experience among surgeons. The clinical presentation of RPS varies widely depending on the tumor location and extent of invasion into adjacent organs and major vessels. This heterogeneity poses a challenge in standardizing surgical techniques and demands a high level of intraoperative adaptability. RPS is commonly found as large tumors, precluding the use of minimally invasive approaches, such as laparoscopy or robotic surgery. The retroperitoneal space also contains critical vascular structures, and inappropriate surgical approaches may lead to life-threatening hemorrhage. At Nagoya University Rare Cancer Center, numerous RPS surgeries have been performed. Through this experience, various technical considerations essential for safe and effective surgery were identified. This article introduces key operative strategies for RPS, including technical “knacks and pitfalls,” derived from extensive clinical experience with RPS surgery. Part 1 discusses general preparations that are specifically required for RPS surgery. Part 2 focuses on the details of the practical techniques of the RPS surgery. Finally, part 3 discusses resection of the tumor involving large retroperitoneal vessels, which need special preparations.

Keywords: retroperitoneal sarcoma, surgery, retroperitoneal mobilization

Abbreviations:

RPS: retroperitoneal sarcoma

IVC: inferior vena cava

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INTRODUCTION

Retroperitoneal sarcoma (RPS) is a rare disease with extremely diverse clinical features. RPS originates from various tissues, such as fat, muscle, and nerves found within the retroperitoneal

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cavity. Their malignancy can vary from low to intermediate to high, and >100 distinct tissue types have been identified and reported.^{1,2} The most common RPS is liposarcoma, followed by leiomyosarcoma, and these account for >70% of total RPS cases.^{1,3} The RPS originates from various locations, including the upper, middle, and lower abdomen, pelvic floor, groin, and trunk wall (Fig. 1).

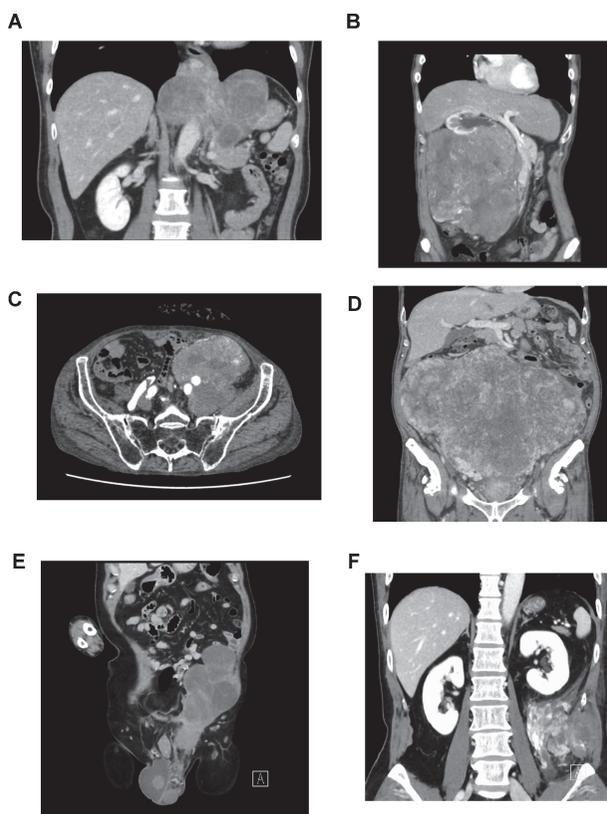


Fig. 1 Coronal computed tomography images of retroperitoneal sarcomas originating from the upper abdomen (A), middle abdomen (B), lower abdomen (C), pelvic floor (D), groin (E), and trunk wall (F)

Tumors occurring in the retroperitoneum rarely cause subjective symptoms; therefore, they are often found as large tumors. In the cases experienced at Nagoya University Rare Cancer Center (NURCC), approximately one-third are found as tumors measuring ≥ 10 cm in diameter at the time of initial examination.¹ Large tumors may severely contact or invade retroperitoneal organs, such as the kidney, ureter, adrenal gland, pancreas, spleen, and duodenum. The tumor may also involve the mesentery of the large or small intestine. In addition, the tumor may come into contact with critical vessels in the retroperitoneal cavity, such as the inferior vena cava (IVC), abdominal aorta, and left and right iliac arteries and veins.

Surgical resection is the first choice in the treatment of RPS because antitumor drugs are generally not sufficiently effective against RPS.⁴ Some studies have reported the usefulness of radiation therapy for RPS, another mainstay of treatment of malignant tumors.^{5,6} However, in most RPS cases, the tumor is in contact with the intestine, posing challenges in implementing radiation therapy. Therefore, complete tumor resection is recommended whenever possible.

Surgery for RPS is complex and challenging. Tumors are located in the retroperitoneum, an area that is generally difficult to access. In addition, these tumors often involve various organs and major blood vessels in the retroperitoneum. The organs affected by retroperitoneal tumors can be broadly divided into those of the urinary tract (kidneys, ureters, and bladder), reproductive system (uterus, ovaries, vas deferens, seminal vesicles, and prostate), intestines, mesentery, pancreas, spleen, liver, and adrenal glands. Therefore, in some cases, surgery requires an interdisciplinary team, involving gastrointestinal surgeons, urologists, gynecologists, and orthopedic surgeons. If the tumor affects large retroperitoneal vessels, collaboration with cardiovascular surgeons is necessary. Moreover, in cases where tumor resection causes a large defect area in the abdominal wall, reconstruction by plastic surgeons is necessary.

In this article, the “knacks and pitfalls” of RPS surgery, particularly for large tumors, are discussed based on the experiences of treating hundreds of RPS cases in the NURCC.

PREPARATIONS FOR RPS SURGERY

Preparation before RPS surgery

Before surgery, a thorough simulation of the surgical procedure according to the tumor location and the organs and blood vessels involved is necessary. When collaboration with other departments (urology, obstetrics and gynecology, cardiovascular surgery, orthopedics, plastic surgery,

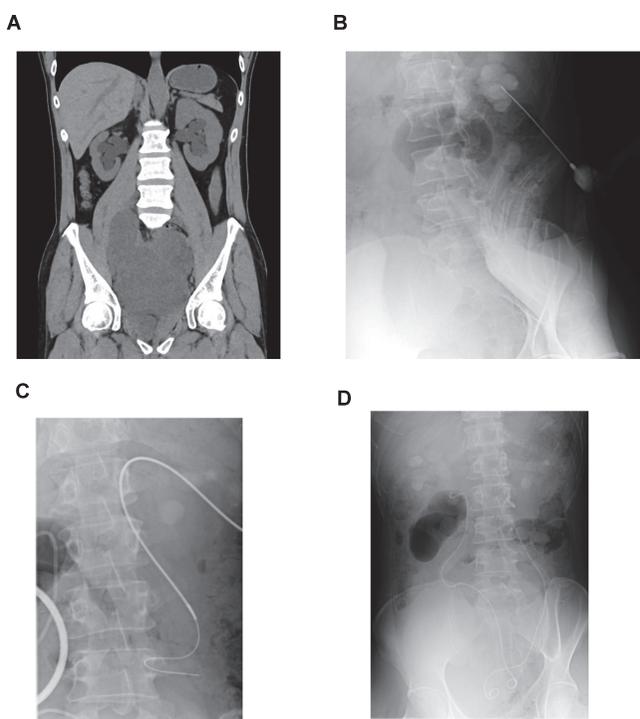


Fig. 2 A case of large sarcoma originating from the pelvic floor

The tumor compresses the bladder and bilateral ureters and induces bilateral hydronephrosis (A). Given the lack of space to manipulate the cystoscopy, a nephrostomy was performed first (B), followed by the antegrade insertion of bilateral ureteral stents through the nephrostomy (C and D). With the guidance of these stents, tumor resection was performed by preserving the bladder and bilateral ureters.

etc) is necessary during surgery, the case must be presented beforehand, and a conference must be held among departments. All specialists involved must understand the preoperative plan to clarify their specific roles and the timing of their involvement in the surgical procedure.

In large RPS, the kidney and ureter are in contact with the tumor; therefore, if surgeons try to preserve the urinary system, the urologist can insert a ureteral stent in advance. In our experience, a giant pelvic floor tumor severely compressed the bladder and ureters and caused bilateral hydronephrosis (Fig. 2A). In this case, retrograde ureteral stent insertion may have been challenging because of the limited space within the bladder, which restricted manipulation of the cystoscope. In such cases, a nephrostomy is initially performed, followed by antegrade insertion of a ureteral stent through the nephrostomy (Fig. 2B–D).

Tumors often firmly adhere to major blood vessels, and in some cases, a tumor thrombus may be present in the IVC (Fig. 3). Such cases require consultation with a cardiovascular surgeon to prepare for extracorporeal circulation or artificial vascular replacement. In cases that require extracorporeal circulation, the sites appropriate for blood withdrawal and reinfusion must be identified and the mode of support must be determined—whether to employ a venovenous or venoarterial shunt or to implement extracorporeal membrane oxygenation.

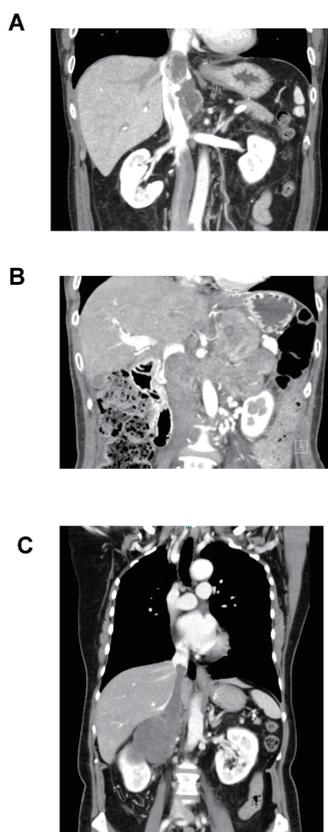


Fig. 3 Retroperitoneal sarcomas forming a tumor thrombus in the inferior vena cava (IVC) (A) A leiomyosarcoma originating from the left side wall of the IVC obstructing hepatic venous flow. (B) A leiomyosarcoma originating from the left renal vein formed a tumor thrombus in the IVC, and the upstream IVC was filled with a thrombus. (C) A leiomyosarcoma originating from the right renal vein formed an IVC tumor thrombus. The tip of the tumor thrombus had reached the right atrium at the time of surgery.

Positioning

In the RPS surgery, positioning is very important, as patient positioning can significantly influence the technical difficulty of the surgical procedure. For tumors arising from the right side, the patient should be placed in a semilateral position facing the left; conversely, for tumors on the left side, the patient should be placed in a semilateral position facing the right. The arm on the tumor side should be raised, and the arm on the opposite side extended (Fig. 4).

A sandbag bed is utilized to stabilize the patient's position during the procedure. The arm extended to the opposite side of the tumor is prone to radial nerve paralysis owing to the pressure on the dorsal side of the upper arm caused by the hardened arm bed. Therefore, pressure on the arm is avoided by utilizing a cushion.

The bars of the tower retractor is positioned on both cranial sides; however, the tower bar on the opposite side of the tumor can only be placed between the lifted arm (cranial side) and the arm extended to the opposite side of the tumor (caudal side) (Fig. 4).

For pelvic floor tumors, the patient is placed in the lithotomy position with both hands extended. However, in laterally located tumors, slight rotation and fixation of the upper body toward the contralateral side of the tumor may facilitate tilting and elevate the tumor-bearing side, thereby improving access to the retroperitoneum.

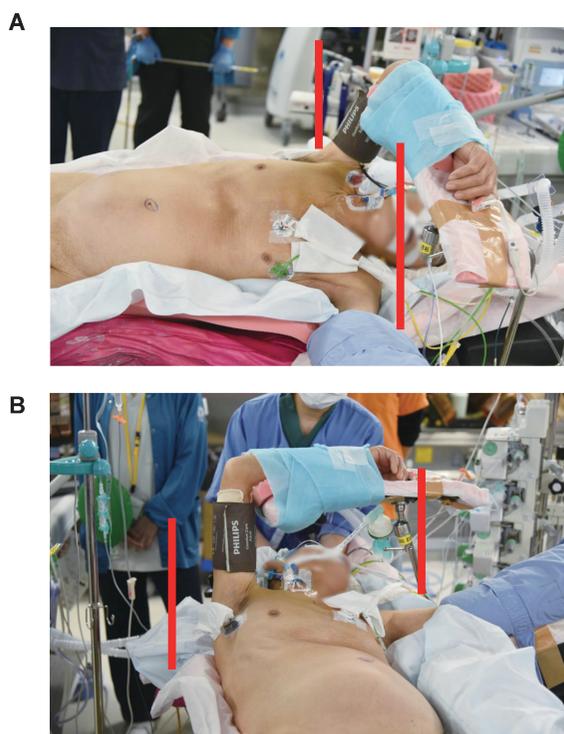


Fig. 4 Left-facing semilateral positioning for a large right-sided retroperitoneal sarcoma. The red bars indicate the expected points for the tower retractor (A and B).

Laparotomy

A large tumor is often challenging to resect through a midline incision alone. After creating a large midline incision from the xiphoid process to the pubic bone to locate the tumor, a transverse incision is then made on the tumor side. The site of the transverse incision varies depending on the tumor location; however, in general, the tumor is best viewed through an incision line made at the site where it bulges most ventrally. In cases that require a colostomy, the skin incision must avoid the expected site of the colostomy (judging whether it should be on the cranial or caudal side of the umbilicus). In large tumors, a transverse incision on the tumor side alone may not be sufficient; thus, a cross incision should be made on the opposite side (Fig. 5).

Some surgeons may employ a retroperitoneal approach to the tumor through a pararectal or lateral oblique incision. However, this incision is not recommended for large RPS because the feeding and drainage vessels usually arise from the lateral side of the vertebral body and appear at the bottom of the surgical field, and they are difficult to identify and dissect through this incision.

The xiphoid process is connected to the left and right rectus abdominis muscles with ligaments, so this part can be cut to the base of the process; the xiphoid process can be removed using a bone cutter. This procedure widens the costal angle and considerably improves the visibility of the upper abdomen (Fig. 6A).

After the laparotomy, the upper abdomen is opened with the tower retractor on both cranial sides. Furthermore, multiple retractors are used to widely open the entire abdominal cavity, and the surgical field necessary for tumor resection is secured (Fig. 6A). The pillar of the multiple retractors can be positioned on the opposite side of the tumor (caudally) to facilitate easier access for the operator. The skin on the foot side, created as a flap by the transverse incision

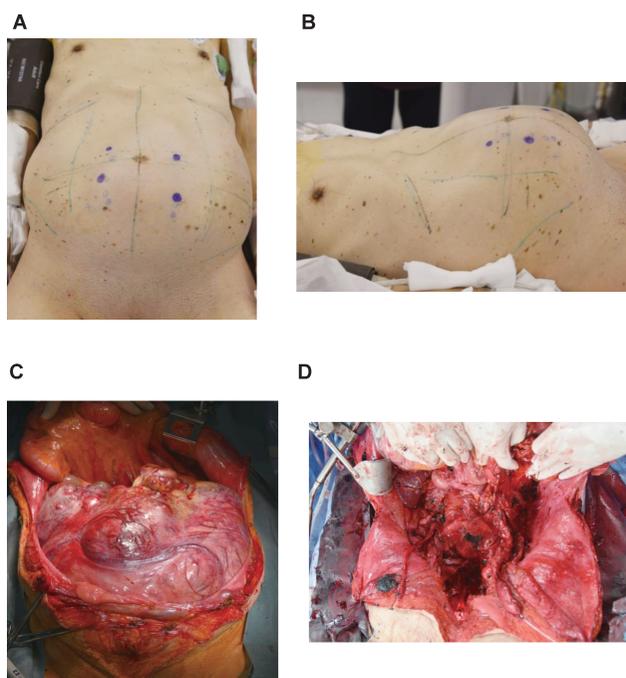


Fig. 5 A large undifferentiated pleomorphic sarcoma originating from the pelvic floor
The sites of the expected colostomy and ileostomy are marked with blue spots (A and B). After laparotomy by a cruciate incision (C). After tumor resection by total pelvic exenteration (D).

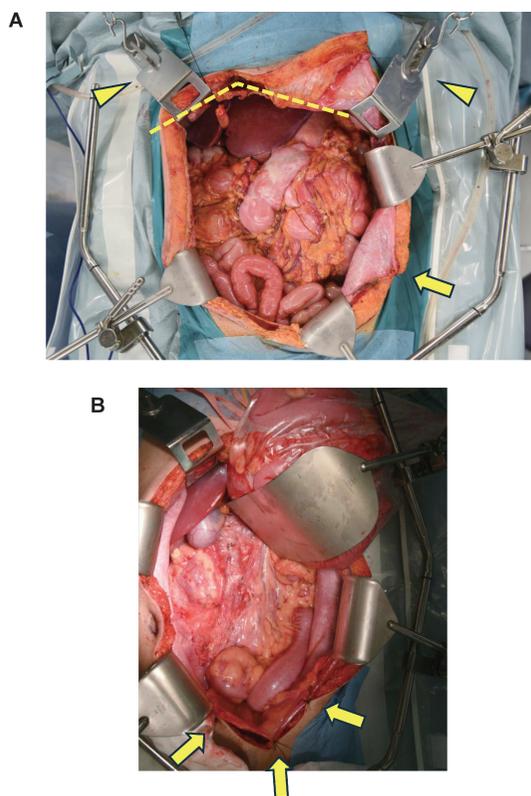


Fig. 6 Securing the surgical field using two tower bars (arrowheads) and multiple retractors (A) The xiphoid process is removed, and the costal angle (dashed line) is widened. The skin on the foot side, which has been made into a flap by the transverse incision, is inverted and sewn to the outer skin to prevent it from obstructing the field of view (arrow). (B) The peritoneum near the bladder is sewn to the skin at several places (arrows) to lift the bladder with the peritoneum and improve the visibility of the pelvic floor.

in the lower abdomen, is inverted and sewn to the outer skin to avoid obstructing the field of view (Fig. 6A).

For lower abdomen or pelvic floor tumors, the midline incision must be extended to the level of the pubic bone. The peritoneum near the bladder is sewn to the skin at multiple points, which elevates the bladder along with the peritoneum, improving the visibility of the pelvic floor (Fig. 6B).

Owing to the large size of the laparotomy wound, commercially available wound edge protectors are not suitable. Therefore, when performing intestinal resection, great care must be taken to avoid contaminating the incision wound with intestinal fluid. In addition, lengthy surgical procedures involving large laparotomy incisions can lead to significant body heat loss, increasing the risk of intraoperative hypothermia. Therefore, the temperature in the operating room should not be kept too low, and measures must be taken to minimize body heat loss.

Anesthesiologists should be fully aware of the risk of intraoperative hypothermia and be promptly notified when the patient's core body temperature drops $<35^{\circ}\text{C}$, allowing for the prompt initiation of countermeasures, such as covering exposed organs with warm towels, irrigating the abdominal cavity with warmed saline, or administering prewarmed intravenous fluids. Surgeons must also recognize that hypothermia not only affects cardiopulmonary function but also signifi-

cantly impairs coagulation and hemostatic function, thereby increasing the risk of intraoperative bleeding and postoperative complications.

RETROPERITONEAL MOBILIZATION

Retroperitoneal mobilization before tumor resection

Retroperitoneal tumor surgery begins with mobilizing the intestine to fully expose the tumor located in the retroperitoneum. The procedure is commonly performed as follows:

1. First, enter the cul-de-sac, cut the lesser omentum, and lift the stomach to the cranial side with tapes.

2. Mobilize the right hemicolon and separate the fusion between the colon and the duodenum until the right-side wall of the superior mesenteric vein (SMV) is visualized. Mobilize the pancreaticoduodenum until the IVC, left renal vein, abdominal aorta, and root of the superior mesenteric artery (SMA) and celiac axis can be seen from the right side.

3. Mobilize the right hemicolon further and continuously mobilize the small intestine mesentery to the ligament of Treitz. When dissection is performed along the correct anatomical planes, bleeding is unlikely to occur, as adhesions between the small intestinal mesentery and the retroperitoneum are typically minimal. The mobilized right hemicolon and total small intestine are then placed in a sterile plastic bag (so called “isolation bag”) and retracted cephalad to fully expose the retroperitoneum (Fig. 7). This provides an excellent view of the retroperitoneal cavity, and the SMV and SMA are retracted cephalad together with the isolation bag, so they may not be damaged during tumor dissection. The third and fourth parts of the duodenum are

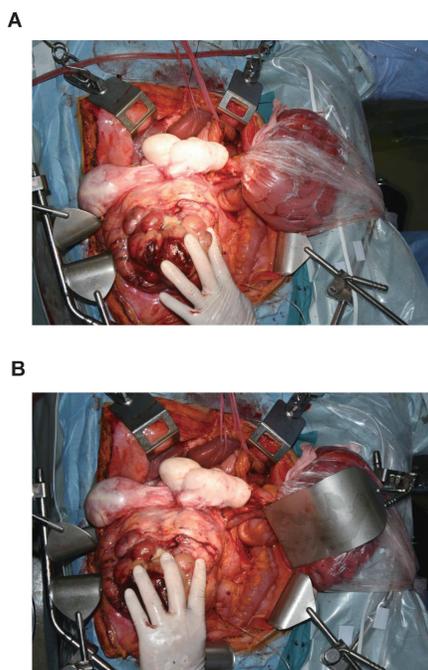


Fig. 7 Images taken after total retroperitoneal exposing mobilization

(A) The right hemicolon and all small intestines are placed in a sterile plastic bag (“isolation bag”). (B) The plastic bag is retracted to cephalad using a retractor.

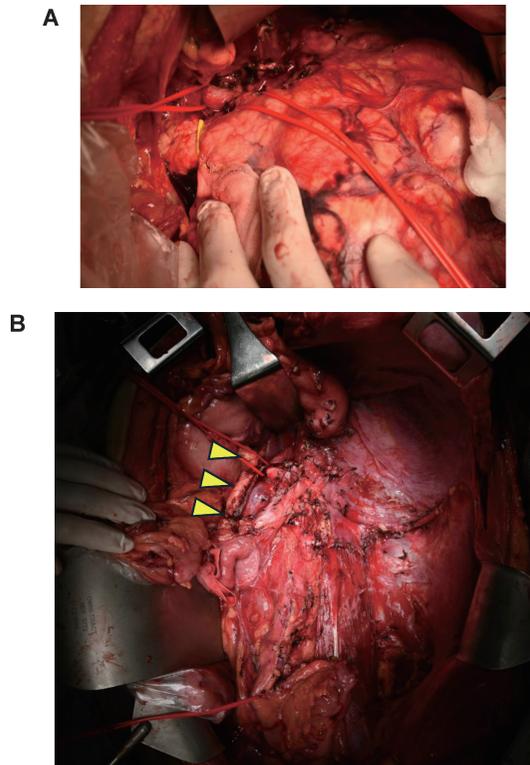


Fig. 8 A large left-sided dedifferentiated liposarcoma involving the pancreatic body and tail (A) The pancreatic body is encircled with a yellow tape at the expected resection line. (B) Image taken following tumor resection with distal pancreatectomy, splenectomy, left nephrectomy, and left hemicolectomy. The arrowheads indicate the resection stump of the pancreas.

also fully visible, facilitating easier dissection when the tumor is in contact with these areas.

This mobilization technique is commonly employed in surgeries for large RPS and is referred to as total retroperitoneal exposing mobilization (TREM). TREM facilitates wide exposure of the IVC and abdominal aorta, exposing the bifurcation of the left and right common iliac arteries and veins. Furthermore, the right testicular/ovarian vein and the right ureter can be easily taped. When taping the ureter, the adventitia of the ureter must be preserved, as complete skeletonization of the ureter leads to ischemia, which ultimately causes ureteral stricture after surgery.

4. Mobilize the left hemicolon as necessary. This procedure is also part of TREM and is important, particularly for left-sided RPS. In this case, the left hemicolon is completely mobilized from the splenic flexure. The mesentery of the left hemicolon and the inferior mesenteric artery are taped together using a cotton tape to facilitate dissection around the abdominal aorta. In addition, the left testicular/ovarian vein and the left ureter can be easily taped following full mobilization of the left hemicolon.

5. For tumors on the upper left side, the pancreatic body, tail, and spleen must be mobilized from the retroperitoneum. If a distal pancreatectomy is required, the pancreas, splenic artery, and splenic vein are taped and secured at the pancreatic resection line (Fig. 8). At this time, the lateral segment of the liver can be mobilized to the right as much as possible because it often obstructs the surgical field when dissecting around the pancreatic body and tail.

6. For right-sided tumors that extend deeply into the posterior side of the liver, the right lobe of the liver should be mobilized extensively. Depending on the tumor type (eg, leiomyosarcoma arising from the IVC or paraganglioma occurring between the IVC and the abdominal aorta), the IVC and caudate lobe may be completely separated. In such cases, the right and left liver lobes are fully mobilized, and the short hepatic veins between the caudate lobe and the IVC are dissected to separate them. In this manner, the liver remains attached only by the hepatoduodenal ligament and the hepatic veins, and the remainder of its attachments are fully mobilized. This technique is referred to as piggyback mobilization.^{7,8} This approach is often necessary when accessing tumors involving or adjacent to the IVC. However, all of the above-mentioned procedures may not be easy depending on the tumor location and extension.

When separating the IVC from the retroperitoneum, the lumbar veins should be isolated and detached from the retroperitoneum. In general, several lumbar veins exist upstream of the renal vein confluence. However, the number of lumbar veins decreased downstream of the renal vein confluence (the part of the caudate lobe attached to the IVC). An incidental damage to the lumbar vein causes massive bleeding, and hemostasis is generally challenging owing to its location on the dorsal side of the IVC. Therefore, surgeons should be very careful when manipulating these lumbar veins.

DISCUSSION

No standard procedure has been established for RPS surgery. Accordingly, the preparation for RPS surgery may vary depending on the tumor location and size and the type of organs/vessels involved. Many RPS cases require a multidisciplinary surgical approach, and surgeons in each department should thoroughly understand their roles during surgery. The detailed techniques of RPS surgery will be discussed in Part 2.

CONFLICT OF INTEREST DISCLOSURE

None reported.

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REFERENCES

- 1 Sassa N, Yokoyama Y, Nishida Y, et al. Clinical characteristics and surgical outcomes of retroperitoneal tumors: a comprehensive data collection from multiple departments. *Int J Clin Oncol.* 2020;25(5):929–936. doi:10.1007/s10147-020-01620-1
- 2 Swallow CJ, Strauss DC, Bonvalot S, et al. Management of Primary Retroperitoneal Sarcoma (RPS) in the adult: an updated consensus approach from the transatlantic australasian RPS working group. *Ann Surg Oncol.* 2021;28(12):7873–7888. doi:10.1245/s10434-021-09654-z
- 3 Caturegli I, Lilley EJ, Fairweather M, Wang J, Raut CP. Retroperitoneal Sarcoma (RPS): a systematic review. *Curr Oncol Rep.* 2025;27(7):856–870. doi:10.1007/s11912-025-01690-2

- 4 Tortorello GN, Li EH, Sharon CE, et al. Neoadjuvant chemotherapy in retroperitoneal sarcoma: a national cohort study. *Ann Surg Oncol*. 2023;30(11):6886–6893. doi:10.1245/s10434-023-13933-2
- 5 Nakajima K, Iwata H, Sudo S, et al. Spot scanning proton therapy for unresectable bulky retroperitoneal dedifferentiated liposarcoma: a case report. *Int Cancer Conf J*. 2024;13(2):171–176. doi:10.1007/s13691-024-00661-x
- 6 Callegaro D, Raut CP, Ajayi T, et al. Preoperative radiotherapy in patients with primary retroperitoneal sarcoma: EORTC-62092 trial (STRASS) versus off-trial (STREXIT) results. *Ann Surg*. 2023;278(1):127–134. doi:10.1097/SLA.0000000000005492
- 7 Ji ZG, Xue C, Li HZ, Wang HJ, Xie Y, Liu GH. Piggyback liver transplant techniques in the surgical management of urological tumors with inferior vena cava tumor thrombus. *Chin Med J (Engl)*. 2009;122(18):2155–2158. doi:10.3760/cma.j.issn.0366-6999.2009.18.015
- 8 Yano D, Yokoyama Y, Tokuda Y, et al. Multidisciplinary surgical approach for renal cell carcinoma with inferior vena cava tumor thrombus. *Surg Today*. 2022;52(7):1016–1022. doi:10.1007/s00595-021-02415-1